Journal of Medical Internet Research

Journal Impact Factor (JIF) (2023): 5.8
Volume 14 (2012), Issue 2 ISSN 1438-8871 Editor in Chief: Gunther Eysenbach, MD, MPH

Contents

Original Papers

The Influence of User Characteristics and a Periodic Email Prompt on Exposure to an Internet-Delivered Computer-Tailored Lifestyle Program (e40)
Francine Schneider, Liesbeth van Osch, Daniela Schulz, Stef Kremers, Hein de Vries. . . . 4

The Role of User Control in Adherence to and Knowledge Gained from a Website: Randomized Comparison Between a Tunneled Version and a Freedom-of-Choice Version (e45)
Rik Crutzen, Dianne Cyr, Nanne de Vries. . . . 52

Design of a Website on Nutrition and Physical Activity for Adolescents: Results From Formative Research (e59)
Debbe Thompson, Karen Cullen, Carol Boushey, Karen Konzelmann. . . . 62

Results from an Online Computer-Tailored Weight Management Intervention for Overweight Adults: Randomized Controlled Trial (e44)
Lenneke van Genugten, Pepijn van Empelen, Brigitte Boon, Gerard Borsboom, Tommy Visscher, Anke Oenema. . . . 77

Web-Based, Computer-Tailored, Pedometer-Based Physical Activity Advice: Development, Dissemination Through General Practice, Acceptability, and Preliminary Efficacy in a Randomized Controlled Trial (e53)
Katrien De Cocker, Heleen Spittaels, Greet Cardon, Ilse De Bourdeaudhuij, Corneel Vandelanotte. . . . 92

A 12-Week Commercial Web-Based Weight-Loss Program for Overweight and Obese Adults: Randomized Controlled Trial Comparing Basic Versus Enhanced Features (e57)
Clare Collins, Philip Morgan, Penelope Jones, Kate Fletcher, Julia Martin, Elroy Aguiar, Ashlee Lucas, Melinda Neve, Robin Callister. . . . 105

Internet-Based Computer Tailored Feedback on Sunscreen Use (e48)
Hein de Vries, Matti Logister, Gertruud Krekels, Frits Klaasse, Verina Servranckx, Liesbeth van Osch. . . . 120

Novel Technologies for Assessing Dietary Intake: Evaluating the Usability of a Mobile Telephone Food Record Among Adults and Adolescents (e58)
Bethany Daugherty, TusaRebecca Schap, Reynolette Ettienne-Gittens, Fengqing Zhu, Marc Bosch, Edward Delp, David Ebert, Deborah Kerr, Carol Boushey. . . . 132

Improving Adherence to Antiretroviral Therapy for Youth Living with HIV/AIDS: A Pilot Study Using Personalized, Interactive, Daily Text Message Reminders (e51)
Nadia Dowshen, Lisa Kuhns, Amy Johnson, Brian Holoyda, Robert Garofalo. . . . 144

XSL•FO
RenderX

Using Smartphone Technology to Monitor Physical Activity in the 10,000 Steps Program: A Matched Case–Control Trial (e55)
Morwenna Kirwan, Mitch Duncan, Corneel Vandelanotte, W Mummery. . . . 152

Online Doctor Reviews: Do They Track Surgeon Volume, a Proxy for Quality of Care? (e50)
Jeffrey Segal, Michael Sacopulos, Virgil Sheets, Irish Thurston, Kendra Brooks, Ryan Puccia. . . . 175

Internet-Based HIV and Sexually Transmitted Infection Testing in British Columbia, Canada: Opinions and Expectations of Prospective Clients (e41)
Travis Hottes, Janine Farrell, Mark Bondyra, Devon Haag, Jean Shoveller, Mark Gilbert. . . . 189

Validation of an Informant-Reported Web-Based Data Collection to Assess Dementia Symptoms (e42)
Kenneth Rockwood, An Zeng, Chris Leibman, Lisa Mucha, Arnold Mitnitski. . . . 200

Online Schools and Children With Special Health and Educational Needs: Comparison With Performance in Traditional Schools (e62)
Lindsay Thompson, Rick Ferdig, Erik Black. . . . 210

How is an Electronic Screening and Brief Intervention Tool on Alcohol Use Received in a Student Population? A Qualitative and Quantitative Evaluation (e56)
Jessica Fraeyman, Paul Van Royen, Bart Vriesacker, Leen De Mey, Guido Van Hal. . . . 219

Breakeven, Cost Benefit, Cost Effectiveness, and Willingness to Pay for Web-Based Versus Face-to-Face Education Delivery for Health Professionals (e47)
Stephen Maloney, Romi Haas, Jenny Keating, Elizabeth Molloy, Brian Jolly, Jane Sims, Prue Morgan, Terry Haines. . . . 231

A Conceptual Framework and Principles for Trusted Pervasive Health (e52)
Pekka Ruotsalainen, Bernd Blobel, Antto Seppälä, Hannu Sorvari, Pirkko Nykänen. . . . 247

Analysis of eHealth Search Perspectives Among Female College Students in the Health Professions Using Q Methodology (e60)
Michael Stellefson, Bruce Hanik, J. Chaney, Bethany Tennant. . . . 259

Health Care Professionals' Beliefs About Using Wiki-Based Reminders to Promote Best Practices in Trauma Care (e49)
Patrick Archambault, Andrea Bilodeau, Marie-Pierre Gagnon, Karine Aubin, André Lavoie, Jean Lapointe, Julien Poitras, Sylvain Croteau, Martin Pham-Dinh, France Légaré. . . . 274

Development of Web-Based Computer-Tailored Advice to Promote Physical Activity Among People Older Than 50 Years (e39)
Denise Peels, Maartje van Stralen, Catherine Bolman, Rianne Golsteijn, Hein de Vries, Aart Mudde, Lilian Lechner. . . . 296

Original papers

Initial and Sustained Participation in an Internet-delivered Long-term Worksite Health Promotion Program on Physical Activity and Nutrition (e43)
Suzan Robroek, Dennis Lindeboom, Alex Burdorf. . . . 18

Program Completion of a Web-Based Tailored Lifestyle Intervention for Adults: Differences between a Sequential and a Simultaneous Approach (e26)
Daniela Schulz, Francine Schneider, Hein de Vries, Liesbeth van Osch, Peter van Nierop, Stef Kremers. . . . 32

XSL•FO
RenderX

Viewpoint

Crowdsourced Health Research Studies: An Important Emerging Complement to Clinical Trials in the Public Health Research Ecosystem (e46)
Melanie Swan. 162

XSL•FO
RenderX

Original Paper

The Influence of User Characteristics and a Periodic Email Prompt on Exposure to an Internet-Delivered Computer-Tailored Lifestyle Program

Francine Schneider[1], MSc; Liesbeth van Osch[1], PhD; Daniela N Schulz[1], MSc; Stef PJ Kremers[2], PhD; Hein de Vries[1], PhD

[1]CAPHRI, Department of Health Promotion, Maastricht University, Maastricht, Netherlands

[2]NUTRIM, Department of Health Promotion, Maastricht University, Maastricht, Netherlands

Corresponding Author:
Francine Schneider, MSc
CAPHRI
Department of Health Promotion
Maastricht University
P O Box 616
Maastricht, 6200 MD
Netherlands
Phone: 31 43 388 2397
Fax: 31 43 367 1032
Email: francine.schneider@maastrichtuniversity.nl

Abstract

Background: The Internet is a promising medium in the field of health promotion for offering tailored and targeted lifestyle interventions applying computer-tailored (CT) techniques to the general public. Actual exposure to CT interventions is not living up to its high expectations, as only a (limited) proportion of the target group is actually using these programs.

Objective: To investigate exposure to an Internet-delivered, CT lifestyle intervention, targeting physical activity, fruit and vegetable intake, smoking behavior, and alcohol intake, we focused on three processes: first use, prolonged use, and sustained use. The first objectives were to identify user characteristics that predict initiation of an online CT lifestyle program (first use) and completion of this program (prolonged use). Furthermore, we studied the effect of using a proactive strategy, consisting of periodic email prompts, on program revisits (sustained use).

Methods: The research population for this study consisted of Dutch adults participating in the Adult Health Monitor, offered by the regional public health services. We used a randomized controlled trial design to assess predictors of first use, prolonged use, and sustained use. Demographics and behavioral characteristics, as well as the strategy used for revisiting, were included as predictors in the model.

Results: A total of 9169 participants indicated their interest in the new program and 5168 actually logged in to the program. Participants significantly more likely to initiate one of the CT modules were male, older, and employed, and had a lower income, higher body mass index, and relatively unhealthy lifestyle. Participants significantly more likely to complete one of the CT modules were older and had a higher income and a relatively healthier lifestyle. Finally, using a proactive strategy influenced sustained use, with people from the prompting condition being more likely to revisit the program (odds ratio 28.92, 95% confidence interval 10.65–78.52; $P < .001$).

Conclusions: Older, male, and employed participants, and those with a lower income, higher body mass index, and a relatively unhealthy lifestyle were more likely to initiate a CT module. Module completers predominantly had a higher income and age. The current program therefore succeeded in reaching those people who benefit most from online lifestyle interventions. However, these people tended to disengage from the program. This underlines the importance of additional research into program adjustments and strategies that can be used to stimulate prolonged program use. Furthermore, sending periodic email prompts significantly increased revisits to the program. Though promising, this effect was modest and needs to be further examined, in order to maximize the potential of periodic email prompting.

XSL•FO
RenderX

Trial Registration: Nederlands Trial Register (NTR: 1786) and Medical Ethics Committee of Maastricht University and the University Hospital Maastricht (NL2723506809/MEC0903016); http://www.trialregister.nl/trialreg/admin/rctview.asp?TC=1786 (Archived by WebCite at http://www.webcitation.org/65hBXA6V7)

(J Med Internet Res 2012;14(2):e40) doi:10.2196/jmir.1939

KEYWORDS

Internet interventions; computer tailoring; lifestyle; behavior change; program use; user characteristics; diffusion; proactive strategy; prompts

Introduction

With a substantial number of people accessing the Internet in search of health-related information [1,2], the Internet has developed into a popular medium for offering a broad range of specific health information, such as information on health and illness, details on treatment-related issues, and information on health promotion practices, such as programs that offer information and advice on lifestyle behaviors [3]. Since Internet penetration rates are still expanding, with almost two billion people having access to the Internet [4], the number of health-related searches is also expected to increase. The Internet is therefore considered to be a promising medium in the field of health promotion for offering tailored and targeted promotion programs to the general public [4-7]. As online health-promoting applications provide many opportunities for interactivity, they are particularly suited for implementing interventions that offer immediate feedback and advice to users. In particular, lifestyle interventions applying computer-tailored (CT) techniques [5,6,8], addressing health behaviors such as physical activity [9,10], fruit and vegetable intake [11,12], smoking cessation [13-16], and alcohol consumption [17,18] have been shown to have positive effects on health behavior.

Despite these promising prospects, actual exposure to CT interventions is not living up to the high expectations [19-23], as only a (limited) proportion of the target group actually uses these programs [21]. Earlier studies defined exposure as pertaining to three different aspects: accessing the intervention (first use), engaging in the intervention content for a substantial period of time (prolonged use), and revisiting the intervention (sustained use) [19]. The level of first-time use of online interventions is generally low, with only small proportions of the potential target population actually accessing the intervention [19,24,25]. Levels of actual engagement in the intervention and of revisits to the intervention are even lower [26]. Since health behavior change is a complex process, actual change requires prolonged and sustained commitment to the program to enable optimal support during the change process. Intensive engagement in an intervention session allows processing of the intervention content and involvement in its effective components and is therefore essential [22,27,28]. Furthermore, a specific number of repeated visits to an intervention may be imperative, as, due to a high dose–response relation [29,30], sustained use of the program is essential to further maximize its effect on subsequent health behavior change [31,32].

To increase adoption rates of online interventions, it is imperative to obtain detailed profiles of those who successfully adopt an intervention [24,25]. By closely studying characteristics of these first-time users and mapping how they use and reuse the intervention, detailed knowledge can be acquired on intervention adopters. It is important to reach those people most in need of online lifestyle interventions—that is, the people who engage in risky behaviors such as smoking, excessive alcohol use, lack of physical activity, or unhealthy eating patterns. Even though unhealthy lifestyle behaviors are prevalent among the whole population [33,34], studies have shown that those who have a lower income and educational level (ie, a low socioeconomic status) are generally more inclined to have an unhealthy lifestyle [34,35]. Furthermore, even though Internet access rates are increasing among people with a lower socioeconomic status [35], their actual exposure to Internet interventions is lagging [36-39]. Besides socioeconomic status, other user characteristics are reported to have an influence on adoption of online interventions. Previous studies have pointed out that Internet interventions tend to reach women [40-43] and older people [44]. It is important to gain more insight into characteristics of people who are being reached by the program, but also of people who are left unexposed to the program. These insights can be used to acquire knowledge on the development of further steps to improve exposure to the program.

Besides focusing on first use of the program, it is also imperative to optimize prolonged use of the program and to study related determinants. Previous studies indicated that tailoring in itself is a strategy to prevent early disengagement from online behavior change programs [28,45,46]. Furthermore, specific user characteristics such as age, gender, and level of education are related to level of program engagement [28,30,40], with women, older people, and those who are more highly educated displaying higher levels of program engagement. Since engagement in the program is an important predictor of revisits to the program [46], it is important to map how the program is used and to study determinants of prolonged program use. This obtained knowledge can be used to make specific program adjustments, or to develop specific strategies that can be used to enhance prolonged use of the program.

Online interventions are often offered reactively to the public, implying that a passive approach is used, in which users themselves must act in order to repeatedly benefit from the intervention [47]. However, since attaining visitors' loyalty to an intervention over an extended period of time is a very strenuous process [22,23,30], efforts should be put into ensuring sustained use by employing more proactive strategies [27]. The use of periodic email prompts has been proposed as an effective proactive strategy to boost revisits to interventions aimed at stimulating a healthy lifestyle [48]. However, most studies merely explored the effectiveness and efficacy of the whole

XSL•FO
RenderX

intervention, instead of focusing on the added value of periodic prompting as a separate intervention component. As a consequence, there is too little evidence on the absolute effectiveness of sending periodic prompts.

In the present study, we aimed at answering three questions. First, which user characteristics predict initiation of an online CT program (first use)? Second, which user characteristics predict completion of the online CT program (prolonged use)? Third, what is the effect of using a proactive strategy, consisting of periodic email prompts, on program revisits (sustained use)? We addressed these questions among participants in an online CT intervention aimed at multiple health behaviors: physical activity, fruit and vegetable intake, smoking cessation, and alcohol consumption.

Methods

In this randomized controlled trial (RCT) we compared the effect on program revisit of a proactive technique applying a periodic email prompt versus the use of a reactive approach. Levels of use and reuse of the program within a 4-month period were studied and linked to specific user characteristics. The current RCT was part of a larger RCT testing the effect of the CT program compared with a control group [49]. Only people allocated to the study arm receiving computer tailoring of the larger RCT were included in the current RCT. This study was approved by the Medical Ethics Committee of Maastricht University and the University Hospital Maastricht (NL27235.068.09/MEC 09-3-016) and is described in more detail elsewhere [49,50].

The research population for this study consisted of Dutch adults of the provinces of Zeeland and North-Brabant, which participated in the Adult Health Monitor 2009 [51]. This Monitor is used by all regional public health services and takes place every 4 years. It serves as a monitoring tool to assess the overall level of health in the Dutch population by approaching a representative sample of the population to fill out a questionnaire assessing different aspects of general health (eg, physical and mental health) and health-related topics (eg, social and physical environment). Participants had the opportunity to complete a written or an online version of this monitoring questionnaire. The CT program was embedded in the online version and was offered as an additional service to online respondents. Data for the present study were collected from November 2009 to August 2010.

Procedure and Respondents

After completing the online version of the Adult Health Monitor, all participants were introduced to the program and were offered the opportunity to receive, free of charge, CT feedback about their current health behaviors, such as physical activity, fruit and vegetable intake, alcohol consumption, and smoking. This program consisted of several modules, one per behavior, which incorporated questionnaire items and provided feedback on several sociocognitive determinants of each health behavior. The content of the program modules was based on programs that have been proven to be effective in RCTs for increasing smoking cessation, promoting the intake of fruit and vegetables, increasing the level of physical activity, and reducing the consumption of alcohol [17,51-54].

Participants who were interested in the new program were asked to leave their email addresses. They received an email including an invitation to log in to the CT program with a personal log-in code and password, approximately 3 weeks after completion of the Monitor. By logging in to the program, participants received detailed information on the content and purpose of the study. Subsequently, data on demographics and the five health behaviors obtained through the Monitor were transported to the CT program, resulting in a personal overview of individuals' current health behavior status. If respondents were not adhering to the Dutch public health guidelines set for these behaviors, a module generating CT health advice for changing behavior was available for each health behavior.

During a 4-month period after the baseline visit, we monitored use of the intervention. People in the prompting condition were prompted proactively via email 3 months after their baseline visit to revisit the CT program. Revisits to the program were stimulated to provide participants with the opportunity to monitor their own behavior. During a revisit participants could log in to the program and complete the health risk appraisal questionnaire. Based on their answers, a new personal health overview was composed entailing information on their current health behavior status, as well as on their status during all previous visits. Improvements, deteriorations, or stability of health behaviors were graphically presented. People in the no-prompting condition did not receive any additional prompts and were encouraged only at baseline to revisit the program. Reactions to this email prompt were monitored during a 1-month period.

Randomization

All included participants were randomly allocated to a prompting condition (receiving additional email prompts) or a no-prompting condition (receiving no additional email prompts). We used a computer software randomization device to determine random allocations at the respondent level.

Content

CT Program

The CT program used a dual approach to guide people toward behavior change. The first part consisted of a health risk appraisal and was aimed at increasing participants' *awareness* of their health behavior status, by comparing their status to the Dutch public health guidelines set for these health behaviors (ie, being moderately physically active for 30 minutes at least 5 days a week, eating two pieces of fruit per day, eating 200 g of vegetables per day, not drinking more than one [women] or two [men] glasses of alcohol a day, and not smoking). In this health risk appraisal, feedback messages were used to inform people of their status for each health behavior and to provide them with additional information on the content of the separate guidelines. These feedback messages were complemented by using graphic representations of traffic lights [55], with a green light corresponding to adherence to the guidelines and a red light corresponding to nonadherence. An amber light was used for people who were close to adherence to these guidelines. In

XSL•FO
RenderX

case of discrepancies between current behavior and the guidelines, people were alerted and directed to the CT modules.

Second, assistance was provided in *changing* participants' health *behavior* by offering five separate CT modules. The content of these modules was based on the Integrated Model for exploring motivational and behavioral change (I-Change Model) [56]. The modules used a fixed, gradual approach consisting of four steps, guiding people toward behavior change. The first step addressed the pros and cons of engaging in the desired behavior under consideration. The second step focused on the role of significant persons in the direct environment and strategies on how to deal with lack of support and bad role models. The final two steps used planning strategies and were aimed at helping people form preparatory plans to start changing their behavior (step 3) and coping plans to help them overcome difficult situations and prevent relapse (step 4) after changing their behavior. Within the modules, all health advice was adapted to individuals' characteristics by considering demographic, behavioral, and cognitive characteristics [57-59]. Demographic and behavioral characteristics, such as participants' gender and health behavior status, were directly obtained through the Adult Health Monitor. Cognitive variables, such as attitude, perceived social influence, self-efficacy, intention, and planning strategies (action plans and coping plans), were assessed by using an additional tailoring questionnaire.

The CT modules were embedded in a website (http://www.mijngezondgedrag.nl/) that was especially designed for the current project. This website contained general information considering a healthy lifestyle and the selected health behaviors. Furthermore, the website provided specific information regarding the project, a direct link to the CT program, and information on frequently asked questions. During the study, new information (eg, advice-supporting messages, recipes, and facts) was structurally added to the website.

Email Prompt

Participants in the prompting condition received an email 3 months after their baseline visit, prompting them to revisit the program. This email opened with a personalized greeting and reminded people about their first visit to the program. Subsequently, people were invited to revisit the program to obtain information on their health status and to monitor their progress. Participants were also informed of the opportunity to receive additional, iterative health advice on the health behavior(s) selected at baseline or on a new behavior. Finally, to facilitate logging in to the program, the email also contained details on personal log-in information (user name and password). The email concluded with greetings from the research team and contact information.

Measures

We collected user characteristics to produce a detailed user profile including information on personal characteristics, health behavior status, and intention to change their health behaviors.

Personal Characteristics

Questions pertaining to personal characteristics included questions on age, gender, educational level, personal net monthly income, work situation, marital status, and native country (Table 1).

XSL•FO
RenderX

Table 1. Characteristics of visitors to an online computer-tailored lifestyle program (n = 3448).

Demographic characteristic	Data
Age (years)	
Range	19–64
Mean (SD)	43.61 (12.60)
Gender, n (%)	
Male	1822 (52.8%)
Female	1626 (47.2%)
Education level, n (%)	
Low	744 (21.6%)
Medium	1188 (34.45%)
High	1452 (42.11%)
Unknown	64 (2%)
Personal net monthly income (€), n (%)	
<1000	223 (6.5%)
1001–1350	227 (6.6%)
1351–1750	367 (10.6%)
1751–3050	1174 (34.05%)
>3051	966 (28.0%)
Unknown	491 (14.2%)
Employment, n (%)	
Employed	2614 (75.8%)
Unemployed	662 (19.2%)
Unknown	172 (5.0%)
Marital status, n (%)	
Married	2089 (60.6%)
Living together	526 (15.3%)
Unmarried	635 (18.4%)
Divorced	170 (4.9%)
Widowed	28 (0.8%)
Native country, n (%)	
The Netherlands	3277 (95.0%)
Other	171 (5.0%)
Body mass index (kg/m2), n (%)	
<18.5	57 (1.7%)
≥18.5 to <25	1795 (52.1%)
≥25 to <30	1240 (36.0%)
≥30	356 (10.2%)
Behavioral characteristic, n (%)	
Physical activity	
Compliant	2939 (85.2%)
Noncompliant	509 (14.8%)
Vegetable consumption	
Compliant	1121 (32.5%)

XSL•FO
RenderX

Demographic characteristic	Data
Noncompliant	2327 (67.5%)
Fruit consumption	
Compliant	1552 (45.0%)
Noncompliant	1896 (55.0%)
Smoking behavior	
Compliant	2790 (80.9%)
Noncompliant	658 (19.1%)
Alcohol intake	
Compliant	2467 (71.5%)
Noncompliant	981 (28.5%)
Number of guidelines complied with, n (%)	
0	25 (0%)
1	203 (5.9%)
2	677 (19.6%)
3	1235 (35.82%)
4	936 (27.1%)
5	372 (10.8%)

Health Behavior Status

Health behavior status consisted of information regarding the five key behaviors. Physical activity was measured by the Short Questionnaire to Assess Health-Enhancing Physical Activity [60], and guideline adherence was calculated following procedures used by Ainsworth et al [61]. Fruit consumption was measured by using a 4-item food frequency questionnaire assessing weekly fruit and fruit juice intake [62], and vegetable consumption was measured using a 4-item food frequency questionnaire assessing the weekly amount of consumed boiled or baked vegetables as well as salad or raw vegetables [62]. The consumption of alcohol was measured by the Dutch Quantity-Frequency-Variability Questionnaire [63]. And finally, smoking status was assessed by asking participants whether they smoked, what they smoked (cigarettes, cigars, packets of pipe tobacco) and how much they smoked per day (cigarettes) and per week (cigars or packets pipe tobacco).

Body Mass Index

Data on participants' height (in centimeters) and weight (in kilograms) were used to calculate their body mass index (BMI). BMI is a heuristic used to estimate the level of body fat, and it is defined by dividing a participant's body weight by the square of the participant's height.

Intention to Change

Intention to change a health behavior was measured by means of 1 item using an algorithm consisting of 10 stages varying from unawareness to action. This variable was recoded in accordance with an adjusted version of the stages of change concept: immotivation (1), precontemplation (2), contemplation (3), preparation (4), and action (5) [64].

Program Evaluation

After completion of each single module, visitors were asked to evaluate the module by providing an overall grade (1 to 10).

Outcomes

To measure first use of the program, we created a dichotomous variable based on program monitoring data, indicating whether participants initiated a module. Initiating a module was labeled as yes when people filled out the first question of this module. To measure prolonged use, we created a new dichotomous variable to indicate whether participants finished a module. Completion of a module was labeled as yes when people also filled out the final question of the module.

To establish sustained use of the program, we created another dichotomous variable, indicating whether participants logged in to the program after baseline. Revisiting of the program was measured by comparing the dates of log-in with the baseline date.

Statistical Analysis

First, we used general descriptive statistics to describe personal characteristics of the participants, as well as the main findings concerning current health behavior adherence to the public health guidelines. Second, logistic regression analyses were conducted. Initiation of a module and completion of a module (0 = no/1 = yes) were the dependent variables. Demographics (age, gender, marital status, native country, educational level, work status, and income), BMI, and health behavior status were included in the model as predictors of initiation. We included the same variables, with addition of intention (measured at the beginning of each CT module), in the model as predictors of completion. Logistic regression analysis was conducted with revisiting of the program (0 = no/1 = yes) as the dependent

XSL•FO
RenderX

variable. The same demographics, as well as study condition, program evaluation, and initiation and completion of a module, were included in the model as predictors of revisiting of the program. All statistical analyses were done in SPSS version 7.0 (IBM Corporation, Somers, NY, USA).

Results

Site Visitors' Baseline Characteristics

In total, 3448 people were allocated to the study arm receiving computer tailoring of the larger RCT and were included in the current RCT. Of all participants, with a mean age of 44 (SD 12.60) years, a little more than half were men, and most had a medium to high education level and an average to high monthly income (Table 1). Three-quarters of all participants were employed and more than half were married. Approximately 2% (57/3448) of all visitors were underweight, whereas more than half had a normal weight. One-third of visitors were slightly overweight and 10.3% (356/3448) were obese. A randomization check revealed no significant differences between respondents in the prompting and no-prompting condition.

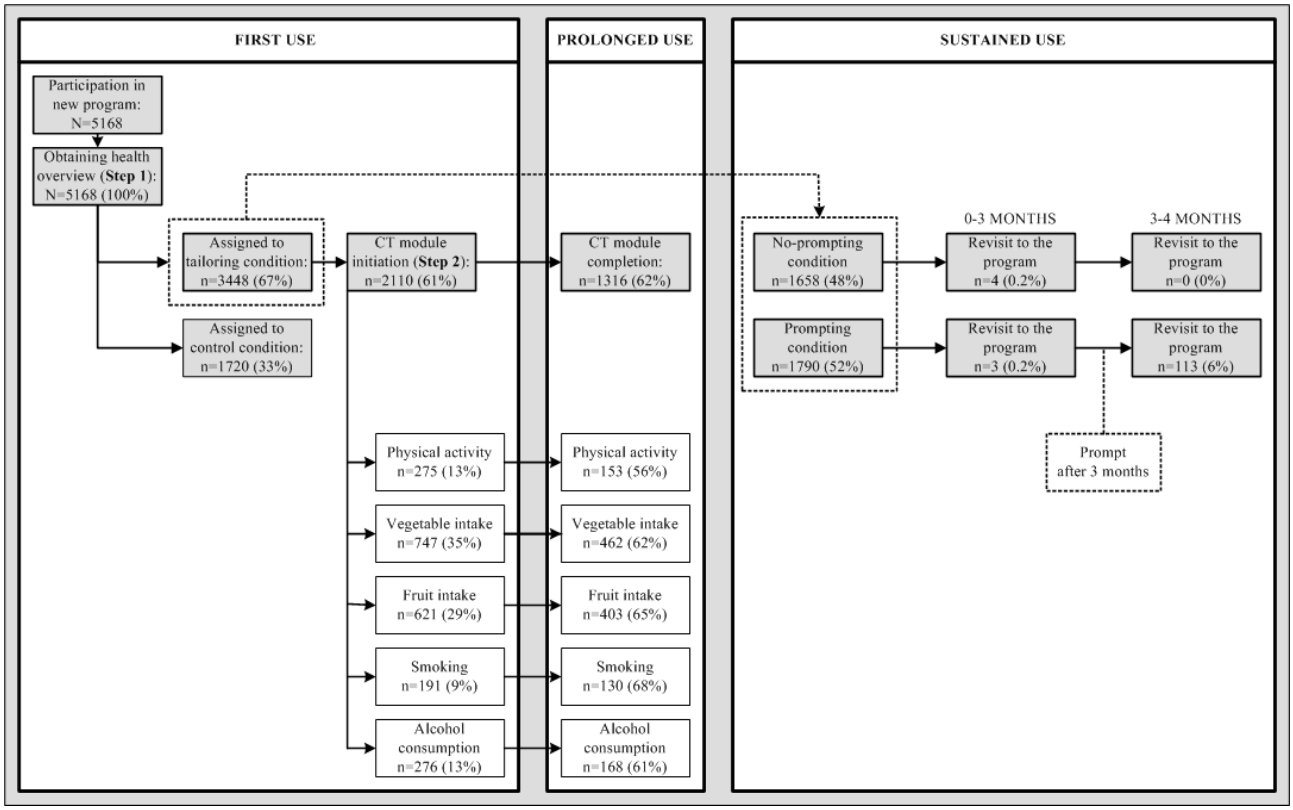
Regarding the five health behaviors included in the program, 14.8% (509/3448) did not comply with the Dutch guidelines of at least 30 minutes of moderately intensive physical activity at least 5 days a week. With regard to fruit and vegetable intake, respectively 54.99% (1896/3448) and 67.49% (2327/3448) were not adhering to the Dutch guidelines of at least two pieces of fruit and at least 200 g of vegetables each day. About one in five visitors indicated to smoke 19.1% (658/3448), and a little more than a quarter (981/3448, 28.5%) did not comply with the Dutch guidelines for alcohol intake.

First Use of the Program

CT Module Initiation

A total of 1338 participants (38.81%) did not participate in the second part of the program, leaving after receiving their personal health overview. The remaining 2110 visitors (61.19%) decided to obtain CT lifestyle advice by initiating one of the five behavioral modules. Of all the visitors who decided to obtain personalized health advice, 13.0% (n = 275) initiated the physical activity module, 35.4% (n = 747) and 29.4% (n = 621) initiated the vegetable and fruit modules, respectively, 9.1% (n = 191) initiated the smoking module, and 13.1% (n = 276) initiated the alcohol module (Figure 1).

Figure 1. Flowchart exposure to CT program: first use, prolonged use and sustained use.



Predictors of CT Module Initiation

Results of multiple logistic regression analyses indicated that male, older, and employed participants, and those with a lower income and a higher BMI were more likely to initiate one of the CT modules (Table 2). Initiation of a CT module was related to the total number of guidelines people adhered to: those with a relatively unhealthy lifestyle (fewer guidelines complied with) were more likely to initiate one of the CT modules (odds ratio [OR] 0.84, 95% confidence interval [CI] 0.77–0.90; $P < .001$).

XSL•FO
RenderX

Table 2. Results of multivariate logistic regression analyses of demographic characteristics, behavioral characteristic, and intention, with initiating a behavioral computer-tailored module as dependent variable (n = 3448).

Characteristic	Initiation of a behavior change module		
	OR[a]	*P* value	95% CI[b]
Demographic characteristics			
Age	1.35*	0.00	1.22–1.49
Gender			
Female (reference)	1.00		
Male	1.38*	0.00	1.16–1.64
Education level			
High (reference)	1.00		
Low	1.07	0.59	0.83–1.38
Medium	1.11	0.31	0.91–1.34
Income	0.46*	0.00	0.42–0.52
Employment			
Unemployed (reference)	1.00		
Employed	1.16*	0.03	1.01–1.33
Marital status			
Not in a relationship (reference)	1.00		
In a relationship	1.00	1.00	0.79–1.28
Native country			
Other (reference)	1.00		
The Netherlands	1.38	0.12	0.92–2.07
Body mass index	1.03*	0.02	1.01–1.05
Behavioral characteristic			
Number of guidelines complied with	0.84*	0.00	0.77–0.90

[a] Odds ratio.

[b] Confidence interval.

*Significant association ($P < .05$).

Prolonged Use of the CT Program

CT Module Completion

Of all the visitors who initiated one of the CT modules to obtain personalized health advice (n = 2110), 62.37% completed a module (n = 1316). A total of 153 of 275 visitors completed the physical activity module (55.6%), 462/747 (61.9%) and 403/621 (64.9%) completed the vegetable and fruit modules, respectively, 130/191 (68.1%) completed the smoking module, and 168/276 (60.9%) completed the alcohol module (Figure 1). All modules were evaluated by visitors upon completion. The physical activity module was graded 7.09 (SD 1.41), vegetable consumption 7.45 (SD 1.02), fruit consumption 7.33 (SD 1.29), smoking 7.35 (SD 1.11), and alcohol consumption 7.39 (SD 1.11).

Predictors of CT Module Completion

Results of multiple logistic regression analyses indicated that older participants and participants with a higher income were more likely to complete one of the CT modules (Table 3). Participants with a relatively healthy lifestyle (complying with more guidelines) were also more likely to complete one of the CT modules.

XSL•FO
RenderX

Table 3. Results of multivariate logistic regression analyses of demographic characteristics, behavioral characteristic, and intention, with completion of a behavioral computer-tailored module as dependent variable (n = 2110).

Characteristic	Completion of a behavior change module		
	OR[a]	*P* value	95% CI[b]
Demographic characteristics			
Age	1.49*	0.00	1.33–1.67
Gender			
Female (reference)	1.00		
Male	1.05	0.63	0.86–1.29
Education level			
High (reference)	1.00		
Low	1.06	0.67	0.80–1.41
Medium	1.02	0.89	0.81–1.28
Income	1.30*	0.00	1.17–1.45
Employment			
Unemployed (reference)	1.00		
Employed	0.90	0.12	0.78–1.03
Marital status			
Not in a relationship (reference)	1.00		
In a relationship	0.89	0.38	0.68–1.16
Native country			
Other (reference)	1.00		
The Netherlands	0.87	0.54	0.57–1.34
Body mass index	1.00	0.94	0.97–1.03
Sociocognitive characteristic			
Intention			
Action (reference)	1.00		
Immotivation	1.03	0.85	0.77–1.37
Precontemplation	1.34	0.41	0.67–2.72
Contemplation	0.94	0.77	0.62–1.42
Preparation	1.03	0.83	0.78–1.36
Behavioral characteristic			
Number of guideline complied with	1.28*	0.02	1.02–1.24

[a] Odds ratio.

[b] Confidence interval.

[c] Coded as 0 (no compliance) or 1 (compliance).

*Significant association ($P < .05$).

Sustained Use of the CT Program

Additional emails prompting a revisit to the program were sent to 51.91% of all participants (n = 1790), while 48.09% (n = 1658) did not receive an additional reminder. In total, 3.5% (n = 120) of all visitors decided to revisit the program within a 4-month period after baseline. Among those in the prompting condition, 0.2% (n = 3) revisited the program within the first 3 months (*before* receiving an additional reminder). A total of 113 participants (6.3%) reacted to the email prompt after 3 months and revisited the program. This number was significantly higher than in the no-prompting condition that received no additional reminder (n = 0, 0.0%; OR 28.92, CI 10.65–78.52; $P < .001$).

Since the number of people from the control condition who revisited the program was extremely low (n = 4), we conducted additional analyses on predictors of revisiting solely within the experimental condition. Univariate logistic regression analyses revealed that completion of a behavior change module significantly predicted revisiting the program (OR 2.58, CI

XSL•FO
RenderX

1.57–4.26; $P < .001$). However, after multivariate analyses, including all predictors, this effect became nonsignificant.

Discussion

The current study aimed at investigating the level of exposure to a CT online lifestyle program integrated into the Dutch Adult Health Monitor. We addressed user characteristics that predicted initiation (first use) and completion (prolonged use) of the CT program and tested a proactive strategy using periodic email prompts to enhance revisits to the program (sustained use).

First Use

Since people with a lower income and educational level are generally more inclined to have an unhealthy lifestyle [36,65], the current program aimed at reaching especially those people in need of lifestyle improvement. However, in line with previous studies, the majority of participants in our sample had a medium to high educational level, an average income, and a relatively healthy lifestyle [36-39]. Even though integrating the CT program into the Monitor environment provided an access point for reaching a substantial proportion of the research population through tailored lifestyle advice, it did not succeed in predominantly reaching the people who benefit most from CT interventions.

However, taking a closer look at CT module initiation reveals that initiators were significantly older, and likelier to be male, employed, and to have a lower income. Furthermore, participants with a higher BMI and an unhealthier lifestyle were more likely to start with one of the CT modules. Whereas the findings concerning age and gender are largely comparable with those of earlier studies [28,30,38,40], the present results are in contrast to previous findings that online health promotion programs tend to be used predominantly by people with a high socioeconomic status and healthy lifestyle [28,30,38,40].

The results imply that the current program succeeded in stimulating those people who are expected to benefit most from lifestyle interventions (ie, the people who engage in risky behaviors, but also people from specific risk groups such as older people and obese people) to initiate one of the CT modules. Embedding the CT program in an existing context, the Adult Health Monitor, may account for these findings. The main objective of the Monitor is to assess different aspects of general health and health-related topics, such as curative care, environment and everyday surroundings, social environment, social safety and violence and nursing and care. Due to this simple focus on assessment and not on health behavior change, participation may have been appealing to participants who are not primarily interested in behavior change. However, direct transportation of data from the Monitor to the CT program database allowed for the immediate and effortless composition of a personal health overview. Subsequently, this overview may have increased awareness of people's lifestyle status and might have served as a cue to action to change their lifestyle, explaining the increased interest in the CT modules, among the unhealthy and low-socioeconomic status participants.

Prolonged Use

Even though the CT program succeeded in attracting people with a relatively unhealthy lifestyle and low-socioeconomic status people to initiate one of the CT modules, it fell short in actually engaging these visitors, since module completers predominantly had a higher income, which is in line with previous studies [28,30,38,40]. The suboptimal level of interactivity within the CT program might account for these findings. Interactivity has been defined as the degree of 2-way interaction that is provided in the program [66,67], providing options for either immediate feedback or reciprocal interaction. Even though the program provided immediate feedback consisting of personalized health information, it did not provide communication features such as email contact and a discussion board, or features such as videos and games [68].

Effort should therefore be put into adjusting program components and content to the needs and wishes of this target group and into developing strategies to keep low-socioeconomic status participants engaged in the program.

Sustained Use

Our results from the current study indicate that prompting visitors to revisit the CT program is an effective strategy to enhance sustained use. However, the effect was limited, with only small percentages of people actually responding to the prompt. Replicating this study is therefore desirable. A possible explanation for these results might be the level of tailoring in the prompt. Although the content of the prompt was tailored to user characteristics, the level of personalization may have been too low, making the prompt less appealing and relevant. Furthermore, since the first prompt was sent after 3 months, people may have forgotten about the program and their participation in it.

The added value of the email prompts used in the present study could be further augmented. Several studies have suggested that the effect of email prompts increases if they alert people to new content that is provided on the program website [69] and if they provide information that is perceived as personally relevant [48,70]. Furthermore, the time of week when prompts are sent influences their effect, with prompts being sent at the beginning of the week being more effective [70].

Since email is a very popular online function used by substantial number of Internet users [71], it is a promising tool to attract people to health-promoting interventions. However, a potential downside of its popularity is the frequent use of email for marketing purposes. Due to the increase in email advertisements, or spam, dissatisfaction among email users is increasing [71] and emails are often neglected or deleted before being read. Future studies should therefore aim at developing prompt content that attracts receivers' attention amidst a plethora of emails sent for marketing purposes. Furthermore, the optimal frequency at which prompts are delivered should be studied to yield further knowledge on future refinements and to maximize their potential.

XSL•FO
RenderX

Strengths and Limitations

This study focused on exposure to an online CT lifestyle program by mapping characteristics of first-time users, examining predictors of first, prolonged and sustained use and by testing the efficacy of a proactive strategy to increase sustained use of the program. Even though several studies have highlighted the added value of periodic email prompts [48], this study is one of the few to focus on the added value of periodic prompting by testing its effect in a randomized control trial.

However, this study is liable to several limitations that need to be accounted for when interpreting the results. First, we used one generic email to prompt revisits to the CT program. Future research should thoroughly study the optimal content of prompts, in order to make them stand out amidst advertisement emails and spam, and to make them more personally relevant and persuasive. Principles used in the field of e-marketing and e-commerce might provide essential information on specific strategies to increase the attractiveness of email prompts.

Finally, even though this study provides evidence for the effectiveness of prompts in enhancing program revisits, additional research is needed to study their effect on subsequent behavior change because, due to a high dose–response relation, multiple visits to the program are necessary to maximize its effect on health behavior.

Conclusion

We found that the CT modules were significantly more often initiated by older, male, employed, low-income participants with a relatively unhealthy lifestyle, which implies that the program succeeded in reaching and engaging those people who benefit most from online lifestyle interventions. However, people with a lower income tended to disengage from the CT program before finishing the modules. This underlines the importance of additional research into specific program adjustment and strategies that can be used to stimulate prolonged program use by low-socioeconomic status visitors. Furthermore, sending periodic email prompts significantly increased revisits to the program. Though promising, this effect was modest and needs to be further examined, in order to maximize the potential of periodic email prompting.

Acknowledgments

This study was funded by ZonMw, the Netherlands Organization for Health Research and Development (grant number: 120710004). Publication of the manuscript was supported by NWO, the Netherlands Organization for Scientific Research.

Conflicts of Interest

Hein de Vries is scientific director of Vision2Health, a company that licenses evidence-based innovative computer-tailored health communication tools.

References

1. Eysenbach G, Köhler C. How do consumers search for and appraise health information on the world wide web? Qualitative study using focus groups, usability tests, and in-depth interviews. BMJ 2002 Mar 9;324(7337):573-577 [FREE Full text] [Medline: 11884321]
2. Fox S. Health topics: 80% of Internet users look for health information online. Washington, DC: Pew Internet & American Life Project; 2011 Feb 01. URL: http://www.pewinternet.org/~/media/Files/Reports/2011/PIP_HealthTopics.pdf [accessed 2012-02-24] [WebCite Cache ID 65hAc9yrr]
3. Bansil P, Keenan NL, Zlot AI, Gilliland JC. Health-related information on the Web: results from the HealthStyles Survey, 2002-2003. Prev Chronic Dis 2006 Apr;3(2):A36 [FREE Full text] [Medline: 16539777]
4. Internet World Stats. Internet World Stats.: Internet World Stats; 2011 Dec 31. Internet Usage Statistics: The Internet Big Picture URL: http://www.internetworldstats.com/stats.htm [accessed 2012-02-27] [WebCite Cache ID 65lNeM7fZ]
5. Brug J, Oenema A, Kroeze W, Raat H. The internet and nutrition education: challenges and opportunities. Eur J Clin Nutr 2005 Aug;59 Suppl 1:S130-7; discussion S138. [doi: 10.1038/sj.ejcn.1602186] [Medline: 16052181]
6. Ritterband LM, Gonder-Frederick LA, Cox DJ, Clifton AD, West RW, Borowitz S. Internet interventions: in review, in use and into the future. Prof Psychol Res Pr 2003;34:527-534. [doi: 10.1037/0735-7028.34.5.527]
7. Lustria ML, Cortese J, Noar SM, Glueckauf RL. Computer-tailored health interventions delivered over the Web: review and analysis of key components. Patient Educ Couns 2009 Feb;74(2):156-173. [doi: 10.1016/j.pec.2008.08.023] [Medline: 18947966]
8. Krebs P, Prochaska JO, Rossi JS. A meta-analysis of computer-tailored interventions for health behavior change. Prev Med 2010;51(3-4):214-221. [doi: 10.1016/j.ypmed.2010.06.004] [Medline: 20558196]
9. van den Berg MH, Schoones JW, Vliet Vlieland TP. Internet-based physical activity interventions: a systematic review of the literature. J Med Internet Res 2007;9(3):e26 [FREE Full text] [doi: 10.2196/jmir.9.3.e26] [Medline: 17942388]
10. Vandelanotte C, Spathonis KM, Eakin EG, Owen N. Website-delivered physical activity interventions a review of the literature. Am J Prev Med 2007 Jul;33(1):54-64. [doi: 10.1016/j.amepre.2007.02.041] [Medline: 17572313]
11. Neville LM, O'Hara B, Milat AJ. Computer-tailored dietary behaviour change interventions: a systematic review. Health Educ Res 2009 Aug;24(4):699-720 [FREE Full text] [doi: 10.1093/her/cyp006] [Medline: 19286893]

XSL•FO
RenderX

12. Brug J, Glanz K, Van Assema P, Kok G, van Breukelen GJ. The impact of computer-tailored feedback and iterative feedback on fat, fruit, and vegetable intake. Health Educ Behav 1998 Aug;25(4):517-531. [Medline: 9690108]
13. Borland R, Balmford J, Hunt D. The effectiveness of personally tailored computer-generated advice letters for smoking cessation. Addiction 2004 Mar;99(3):369-377. [doi: 10.1111/j.1360-0443.2003.00623.x] [Medline: 14982550]
14. Strecher VJ. Computer-tailored smoking cessation materials: a review and discussion. Patient Educ Couns 1999 Feb;36(2):107-117. [Medline: 10223016]
15. Myung SK, McDonnell DD, Kazinets G, Seo HG, Moskowitz JM. Effects of Web- and computer-based smoking cessation programs: meta-analysis of randomized controlled trials. Arch Intern Med 2009 May 25;169(10):929-937 [FREE Full text] [doi: 10.1001/archinternmed.2009.109] [Medline: 19468084]
16. Dijkstra A, De Vries H, Roijackers J. Long-term effectiveness of computer-generated tailored feedback in smoking cessation. Health Educ Res 1998 Jun;13(2):207-214 [FREE Full text] [Medline: 10181019]
17. Riper H, Kramer J, Smit F, Conijn B, Schippers G, Cuijpers P. Web-based self-help for problem drinkers: a pragmatic randomized trial. Addiction 2008 Feb;103(2):218-227. [doi: 10.1111/j.1360-0443.2007.02063.x] [Medline: 18199300]
18. White A, Kavanagh D, Stallman H, Klein B, Kay-Lambkin F, Proudfoot J, et al. Online alcohol interventions: a systematic review. J Med Internet Res 2010;12(5):e62 [FREE Full text] [doi: 10.2196/jmir.1479] [Medline: 21169175]
19. Crutzen R. Hard to Get, Hard to Keep: Dissemination of and Exposure to Internet-Delivered Health Behavior Change Interventions Aimed at Adolescents [doctoral thesis]. Maastricht, Netherlands: Maastricht University; 2009.
20. De Nooijer JOA, Kloek G, Brug J, De Vries H, De Vries NK. Bevordering van gezondheidsgedrag via internet: nu en in de toekomst [Promotion of Healthy Behavior Through the Internet: Now and in the Future]. Maastricht: Maastricht University; 2005.
21. Evers KE, Cummins CO, Prochaska JO, Prochaska JM. Online health behavior and disease management programs: are we ready for them? Are they ready for us? J Med Internet Res 2005 Jul 1;7(3):e27 [FREE Full text] [doi: 10.2196/jmir.7.3.e27] [Medline: 15998618]
22. Eysenbach G. The law of attrition. J Med Internet Res 2005;7(1):e11 [FREE Full text] [doi: 10.2196/jmir.7.1.e11] [Medline: 15829473]
23. Glasgow RE, Nelson CC, Kearney KA, Reid R, Ritzwoller DP, Strecher VJ, et al. Reach, engagement, and retention in an Internet-based weight loss program in a multi-site randomized controlled trial. J Med Internet Res 2007;9(2):e11 [FREE Full text] [doi: 10.2196/jmir.9.2.e11] [Medline: 17513282]
24. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. Am J Public Health 1999 Sep;89(9):1322-1327. [Medline: 10474547]
25. Rogers EM. Diffusion of Innovations. New York, NY: Free Press; 1995.
26. Brouwer W, Kroeze W, Crutzen R, de Nooijer J, de Vries NK, Brug J, et al. Which intervention characteristics are related to more exposure to internet-delivered healthy lifestyle promotion interventions? A systematic review. J Med Internet Res 2011;13(1):e2 [FREE Full text] [doi: 10.2196/jmir.1639] [Medline: 21212045]
27. Danaher BG, Boles SM, Akers L, Gordon JS, Severson HH. Defining participant exposure measures in Web-based health behavior change programs. J Med Internet Res 2006;8(3):e15 [FREE Full text] [doi: 10.2196/jmir.8.3.e15] [Medline: 16954125]
28. Strecher VJ, McClure J, Alexander G, Chakraborty B, Nair V, Konkel J, et al. The role of engagement in a tailored web-based smoking cessation program: randomized controlled trial. J Med Internet Res 2008;10(5):e36 [FREE Full text] [doi: 10.2196/jmir.1002] [Medline: 18984557]
29. Crutzen R, de Nooijer J, Candel MJ, de Vries NK. Adolescents who intend to change multiple health behaviours choose greater exposure to an internet-delivered intervention. J Health Psychol 2008 Oct;13(7):906-911. [doi: 10.1177/1359105308095064] [Medline: 18809641]
30. Verheijden MW, Jans MP, Hildebrandt VH, Hopman-Rock M. Rates and determinants of repeated participation in a web-based behavior change program for healthy body weight and healthy lifestyle. J Med Internet Res 2007;9(1):e1 [FREE Full text] [doi: 10.2196/jmir.9.1.e1] [Medline: 17478410]
31. Christensen H, Griffiths KM, Farrer L. Adherence in internet interventions for anxiety and depression. J Med Internet Res 2009;11(2):e13 [FREE Full text] [doi: 10.2196/jmir.1194] [Medline: 19403466]
32. Norman GJ, Zabinski MF, Adams MA, Rosenberg DE, Yaroch AL, Atienza AA. A review of eHealth interventions for physical activity and dietary behavior change. Am J Prev Med 2007 Oct;33(4):336-345. [doi: 10.1016/j.amepre.2007.05.007] [Medline: 17888860]
33. World Health Organization. World Health Organization. 2007 Feb. The Top Ten Causes of Death: Fact Sheet No 310 URL: http://www.who.int/mediacentre/factsheets/fs310.pdf [accessed 2012-02-27] [WebCite Cache ID 65lORCnFH]
34. Rijksinstituut voor Volksgezondheid en Milieu. Rijksinstituut voor Volksgezondheid en Milieu. 2012 Jan 31. Volksgezondheid Toekomst Verkenning: Nationaal Kompas Volksgezondheid URL: http://www.nationaalkompas.nl/ [accessed 2012-02-27] [WebCite Cache ID 65lOSMgjt]
35. Tu HT, Cohen GR. Striking jump in consumers seeking health care information. Track Rep 2008 Aug(20):1-8. [Medline: 18770913]

XSL•FO
RenderX

36. Yang S, Lynch J, Schulenberg J, Roux AV, Raghunathan T. Emergence of socioeconomic inequalities in smoking and overweight and obesity in early adulthood: the national longitudinal study of adolescent health. Am J Public Health 2008 Mar;98(3):468-477. [doi: 10.2105/AJPH.2007.111609] [Medline: 18235067]
37. Lorence D, Park H. Group disparities and health information: a study of online access for the underserved. Health Informatics J 2008 Mar;14(1):29-38. [doi: 10.1177/1460458207086332] [Medline: 18258673]
38. Spittaels H, De Bourdeaudhuij I, Brug J, Vandelanotte C. Effectiveness of an online computer-tailored physical activity intervention in a real-life setting. Health Educ Res 2007 Jun;22(3):385-396 [FREE Full text] [doi: 10.1093/her/cyl096] [Medline: 16971674]
39. Vandelanotte C, De Bourdeaudhuij I, Sallis JF, Spittaels H, Brug J. Efficacy of sequential or simultaneous interactive computer-tailored interventions for increasing physical activity and decreasing fat intake. Ann Behav Med 2005 Apr;29(2):138-146. [doi: 10.1207/s15324796abm2902_8] [Medline: 15823787]
40. Brouwer W, Oenema A, Raat H, Crutzen R, de Nooijer J, de Vries NK, et al. Characteristics of visitors and revisitors to an Internet-delivered computer-tailored lifestyle intervention implemented for use by the general public. Health Educ Res 2010 Aug;25(4):585-595 [FREE Full text] [doi: 10.1093/her/cyp063] [Medline: 19897515]
41. Etter JF. Comparing the efficacy of two Internet-based, computer-tailored smoking cessation programs: a randomized trial. J Med Internet Res 2005;7(1):e2 [FREE Full text] [doi: 10.2196/jmir.7.1.e2] [Medline: 15829474]
42. Harvey-Berino J, Pintauro S, Buzzell P, DiGiulio M, Casey Gold B, Moldovan C, et al. Does using the Internet facilitate the maintenance of weight loss? Int J Obes Relat Metab Disord 2002 Sep;26(9):1254-1260 [FREE Full text] [doi: 10.1038/sj.ijo.0802051] [Medline: 12187404]
43. Spittaels H, De Bourdeaudhuij I. Who participates in a computer-tailored physical activity program delivered through the Internet? A comparison of participants' and non-participants' characteristics. Int J Behav Nutr Phys Act 2007;4:39 [FREE Full text] [doi: 10.1186/1479-5868-4-39] [Medline: 17880696]
44. Steyaert J, de Haan J. Jaarboek ICT en samenleving 2007: Gewoon digitaal [Yearbook ICT and Society 2007: Simply Digital]. Amsterdam: Boom; 2007.
45. Brouwer W, Oenema A, Crutzen R, de Nooijer J, de Vries NK, Brug J. An exploration of factors related to dissemination of and exposure to internet-delivered behavior change interventions aimed at adults: a Delphi study approach. J Med Internet Res 2008;10(2):e10 [FREE Full text] [doi: 10.2196/jmir.956] [Medline: 18417443]
46. Couper MP, Alexander GL, Zhang N, Little RJ, Maddy N, Nowak MA, et al. Engagement and retention: measuring breadth and depth of participant use of an online intervention. J Med Internet Res 2010;12(4):e52 [FREE Full text] [doi: 10.2196/jmir.1430] [Medline: 21087922]
47. Prochaska JO, Velicer WF, Fava JL, Rossi JS, Tsoh JY. Evaluating a population-based recruitment approach and a stage-based expert system intervention for smoking cessation. Addict Behav 2001;26(4):583-602. [Medline: 11456079]
48. Fry JP, Neff RA. Periodic prompts and reminders in health promotion and health behavior interventions: systematic review. J Med Internet Res 2009;11(2):e16 [FREE Full text] [doi: 10.2196/jmir.1138] [Medline: 19632970]
49. Schulz DN, Kremers SP, van Osch LA, Schneider F, van Adrichem MJ, de Vries H. Testing a Dutch web-based tailored lifestyle programme among adults: a study protocol. BMC Public Health 2011;11:108 [FREE Full text] [doi: 10.1186/1471-2458-11-108] [Medline: 21324181]
50. Schneider F, van Osch LA, Kremers SP, Schulz DN, van Adrichem MJ, de Vries H. Optimizing diffusion of an online computer tailored lifestyle program: a study protocol. BMC Public Health 2011;11:480 [FREE Full text] [doi: 10.1186/1471-2458-11-480] [Medline: 21689412]
51. Brug J, Steenhuis I, van Assema P, Glanz K, De Vries H. Computer-tailored nutrition education: differences between two interventions. Health Educ Res 1999 Apr;14(2):249-256 [FREE Full text] [Medline: 10387504]
52. Te Poel F, Bolman C, Reubsaet A, de Vries H. Efficacy of a single computer-tailored e-mail for smoking cessation: results after 6 months. Health Educ Res 2009 Dec;24(6):930-940 [FREE Full text] [doi: 10.1093/her/cyp036] [Medline: 19574405]
53. Smeets T, Brug J, de Vries H. Effects of tailoring health messages on physical activity. Health Educ Res 2008 Jun;23(3):402-413 [FREE Full text] [doi: 10.1093/her/cyl101] [Medline: 17032705]
54. van Keulen HM, Mesters I, Brug J, Ausems M, Campbell M, Resnicow K, et al. Vitalum study design: RCT evaluating the efficacy of tailored print communication and telephone motivational interviewing on multiple health behaviors. BMC Public Health 2008;8:216 [FREE Full text] [doi: 10.1186/1471-2458-8-216] [Medline: 18565222]
55. Bergström G, Björklund C, Fried I, Lisspers J, Nathell L, Hermansson U, et al. A comprehensive workplace intervention and its outcome with regard to lifestyle, health and sick leave: the AHA study. Work 2008;31(2):167-180. [Medline: 18957735]
56. de Vries H, Mudde A, Leijs I, Charlton A, Vartiainen E, Buijs G, et al. The European Smoking Prevention Framework Approach (EFSA): an example of integral prevention. Health Educ Res 2003 Oct;18(5):611-626 [FREE Full text] [Medline: 14572020]
57. de Vries H, Brug J. Computer-tailored interventions motivating people to adopt health promoting behaviours: introduction to a new approach. Patient Educ Couns 1999 Feb;36(2):99-105. [Medline: 10223015]
58. Dijkstra A, De Vries H. The development of computer-generated tailored interventions. Patient Educ Couns 1999 Feb;36(2):193-203. [Medline: 10223023]

XSL•FO
RenderX

59. Kreuter M, Farrell D, Olevitch L, Brennan L. Tailoring Health Messages: Customizing Communication With Computer Technology. Mahwah, NJ: Lawrence Erlbaum Associates; 2000.
60. Wendel-Vos GC, Schuit AJ, Saris WH, Kromhout D. Reproducibility and relative validity of the short questionnaire to assess health-enhancing physical activity. J Clin Epidemiol 2003 Dec;56(12):1163-1169. [Medline: 14680666]
61. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc 2000 Sep;32(9 Suppl):S498-S504. [Medline: 10993420]
62. Anonymous. Lokale en nationale Monitor gezondheid: indicatoren voor de Monitor Volksgezondheid [Local and National Health Monitor: Indicators of the Public Health Monitor]. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu; 2005.
63. Lemmens P, Tan ES, Knibbe RA. Measuring quantity and frequency of drinking in a general population survey: a comparison of five indices. J Stud Alcohol 1992 Sep;53(5):476-486. [Medline: 1405641]
64. Dijkstra A, Roijackers J, De Vries H. Smokers in four stages of readiness to change. Addict Behav 1998;23(3):339-350. [Medline: 9668931]
65. Roos G, Johansson L, Kasmel A, Klumbiené J, Prättälä R. Disparities in vegetable and fruit consumption: European cases from the north to the south. Public Health Nutr 2001 Feb;4(1):35-43. [Medline: 11255494]
66. Kiousis S. Interactivity: a concept explication. New Media Soc 2002;4:355-383. [doi: 10.1177/146144480200400303]
67. Noar SM, Clark A, Cole C, Lustria ML. Review of interactive safer sex Web sites: practice and potential. Health Commun 2006;20(3):233-241. [doi: 10.1207/s15327027hc2003_3] [Medline: 17137415]
68. Lustria MLA. Can interactivity make a difference? Effects of interactivity on the comprehension of and attitudes toward online health content. J Am Soc Inf Sci Technol 2007;58:766-776. [doi: 10.1002/asi.20557]
69. Woodall WG, Buller DB, Saba L, Zimmerman D, Waters E, Hines JM, et al. Effect of emailed messages on return use of a nutrition education website and subsequent changes in dietary behavior. J Med Internet Res 2007;9(3):e27 [FREE Full text] [doi: 10.2196/jmir.9.3.e27] [Medline: 17942389]
70. Houston TK, Coley HL, Sadasivam RS, Ray MN, Williams JH, Allison JJ, DPBRN Collaborative Group. Impact of content-specific email reminders on provider participation in an online intervention: a dental PBRN study. Stud Health Technol Inform 2010;160(Pt 2):801-805. [Medline: 20841796]
71. Radicati S, Hoang Q. The Radicati Group, Inc. 2011 May. E-mail Statistics Report, 2011-2015 URL: http://www.radicati.com/wp/wp-content/uploads/2011/05/Email-Statistics-Report-2011-2015-Executive-Summary.pdf [accessed 2012-02-27] [WebCite Cache ID 65lOlGEhI]

Abbreviations

BMI: body mass index
CT: computer tailored

Edited by B Bewick; submitted 15.09.11; peer-reviewed by Z Khadjesari, N Zhang; comments to author 27.10.11; revised version received 14.12.11; accepted 09.01.12; published 01.03.12.

Please cite as:
Schneider F, van Osch L, Schulz DN, Kremers SPJ, de Vries H
The Influence of User Characteristics and a Periodic Email Prompt on Exposure to an Internet-Delivered Computer-Tailored Lifestyle Program
J Med Internet Res 2012;14(2):e40
URL: http://www.jmir.org/2012/2/e40/
doi:10.2196/jmir.1939
PMID:22382037

©Francine Schneider, Liesbeth van Osch, Daniela N Schulz, Stef PJ Kremers, Hein de Vries. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 01.03.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original paper

Initial and Sustained Participation in an Internet-delivered Long-term Worksite Health Promotion Program on Physical Activity and Nutrition

Suzan JW Robroek[1], PhD; Dennis EM Lindeboom[2], MSc; Alex Burdorf[1], PhD

[1]Department of Public Health, Erasmus MC, Rotterdam, Netherlands

[2]Lifeguard, Utrecht, Netherlands

Corresponding Author:
Alex Burdorf, PhD
Department of Public Health
Erasmus MC
PO Box 2040
Rotterdam, 3000CA
Netherlands
Phone: 31 107038469
Fax: 31 107038475
Email: a.burdorf@erasmusmc.nl

Abstract

Background: Determinants of participation in health promotion programs are largely unknown. To evaluate and implement interventions, information is needed regarding their reach as well as regarding the characteristics of program users and non-users.

Objective: In this study, individual, lifestyle, and health indicators were investigated in relation to initial, and sustained participation in an Internet-delivered physical activity and healthy nutrition program in the workplace setting. In addition, determinants of program website use were studied.

Methods: Determinants of participation were investigated in a longitudinal study among employees from six workplaces participating in a two-year cluster randomized controlled trial. The employees were invited by email to participate. At baseline, all participants visited a website to fill out the questionnaire on lifestyle, work, and health factors. Subsequently, a physical health check was offered, followed by face-to-face advice. Throughout the study period, all participants had access to a website with information on lifestyle and health, and to fully automated personalized feedback on the questionnaire results. Only participants in the intervention received monthly email messages to promote website visits during the first year and had access to additional Web-based tools (self-monitors, a food frequency questionnaire assessing saturated fat intake, and the possibility to ask questions) to support behavior change. Website use was monitored by website statistics measuring access. Logistic regression analyses were conducted to identify characteristics of employees who participated in the program and used the website.

Results: Complete baseline data were available for 924 employees (intervention: n=456, reference: n=468). Lifestyle and health factors were not associated with initial participation. Employees aged 30 years and older were more likely to start using the program and to sustain their participation. Workers with a low intention to increase their physical activity level were less likely to participate (Odds Ratio (OR)=0.60, 95% Confidence interval (95%CI), 0.43-0.85) but more likely to sustain participation throughout the study period (ORs ranging from 1.40 to 2.06). Furthermore, it was found that smokers were less likely to sustain their participation in the first and second year (OR=0.54, 95%CI 0.35-0.82) and to visit the website (OR=0.72, 95%CI 0.54-0.96). Website use was highest in the periods immediately after the baseline (73%) and follow-up questionnaires (71% and 87%). Employees in the intervention were more likely to visit the website in the period they received monthly emails (OR=5.88, 95%CI 3.75-9.20) but less likely to visit the website in the subsequent period (OR=0.62, 95%CI 0.45-0.85).

Conclusions: Modest initial participation and high attrition in program use were found. Workers with a low intention to change their behavior were less likely to participate, but once enrolled they were more likely to sustain their participation. Lifestyle and health indicators were not related to initial participation, but those with an unhealthy lifestyle were less likely to sustain. This might influence program effectiveness. Regular email messages prompted website use, but the use of important Web-based tools was modest. There is a need for more appealing techniques to enhance retention and to keep those individuals who need it most attracted to the program.

XSL•FO
RenderX

Trial Registration: ISRCTN52854353; http://www.controlled-trials.com/ISRCTN52854353

(J Med Internet Res 2012;14(2):e43) doi:10.2196/jmir.1788

KEYWORDS

Participation; Retention; Internet; Physical activity; Nutrition; Workplace; Health promotion

Introduction

Low participation is a concern in health promotion programs [1]. The workplace has been thought to be a promising setting for health promotion, providing access to large groups. However, in workplace health promotion, participation levels are typically below 50% [1]. These low participation levels may have important consequences for the effectiveness of health promotion programs and raise concerns about the generalizability of results. Therefore, information on participation and its determinants is needed. Furthermore, to assess whether participants obtain sufficient exposure to the intervention, program use as well as characteristics of program users and non-users need to be studied [2].

The RE-AIM framework stresses the importance of evaluating the reach of health promotion programs and the representativeness of program participants [3]. Several studies provide information on the reach of their program, but information on the representativeness of program participants, or specifically the reach of the program to individuals at-risk, is scarce [1]. In addition to program reach and determinants of initial participation, sustained participation is of importance because studies with longer-term program utilization tend to have better outcomes concerning physical activity (PA), dietary behavior change [4], and weight loss [5]. In our study, a health promotion program was offered in the workplace setting, combining face-to-face contact with an Internet-delivered program. It has been found that frequent email messages might enhance sustained participation in Internet-delivered programs [6,7]. However, low initial participation levels and high levels of attrition are also common in Internet-delivered health promotion programs [4,8,9].

In previous research, several factors that influence participation in Internet-delivered behavior change programs have been identified. It has been reported that women [10-14], and individuals with a medium or high educational level [10,12-13] are more likely to start participating. However, there is only scarce information on lifestyle- and health-related determinants of initial participation, with some studies showing that individuals with a normal body weight or a healthier lifestyle more often participate [14,15], and another study reporting that individuals who needed it most were reached [16].

A number of studies on determinants of sustained participation reported that particularly women [14,17], individuals with a lower educational level [18], and older employees [10,13,14,16,17,19,20] were more likely to sustain participating in Internet-delivered behavior change programs. For lifestyle and health indicators, the evidence is contradictory. In some studies, participants with a healthy lifestyle at baseline, particularly non-smokers, more often sustained their participation [10,19,21], whereas in other studies a higher sustained participation was present among overweight participants [10] or among those not complying with healthy lifestyle guidelines [14].

Since exposure to behavior change programs is required for effective interventions, insight into program use and into characteristics of program users and non-users is needed. More studies are needed to investigate whether there is a consistent pattern in whom we reach in health promotion and who keeps participating in primary preventive interventions. Therefore, the aims of this study were to investigate in an occupational population participation in an Internet-delivered health promotion program on PA and healthy nutrition and to identify the factors that determined their participation.

Methods

Study Design, Participants and Recruitment

An observational study was conducted among participants who had enrolled in a 2-year cluster randomized controlled trial (cRCT), with departments (n=74) within companies (n=6) as the unit of randomization. Participants were blinded to the type of intervention. An extensive description of the cRCT conducted between November 2007 and October 2010 is published elsewhere [22]. Participants were employees from health care organizations (n=2), commercial services (n=2), and the executive branch of government (n=2) in the Netherlands. Within the participating companies, the study was announced through email, intranet, and/or a company magazine. Afterwards, an invitation to participate, with login codes, were sent by the provider of the website (Lifeguard Inc.). Participants enrolled voluntarily in the study by visiting the website (see Figure 1) and completing the online baseline questionnaire on lifestyle factors, health, and work demands. The website also provided general information concerning lifestyle and health, as well as feedback based on the online questionnaire, and could be visited from every computer. Subsequently, all participants could participate in a physical health check followed by a face-to-face contact discussing the health check and questionnaire results. These health checks and face-to-face contacts took place at the company. One year after the baseline measurements, participants were asked to fill out the first follow-up questionnaire. Two years after baseline, all participants were invited to fill out the second follow-up questionnaire and to participate again in the physical health check.

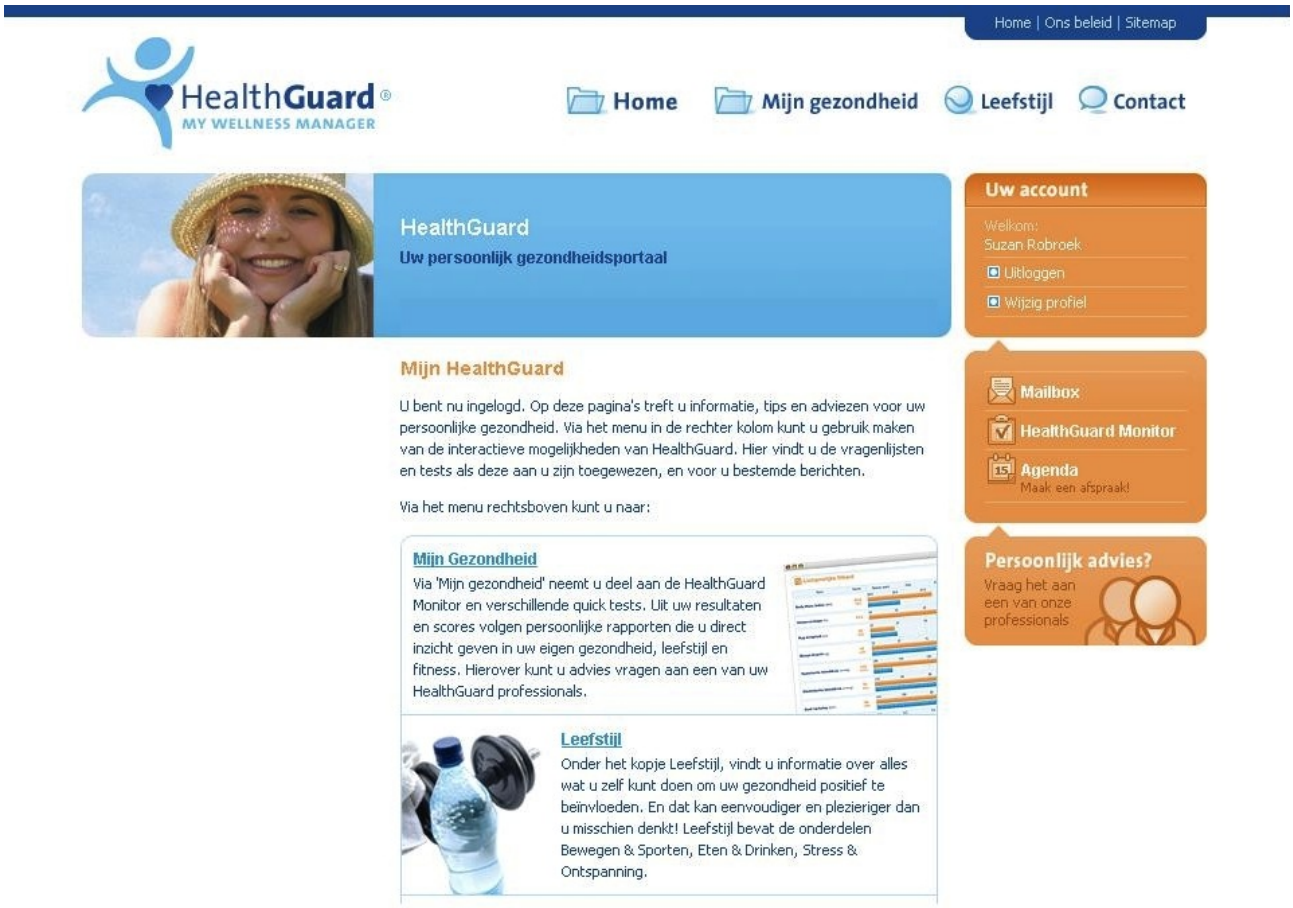
In total, 12,895 employees were invited to participate. The three largest companies restricted the maximum number of participants to 200 or 300 on a ‘first in’ principle. In the companies not restricting the enrolment, participation levels ranged from 36% to 61%. During the first year after baseline, 860 non-participants received an abbreviated version of the

XSL•FO
RenderX

questionnaire asking for the reason for not participating and a few questions on lifestyle, health, and work. A sample of non-participants in the health care organizations, and all non-participants in the 2 commercial services and in 1 executive branch of government received the questionnaire. In the other organization in the executive branch of government, non-participants were not invited to fill out the questionnaire. Since the program was initiated in the holiday period and communicated in a very limited way, and only 200 workers were allowed to participate, most workers in that organization were unaware of the program. Due to privacy regulations, the non-participant questionnaire was sent out only once without any reminders.

The Medical Ethics Committee of Erasmus MC, University Medical Center in Rotterdam, the Netherlands, approved the study and all participants gave written informed consent at the face-to-face contact.

Figure 1. Screenshot of the website.



Reference Condition

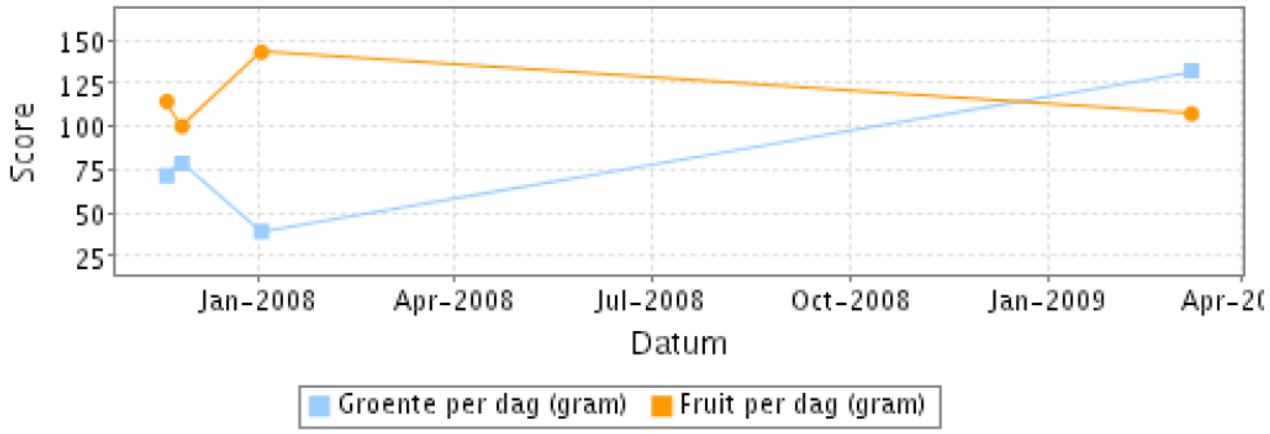
Participants in the reference group had access to individual reports based on the online questionnaire and physical health check. These reports presented details on their personal PA level and fruit and vegetable intake, recommended levels of physical activity and fruit and vegetable intake in the Netherlands, and references to the general information on lifestyle and health on the website.

Intervention Condition

Participants in the intervention condition had access to several additional Web-based tools compared to participants in the reference condition. The following Web-based tools were available during the two-year study period. Participants in the intervention condition had access to a more extensive computer-tailored advice on their self-reported PA and nutrition behavior than participants in the reference condition. The electronically generated advice included personal and action feedback taking into account perceived barriers for participants not meeting the guidelines [22,23]. Secondly, online self-monitors were available to monitor progress on fruit and vegetable intake, PA, and weight and to obtain tracking charts (see Figure 2). Thirdly, participants in the intervention condition were invited to fill out a food frequency questionnaire (FFQ) assessing saturated fat intake for tailored advice [24]. Furthermore, they had the opportunity to asking questions to several professionals. In addition, during the first 12 months of the study, monthly email messages were sent on PA and nutrition, and participants were encouraged to make use of the available Web-based tools on their personalized web page.

XSL•FO
RenderX

Figure 2. Example of the self-monitor for fruit and vegetable intake.



Initial and Sustained Participation

Initial participation was defined as filling out the baseline questionnaire to obtain advice on lifestyle. Sustained participation was defined as filling out the questionnaire after 12 or 24 months. The use of the Internet-delivered program was measured as visiting the website throughout the study period. To correct for website visit solely to fill out questionnaires, one login was subtracted in the periods following an invitation to fill out the questionnaires. Two periods for program use were distinguished: the first three months after filling out the questionnaire, and the remaining period.

Determinants

Individual Characteristics

In the baseline questionnaire, participants were asked about their age, sex, education, ethnicity, and marital status. Educational level was assessed by the highest level of education completed and was defined as low (primary school, lower and intermediate secondary school, or lower vocational training), intermediate (higher secondary school or intermediate vocational school) and high (higher vocational school or university). Ethnicity distinguished Dutch born citizens from others, according to the standardized procedures described by Statistics Netherlands [25].

Lifestyle and Health Indicators

Moderate and vigorous intensity PA was self-assessed in the baseline questionnaire by the short version of the International Physical Activity Questionnaire (IPAQ) [26]. The average time spent on PA per day was calculated. Walking was not included in this calculation, because casual walking is regarded as a light-intensity activity [27]. For all behaviors, a dichotomous variable was calculated. For PA level, we used a cut-off point of 30 minutes or more of moderate or vigorous PA per day. For fruit and vegetable intake (FV), 400 grams of fruit and vegetable intake as measured with a self-administered 9-item validated Dutch Food Frequency Questionnaire was used as cut-off point [28]. Smoking was defined as current smoking status, and excessive alcohol use as drinking 15 or more glasses of alcohol per week for women and 22 or more glasses for men. The first question of the Short Form-12 questionnaire rated perceived general health, which was dichotomized into ‘poor or moderate’ and ‘good to excellent’ [29].

In the physical health check, height and weight were measured to calculate the Body Mass Index (BMI) and to categorize individuals as normal weight (BMI<25kg/m^2), overweight (25£BMI<30kg/m^2), and obese (BMI³30kg/m^2). For non-participants, weight was self-reported in the questionnaire. Total blood cholesterol was measured in non-fasting blood through a finger prick (Accutrend GC, Roche Company, Mannheim, Germany), and blood pressure was measured with a fully automated sphygmomanometer (Omron M4-I, Omron HealthCare Europe BV, Hoofddorp, the Netherlands). A total cholesterol level above 5.0 mmol/l and a systolic or diastolic blood pressure above 140 mmHg and 90 mmHg respectively were considered elevated. A submaximal exercise test on a bicycle ergometer was conducted to predict maximal oxygen uptake, according to the American College of Sports Medicine’s protocol, using their sex- and age-dependent cut-off points [30].

Social Cognitive Variables

For both PA and fruit and vegetable intake, attitude, social support, self-efficacy, and intention to change were measured in the baseline questionnaire. To measure attitude, individuals were asked to indicate on a 5-point Likert scale (‘certainly not’ to ‘certainly’) whether they thought improving the behavior would take a lot of effort [31]. Those participants who answered ‘probably or certainly not’ were considered as having a positive attitude. Social support was measured by asking whether family and friends support them in changing the specific behaviors (4-point Likert scale ranging from ‘seldom’ or ‘never’ to ‘a lot’) [32]. High social support was defined as perceiving ‘pretty much’ or ‘a lot’ of support. Self-efficacy was assessed on a 5-point Likert scale (‘certainly not’ to ‘certainly’) by asking whether the participant was confident to engage in the healthy behaviors in the next month [32]. High self-efficacy was defined as ‘probably’ or ‘certainly’ confident to change the behavior. Intention was also measured on a 5-point Likert scale (‘certainly not’ to ‘certainly’) by asking whether the participant intended to change the behavior in the next month [29]. A high intention

XSL•FO
RenderX

was defined as 'probably' or 'certainly' intended to change the behavior.

Work-Related Factors

Physical work demands were measured by one item, asking whether participants perceive their current job as mainly physically or mentally demanding.

Statistical Analyses

Descriptive statistics were used to present the baseline characteristics of the study population. For *initial participation*, individual characteristics, behaviors, social cognitive variables, and health indicators of participants were compared with workers who did not start in the program. Determinants of initial participation were investigated with univariate logistic regression analyses.

For *sustained participation*, individual characteristics, behaviors, and health indicators from participants at 12 and 24 months follow-up were compared with initial participants who dropped out of these follow-up measurements. Determinants of sustained participation were also investigated with logistic regression analyses. First, univariate logistic regression models were carried out to determine the single effects of the possible determinants. All variables with a *p*-value less than 0.05 in the univariate model either at 12 or 24 months were included in both multivariate analyses to increase comparability between models. A backward selection method was used to determine the multivariate models, whereby age and sex were included by default. Variables with a *p*-value of 0.05 or less in either the 12 months or 24 months model were retained in the multivariate model. All analyses were adjusted for company and carried out with the PASW Statistics version 17.0.2 (SPSS Inc, Chicago, IL, USA).

For *website use* individual characteristics, behaviors, and health indicators from participants who visited the Internet-delivered program were compared with non-visitors. Descriptive statistics presented the use of the different website functionalities, and multilevel General Estimating Equations (GEE) were used for determinants of website visit. The same procedure was followed as for sustained participation. GEE is suitable for the analysis of repeated measurements within participants and was carried out with SAS 9.2 statistical software package.

The results are presented by the odds ratios (OR) and corresponding 95% confidence intervals (95%CI), with ORs below and above 1 representing respectively lower and higher participation.

Results

At baseline, 987 participants filled out the questionnaire, of which 36 were excluded due to working less than 12 hours per week for the company, and an additional 27 were excluded because they did not complete the questionnaire. In total, 924 employees met the inclusion criteria. Concerning the non-participants, 213 employees out of the 860 invited non-participants responded (24.8%) of which 183 (85.9%) met the inclusion criteria. The baseline characteristics of the study group are presented in Table 1. Half of the participants (450 out of 924, 49%) were male workers. The mean age was 42 years, ranging from 20 to 63 years, and 414 out of 924 (45%) had a high education level. Almost a third of the participants (297 out of 924, 32%) were not physically active at moderate to vigorous intensity for at least 30 minutes per day, and 435 out of 924 (47%) had insufficient fruit and vegetable intake. The randomization was not completely successful in creating comparable groups. There was a difference for fruit intake at baseline, with more participants in the intervention meeting the guideline (intervention: 57%, reference: 50%).

Initial Participation

Of the 183 non-participants responding to the questionnaire for non-participants, most gave 'I am healthy' (41%) as their reason for not participating in the program; followed by 'other reasons' (34%), of which most were practical reasons such as a lack of time, forgotten to subscribe, or unaware of the existence of the program; 13% of the non-participants would like to keep private life and work separated; and 19% of the non-participants preferred to arrange health promotion activities themselves. Most participants (86%) mentioned 'curious about my health' as their most important reason to participate.

Employees aged 30 years and older were more likely to participate in the program (ORs between 1.57 and 2.25). Workers with a low intention to increase their PA level were less likely to participate (OR=0.60, 95%CI 0.43-0.85).

XSL•FO
RenderX

Table 1. Differences between participants (n=924) and a sample of non-participants (n=183) in a workplace health promotion program.

Characteristics		Participants n (%)	Non-participants n (%)	Initial participation univariate analyses OR (95%CI)
Demographics				
	Male gender	450 (49)	62 (34)	1.17 (0.81-1.70)
	Age <30 years	128 (14)	43 (24)[c]	1.00
	Age 30-39 years	253 (27)	46 (25)	1.57 (0.96-2.57)
	Age 40-49 years	277 (30)	39 (22)	2.25[a] (1.36-3.72)
	Age ≥50 years	266 (29)	53 (29)	1.61 (0.99-2.62)
	Education high	414 (45)	102 (56)	1.00
	Education intermediate	306 (33)	49 (27)	1.15 (0.78-1.70)
	Education low	204 (22)	32 (18)	1.05 (0.66-1.68)
	Non-Dutch ethnicity	151 (16)	29 (16)	1.04 (0.66-1.63)
	Unmarried / not cohabiting	222 (24)	41 (22)	1.20 (0.81-1.77)
Lifestyle factors				
	<30min/day PA	297 (32)	58 (32)	1.01 (0.71-1.44)
	<3x20min/day vigorous PA	652 (71)	128 (70)	1.15 (0.80-1.65)
	<400g/day fruit and vegetables	435 (47)	n/a[d]	n/a
	Current smoker	165 (18)	28 (15)	1.08 (0.69-1.70)
	Excessive alcohol consumption	24 (3)	5 (3)	0.98 (0.36-2.67)
	BMI[b] < 25 kg/m^2	460 (57)	119 (65)	1.00
	25 kg/m^2 ≤ BMI[b] < 30	277 (34)	58 (32)	1.11 (0.69-1.44)
	BMI≥30 kg/m^2	70 (9)	6 (3)	2.24 (0.93-5.42)
Social cognitive factors for physical activity				
	Poor attitude	464 (50)	87 (47)	1.24 (0.89-1.72)
	Low support from family	772 (84)	166 (90)	0.63 (0.37-1.08)
	Low self-efficacy	214 (23)	33 (18)	1.48 (0.97-2.25)
	Low intention	478 (52)	121 (66)	0.60[a] (0.43-0.85)
Social cognitive factors for fruit and vegetable intake				
	Poor attitude	280 (30)	n/a	n/a
	Low support family	784 (85)	n/a	n/a
	Low self-efficacy	167 (18)	n/a	n/a
	Low intention	180 (20)	n/a	n/a
Health Indicators				
	Poor/moderate general health	58 (6)	15 (8)	0.83 (0.45-1.52)
	Elevated blood pressure[b]	258 (32)	n/a	n/a
	Poor predicted Vo_2max[b]	267 (36)	n/a	n/a
	Elevated total cholesterol[b]	338(42)	n/a	n/a
Work-related factors				
	Physical job demands	148 (16)	42 (24)	0.84 (0.56-1.56)

XSL•FO
RenderX

Characteristics	Participants n (%)	Non-participants n (%)	Initial participation univariate analyses OR (95%CI)
Health Check participation	811 (88)	n/a	n/a
Intervention group	456 (49)	n/a	n/a

[a]*P*<0.05, analyses adjusted for company

[b]BMI, blood pressure, maximum oxygen uptake, and cholesterol level are only available for the participants in the physical health check (n=807)

[c] n=2 missing for age of non-participants.

[d]n/a: not available

Sustained Participation: Questionnaire and Health Check

After 1 year, 666 out of 924 participants (72%) filled out the questionnaire, and 558 out of 924 (60%) filled out the 2-year follow-up questionnaire to obtain feedback on their lifestyle. In the intervention group, 68% filled out the first follow-up questionnaire and 58% the second follow-up questionnaire. In the reference group this was respectively 76% and 63%.

As shown in Table 2, older employees were more likely to sustain their participation at follow-up, while employees with a non-Dutch ethnicity were less likely to sustain their participation. In the univariate analysis married/cohabiting participants were more likely to keep participating, but after adjustment for age, lifestyle and health indicators the association diminished and did not remain statistically significant (OR_{1yr}= 1.34, 95%CI 0.87-2.07; OR_{2yr}=0.94, 95%CI 0.63-1.40).

Smokers and participants with a poor predicted maximum oxygen uptake were less likely to sustain their participation. Insufficient fruit and vegetable intake was also associated with reduced participation in the follow-up measurements, but this association did not remain statistically significant after adjustment for the predicted maximum oxygen uptake (OR_{1yr}=0.87, 95%CI 0.60-1.26, OR_{2yr}=0.87, 95%CI 0.63-1.20). Participants in the intervention condition were less likely to participate again after one year compared with the reference condition. This relation was not apparent in the analysis for participation at 2-year follow-up.

Participants with a low intention to change their PA level (OR_{1yr}=1.69, 95%CI 1.26-2.27; OR_{2yr} 1.40, 95%CI 1.07-1.83) or fruit and vegetable intake (OR_{1yr}=2.06, 95%CI 1.45-2.92; OR_{2yr} =1.93, 95%CI 1.38-2.70) were more likely to participate at 1- and 2-yr follow-up. Workers with low social support (PA: OR=0.44, 95%CI 0.30-0.63, FV: OR=0.46, 95%CI 0.31-0.68) and low self-efficacy (PA: OR=0.16, 95%CI 0.11-0.23, FV: OR=0.38, 95%CI 0.22-0.66) were less likely to have the intention to change their behavior (not in table).

Most employees participating in the 2nd follow-up questionnaire also participated in the 2nd physical health check (65%), and, except insufficient fruit and vegetable intake, similar determinants were found as for sustained questionnaire participation. Older participants ($OR_{40\text{-}49yr}$=1.99, 95%CI 1.19-3.33; OR_{50+yr}=1.74, 95%CI 1.01-2.9) and those with a Dutch ethnicity (OR=1.59, 95%CI 1.02-2.44) were statistically significantly more likely to participate in the physical health check. Employees with a low intention to change their behavior were more likely to participate in the follow-up health check (PA: OR=1.28, 95%CI 0.97-1.70, FV: OR=1.47, 95%CI 1.01-2.15) (not in table).

XSL•FO
RenderX

Table 2. Determinants of sustained participation after 1 and 2 years in a workplace health promotion program (n=924).

Characteristics		1 year follow-up participation		2 year follow-up participation	
		univariate	multivariate	univariate	multivariate
		OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Demographics					
	Male gender	1.42[a] (1.03-1.97)	1.04 (0.70-1.55)	1.41[a] (1.05-1.90)	1.15 (0.81-1.64)
	Age <30 years	1.00	1.00	1.00	1.00
	Age 30-39 years	1.51 (0.97-2.36)	1.47 (0.70-1.55)	1.33 (0.86-2.05)	1.39 (0.83-2.32)
	Age 40-49 years	2.52[a] (1.59-4.00)	2.36[a] (1.35-4.12)	2.29[a] (1.48-3.54)	2.08[a] (1.25-3.47)
	Age ≥50 years	3.01[a] (1.86-4.86)	2.38[a] (1.30-4.33)	2.89[a] (1.84-4.55)	2.47[a] (1.43-4.26)
	Education high	1.00	1.00	1.00	1.00
	Education intermediate	1.14 (0.80-1.62)		0.98 (0.71-1.34)	
	Education low	0.77 (0.52-1.14)		0.72 (0.50-1.03)	
	Non-Dutch ethnicity	0.62[a] (0.42-0.89)	0.77 (0.48-1.22)	0.47[a] (0.33-0.67)	0.51[a] (0.34-0.78)
	Unmarried / not cohabiting	0.61[a] (0.44-0.85)		0.73[a] (0.53-0.99)	
Lifestyle factors					
	<30min/day PA	0.75 (0.56-1.02)		0.83 (0.63-1.11)	
	<3x 20min/day vigorous PA	1.03 (0.74-1.42)		1.14 (0.85-1.53)	
	<400gr/day fruit & vegetables	0.65[a] (0.49-0.88)		0.73[a] (0.56-0.96)	
	Current smoker	0.53[a] (0.37-0.75)	0.52[a] (0.33-0.82)	0.51[a] (0.36-0.72)	0.54[a] (0.35-0.82)
	Excessive alcohol intake	1.29 (0.50-3.33)		0.93 (0.41-2.13)	
	BMI < 25 kg/m^2	1.00	1.00	1.00	1.00
	25 kg/m^2 ≤ BMI < 30	1.17 (0.81-1.68)		0.98 (0.71-1.35)	
	BMI ≥ 30 kg/m^2	1.29 (0.69-2.42)		0.90 (0.53-1.53)	
Health indicators[a]					
	Elevated blood pressure	1.22 (0.85-1.76)		0.95 (0.69-1.31)	
	Poor predicted Vo_2max	0.54[a] (0.38-0.76)	0.56[a] (0.39-0.81)	0.66[a] (0.48-0.91)	0.76 (0.55-1.06)
	Elevated total cholesterol	1.07 (0.77-1.49)		1.35[a] (1.00-1.82)	
	Decreased general health	0.71 (0.40-1.25)		0.49[a] (0.28-0.84)	
Work-related factors					
	Physical job demands	0.71 (0.48-1.05)		0.75 (0.52-1.09)	
Intervention group		0.63[a] (0.47-0.85)	0.56[a] (0.39-0.81)	0.85 (0.65-1.12)	0.92 (0.67-1.28)

* P<0.05, analyses adjusted for company

[a] BMI, blood pressure, maximum oxygen uptake, and cholesterol level are only available for the participants in the physical health check (n=807)

Sustained Participation: Website Use

Six percent of the participants did not visit the website throughout the study period, 18% visited the website once, 13% twice, and 64% three times or more. The range of website visits during the whole 2-year study period was 0–46, with a median of 3 visits (interquartile range: 2-6 visits). Participants visited the website more frequently in the first months after the questionnaires (Table 3). In the period 4-12 months after baseline, participants in the intervention condition, who received monthly email messages during this period, were more likely to visit the website (OR=5.88, 95%CI 3.75-9.20, adjusted for company).

As shown in Table 4, smokers were less likely to visit the website than non-smokers. Participants with a low intention to

XSL•FO
RenderX

increase their fruit and vegetable intake (1-3 months: 1.73, 95%CI 1.31-2.27; 4-12 months: OR=1.47, 95%CI 0.92-2.36) were more likely to visit the website (not in table).

Table 3. Website visits and use of different website functionalities throughout the study in the reference (R) and intervention (I) program.

Month	Study population		Website visits		Viewed advice physical activity		Viewed advice fruit and vegetables		Self-monitor	fat FFQ	Asked question
	R	I	R	I	R	I	R	I	I only	I only	I only
	n	n	%	%	%	%	%	%	%	%	%
1-3[b]	386	412	74	71	30	27	30	25	7	n/a	0
4-12	468	456	6	27[a]	2	3	2	3	6	15	3
13-15[c]	385	344	76[a]	66	23	18	26[a]	17	1	n/a	1
16-24[c]	385	344	2	3	1	0	1	0	0	n/a	0
25-28[d]	294	264	89	85	18[a]	11	19[a]	10	2	n/a	1

[a] Chi-square, $P<0.05$

[b] for one company (executive branch of government) no information was available for website use in the first three months of the study.

[c] participants not responding to the first and second follow-up questionnaire were considered as drop-outs and not included in the analysis for 13-24 months.

[d] participants not responding to the second follow-up questionnaire were considered as drop-outs and not included in the analysis for 25-28 months.

XSL•FO
RenderX

Table 4. Determinants of website use of a workplace health promotion program.

Characteristics		Website use month 1-3 after invitations to fill out questionnaire (n=630)[c]		Website use month 4-12 after invitations to fill out questionnaire (n=729)	
		univariate OR (95%CI)	multivariate OR (95%CI)	univariate OR (95%CI)	multivariate OR (95%CI)
Demographics					
	Male gender	0.88 (0.71-1.11)	0.87 (0.69-1.09)	1.09 (0.78-1.52)	
	Age <30 years	1.00	1.00	1.00	1.00
	Age 30-39 years	1.05 (0.74-1.51)	1.06 (0.74-1.52)	0.90 (0.50-1.61)	0.85 (0.47-2.20)
	Age 40-49 years	1.31 (0.92-1.88)	1.32 (0.92-1.89)	1.15 (0.66-2.00)	1.12 (0.64-1.98)
	Age ≥50 years	1.14 (0.80-1.63)	1.18 (0.82-1.70)	1.25 (0.72-2.18)	1.24 (0.70-1.52)
	Education high	1.00		1.00	
	Education intermediate	0.86 (0.67-1.11)		0.96 (0.66-1.40)	
	Education low	0.73[a] (0.54-0.97)		0.83 (0.53-1.30)	
	Non-Dutch ethnicity	0.96 (0.70-1.31)		0.82 (0.51-1.33)	
	Unmarried / not cohabiting	1.06 (0.81-1.38)		0.86 (0.58-1.29)	
Lifestyle factors					
	<30min/day PA	1.03 (0.81-1.31)		1.04 (0.73-1.48)	
	<3x 20min/day vigorous PA	1.11 (0.87-1.41)		0.83 (0.59-1.18)	
	<400gr/day fruit & vegetables	0.86 (0.69-1.07)		0.83 (0.59-1.16)	
	Current smoker	0.71[a] (0.53-0.95)	0.72[a] (0.54-0.96)	0.64 (0.39-1.04)	0.66 (0.40-1.08)
	Excessive alcohol intake	1.01 (0.50-2.05)		0.87 (0.29-2.59)	
	BMI < 25 kg/m^2	1.00		1.00	
	25 kg/m^2 ≤ BMI < 30	1.08 (0.84-1.40)		1.03 (0.56-1.91)	
	BMI ≥ 30 kg/m^2	1.19 (0.76-1.86)		0.96 (0.52-1.77)	
Health indicators					
	Elevated blood pressure	1.13 (0.87-1.46)		1.13 (0.79-1.61)	
	Poor predicted Vo_2max	0.75 (0.53-1.08)		0.99 (0.59-1.65)	
	Elevated total cholesterol	1.04 (0.81-1.32)		0.84 (0.59-1.18)	
	Decreased general health	0.83 (0.51-1.34)		0.97 (0.48-1.96)	
Work-related factors					
	Physical job demands	1.00 (0.73-1.36)	0.99 (0.71-1.36)	0.57[a] (0.33-0.97)	0.59 (0.34-1.02)

[a] $P<0.05$, analyses adjusted for company

[b] BMI, blood pressure, maximum oxygen uptake, and cholesterol level are only available for the participants in the physical health check (n=807)

[c] for one company (executive branch of government) no information was available for website use in the first three months of the study.

Discussion

Modest initial participation and a high attrition in a health promotion program were found in the current study. Employees aged 30 years and older were more likely to start in the program as well as to sustain their participation. Lifestyle and health indicators were not related to initial participation, but did play a role in sustained participation as well as in visiting the website throughout the study period. Workers with a low intention to change their PA level were less likely to start, but once enrolled they were more likely to sustain participation and use the website.

XSL•FO
RenderX

Participation

Previous studies reported low participation and high levels of attrition in Internet-delivered health promotion programs [4,8-10]. In a systematic review, a median reach of 33% (95% CI 25–42%) was found in workplace health promotion programs [1]. In our study, three companies restricted the maximum number of employees allowed to enroll, leading to an artificially lower participation level. Without these companies, a mean initial participation level of 43% was established. Once enrolled, 72% also participated in the 1st follow-up, and 60% in the 2nd follow-up measurement. This is in agreement with a systematic review reporting that the majority of Internet-delivered weight loss programs had less than 80% retention [5].

Determinants of Participation

In a systematic review studying initial participation in workplace health promotion, no major differences in lifestyle and health indicators were identified between those who participated and those that did not [1]. With our focus on workers, a relatively healthy group was reached, since workers are in better health than unemployed individuals [33]. In general, the employees who participated in our study had a quite similar lifestyle and health as non-participants. Although non-significant, obese workers were more likely to enroll in the study. This is in accordance with other recent studies [10,16] which have argued that this might be due to the non-stigmatizing way of addressing body weight through the Internet.

In line with other studies [10,13,14,16,17,19], we found that older employees started more often and sustained their participation during the follow-up measurements. A recent study on a workplace health promotion program also reported increased participation among older workers [34], which is a promising finding regarding the higher risk of cardiovascular diseases at older age, and employers' focus on keeping the ageing workforce healthy. However, although we found that older employees visited the website more often, they did not use the website components more often compared with younger workers.

It is remarkable that employees with a low intention to change their behavior were less likely to enroll in the study, but once participating, those with a low intention were more likely to sustain at follow-up, and to visit the website throughout the study period. This might indicate that the program is appealing for employees with a low intention to change their behavior. Alternatively, it might also indicate that those participants who intend to change their behavior do not need the program to get into action. To our knowledge, only one previous study provided information on the role of intention to change in participation [13]. They did report that workers with a positive health motivation were more likely to continue website use, but did not find an influence of intention to increase PA and participation. Measuring intention to change in other studies could provide more insight into the role of intention in participation, and might help to find out what program content facilitates reach and sustained participation for those with a low intention to change.

Previous studies have presented contradictory results concerning the relationship between lifestyle and health indicators and sustained participation, with some studies describing elevated participation among those who need it most [10,14] and other studies among those who are already healthy or engage in a healthy lifestyle [10,19,21]. We found a consistently lower sustained participation among smokers and employees with a low cardiorespiratory fitness. These associations between unhealthy lifestyle behaviors and decreased participation might reduce the effectiveness of primary preventive interventions.

Website Functionalities

Previous studies reported high attrition in Internet-delivered health promotion programs [8,10]. We also found a reduction in website visitors throughout the study period, with peaks in the months after the invitations to fill out the questionnaires. Between the questionnaire invitations, the companies did too little to communicate about the program to their personnel. Therefore, the embedding of the program in the organizations was limited.

Participants in the intervention group received monthly email messages during the first study year, and 27% visited the website compared with 6% in the reference group during this period. These monthly email messages seem to work as a prompt for website visits, but might have had a negative influence on sustained participation, since less participants in the intervention group filled out the first follow-up questionnaire. In the second year after baseline, no monthly email messages were sent, and at the end of the second year there was no statistically significant difference between the reference and intervention condition in both follow-up participation and website visit. A possible explanation for the lower response among intervention participants at the first follow-up could be that they felt less need to fill out the questionnaire to obtain feedback, because they already received information in the monthly messages and self-monitors throughout the year. In a systematic review it was concluded that the use of periodic prompts can be effective in behavior change interventions [35]. However, the optimal frequency and structure of such prompts is still unknown.

In accordance with previous studies [36], users appear not to be optimally utilizing key aspects of the intervention. A qualitative systematic review suggested that only peer support, counselor support, email/phone contact with visitors, and updates of the intervention website were related to better exposure to health promotion through the Internet [37]. In the current study, only a minority of the employees who filled out the questionnaires also read the subsequent advice on PA and fruit and vegetable intake, and the number of participants using self-monitors on a regular basis and asking questions to professionals was limited. This is in contrast with the wishes of potential users as identified in focus group interviews [38]. It could be questioned whether self-monitoring and the possibility of asking questions fit with the wishes of our target group. In addition, there are numerous websites freely available with self-monitor functions and possibilities to obtain personal feedback on lifestyle and health, which might reduce employees' need of another website. Participants could use the website at their own discretion, which might have led to lower use, making

XSL•FO
RenderX

this minimal effort intervention not enough to elicit program compliance.

Limitations

This study has some limitations. First, the 25% response to the questionnaire for non-participants was low, and might hamper comparison between responders and non-responders. Second, the measures for website use did not provide any information as to what extent the participants actually read the available information or how much time they spent on the website. In addition, reasons for drop-out are unknown. Therefore, we do not know whether individuals stop participating because they do not need the program anymore, because they are dissatisfied with the program, or because of another reason. Furthermore, because of technical problems no data on website use were collected for 99 participants during the first three study months. Third, there was no information available on the use of other lifestyle-related websites simultaneous with our website. However, we do not expect a difference between the intervention and reference condition concerning the use of other websites. Last, walking was not included in moderate to vigorous PA. Because of the many hours individuals indicated they spent walking, we hypothesize that work-related walking played a major role in over-reporting physical activity. Since work-related walking is, in most cases, not brisk walking, we decided to exclude the question.

Conclusion

Modest initial participation and high attrition in program use were found in the current study. Workers with a low intention to increase their PA level were less likely to enroll in the intervention, but once participating they were more likely to sustain their participation. Lifestyle and health indicators were not related to initial participation, but those with an unhealthier lifestyle were less likely to sustain their participation. This might influence program effectiveness as those who can benefit most are limitedly utilizing health promotion programs. Regular email messages prompted website use, but the use of important Web-based tools was limited. There is a need for more appealing techniques to enhance retention and to keep those individuals who need it most attracted to the program.

Acknowledgments

The Netherlands Organisation for Health Research and Development (ZonMw) funded this study. ZonMw project number: 62300039.

Conflicts of Interest

Dennis Lindeboom is employed at Lifeguard Inc, which developed and has proprietary interests in the program described in this paper. All analyses for the article were supervised and performed by personnel not part of Lifeguard Inc.

References

1. Robroek SJ, van Lenthe FJ, van Empelen P, Burdorf A. Determinants of participation in worksite health promotion programmes: a systematic review. Int J Behav Nutr Phys Act 2009;6:26 [FREE Full text] [doi: 10.1186/1479-5868-6-26] [Medline: 19457246]
2. Danaher BG, Boles SM, Akers L, Gordon JS, Severson HH. Defining participant exposure measures in Web-based health behavior change programs. J Med Internet Res 2006;8(3):e15 [FREE Full text] [doi: 10.2196/jmir.8.3.e15] [Medline: 16954125]
3. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. Am J Public Health 1999 Sep;89(9):1322-1327. [Medline: 10474547]
4. Norman GJ, Zabinski MF, Adams MA, Rosenberg DE, Yaroch AL, Atienza AA. A review of eHealth interventions for physical activity and dietary behavior change. Am J Prev Med 2007 Oct;33(4):336-345. [doi: 10.1016/j.amepre.2007.05.007] [Medline: 17888860]
5. Neve M, Morgan PJ, Jones PR, Collins CE. Effectiveness of web-based interventions in achieving weight loss and weight loss maintenance in overweight and obese adults: a systematic review with meta-analysis. Obes Rev 2010 Apr;11(4):306-321. [doi: 10.1111/j.1467-789X.2009.00646.x] [Medline: 19754633]
6. McNeill LH, Viswanath K, Bennett GG, Puleo E, Emmons KM. Feasibility of using a web-based nutrition intervention among residents of multiethnic working-class neighborhoods. Prev Chronic Dis 2007 Jul;4(3):A55 [FREE Full text] [Medline: 17572959]
7. Robroek SJ, Brouwer W, Lindeboom D, Oenema A, Burdorf A. Demographic, behavioral, and psychosocial correlates of using the website component of a worksite physical activity and healthy nutrition promotion program: a longitudinal study. J Med Internet Res 2010;12(3):e44 [FREE Full text] [doi: 10.2196/jmir.1402] [Medline: 20921001]
8. Eysenbach G. The law of attrition. J Med Internet Res 2005;7(1):e11 [FREE Full text] [doi: 10.2196/jmir.7.1.e11] [Medline: 15829473]
9. Im EO, Chee W. Methodological issues in the recruitment of ethnic minority subjects to research via the Internet: a discussion paper. Int J Nurs Stud 2005 Nov;42(8):923-929. [doi: 10.1016/j.ijnurstu.2005.01.002] [Medline: 16210030]

XSL•FO
RenderX

10. Verheijden MW, Jans MP, Hildebrandt VH, Hopman-Rock M. Rates and determinants of repeated participation in a web-based behavior change program for healthy body weight and healthy lifestyle. J Med Internet Res 2007;9(1):e1 [FREE Full text] [doi: 10.2196/jmir.9.1.e1] [Medline: 17478410]
11. Buis LR, Poulton TA, Holleman RG, Sen A, Resnick PJ, Goodrich DE, et al. Evaluating Active U: an Internet-mediated physical activity program. BMC Public Health 2009;9:331 [FREE Full text] [doi: 10.1186/1471-2458-9-331] [Medline: 19744311]
12. Spittaels H, De Bourdeaudhuij I. Who participates in a computer-tailored physical activity program delivered through the Internet? A comparison of participants' and non-participants' characteristics. Int J Behav Nutr Phys Act 2007;4:39 [FREE Full text] [doi: 10.1186/1479-5868-4-39] [Medline: 17880696]
13. Van 't Riet J, Crutzen R, De Vries H. Investigating predictors of visiting, using, and revisiting an online health-communication program: a longitudinal study. J Med Internet Res 2010;12(3):e37 [FREE Full text] [doi: 10.2196/jmir.1345] [Medline: 20813716]
14. Brouwer W, Oenema A, Raat H, Crutzen R, de Nooijer J, de Vries NK, et al. Characteristics of visitors and revisitors to an Internet-delivered computer-tailored lifestyle intervention implemented for use by the general public. Health Educ Res 2010 Aug;25(4):585-595 [FREE Full text] [doi: 10.1093/her/cyp063] [Medline: 19897515]
15. Glasgow RE, Strycker LA, Kurz D, Faber A, Bell H, Dickman JM, et al. Recruitment for an internet-based diabetes self-management program: scientific and ethical implications. Ann Behav Med 2010 Aug;40(1):40-48. [doi: 10.1007/s12160-010-9189-1] [Medline: 20411443]
16. Ware LJ, Hurling R, Bataveljic O, Fairley BW, Hurst TL, Murray P, et al. Rates and determinants of uptake and use of an internet physical activity and weight management program in office and manufacturing work sites in England: cohort study. J Med Internet Res 2008;10(4):e56 [FREE Full text] [doi: 10.2196/jmir.1108] [Medline: 19117828]
17. Moore TJ, Alsabeeh N, Apovian CM, Murphy MC, Coffman GA, Cullum-Dugan D, et al. Weight, blood pressure, and dietary benefits after 12 months of a Web-based Nutrition Education Program (DASH for health): longitudinal observational study. J Med Internet Res 2008;10(4):e52 [FREE Full text] [doi: 10.2196/jmir.1114] [Medline: 19073541]
18. Bot M, Milder IE, Bemelmans WJ. Nationwide implementation of Hello World: a Dutch email-based health promotion program for pregnant women. J Med Internet Res 2009;11(3):e24 [FREE Full text] [doi: 10.2196/jmir.1183] [Medline: 19674957]
19. Spittaels H, De Bourdeaudhuij I, Brug J, Vandelanotte C. Effectiveness of an online computer-tailored physical activity intervention in a real-life setting. Health Educ Res 2007 Jun;22(3):385-396 [FREE Full text] [doi: 10.1093/her/cyl096] [Medline: 16971674]
20. Wanner M, Martin-Diener E, Bauer G, Braun-Fahrländer C, Martin BW. Comparison of trial participants and open access users of a web-based physical activity intervention regarding adherence, attrition, and repeated participation. J Med Internet Res 2010;12(1):e3 [FREE Full text] [doi: 10.2196/jmir.1361] [Medline: 20147006]
21. Oenema A, Brug J, Dijkstra A, de Weerdt I, de Vries H. Efficacy and use of an internet-delivered computer-tailored lifestyle intervention, targeting saturated fat intake, physical activity and smoking cessation: a randomized controlled trial. Ann Behav Med 2008 Apr;35(2):125-135. [doi: 10.1007/s12160-008-9023-1] [Medline: 18363076]
22. Robroek SJ, Bredt FJ, Burdorf A. The (cost-)effectiveness of an individually tailored long-term worksite health promotion programme on physical activity and nutrition: design of a pragmatic cluster randomised controlled trial. BMC Public Health 2007;7:259 [FREE Full text] [doi: 10.1186/1471-2458-7-259] [Medline: 17888161]
23. Kroeze W, Oenema A, Dagnelie PC, Brug J. Examining the minimal required elements of a computer-tailored intervention aimed at dietary fat reduction: results of a randomized controlled dismantling study. Health Educ Res 2008 Oct;23(5):880-891 [FREE Full text] [doi: 10.1093/her/cym075] [Medline: 18063650]
24. van Assema P, Brug J, Ronda G, Steenhuis I. The relative validity of a short Dutch questionnaire as a means to categorize adults and adolescents to total and saturated fat intake. J Hum Nutr Diet 2001 Oct;14(5):377-390. [Medline: 11906579]
25. Statistics Netherlands. Foreigners in the Netherlands (Allochtonen in Nederland). Voorburg: Statistics Netherlands; 2003.
26. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003 Aug;35(8):1381-1395. [doi: 10.1249/01.MSS.0000078924.61453.FB] [Medline: 12900694]
27. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc 2000 Sep;32(9 Suppl):S498-S504. [Medline: 10993420]
28. Bogers RP, Van Assema P, Kester AD, Westerterp KR, Dagnelie PC. Reproducibility, validity, and responsiveness to change of a short questionnaire for measuring fruit and vegetable intake. Am J Epidemiol 2004 May 1;159(9):900-909 [FREE Full text] [Medline: 15105183]
29. Ware J, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care 1996 Mar;34(3):220-233. [Medline: 8628042]
30. Balady GJ. ASCM's guidelines for exercise testing and prescription. Philadelphia: Lippincott Williams & Wilkins; 2000.
31. Ronda G, Van Assema P, Brug J. Stages of change, psychological factors and awareness of physical activity levels in The Netherlands. Health Promot Int 2001 Dec;16(4):305-314 [FREE Full text] [Medline: 11733449]

XSL•FO
RenderX

32. Engbers LH, van Poppel MN, Chin A Paw M, van Mechelen W. The effects of a controlled worksite environmental intervention on determinants of dietary behavior and self-reported fruit, vegetable and fat intake. BMC Public Health 2006;6:253 [FREE Full text] [doi: 10.1186/1471-2458-6-253] [Medline: 17044935]
33. van den Berg T, Schuring M, Avendano M, Mackenbach J, Burdorf A. The impact of ill health on exit from paid employment in Europe among older workers. Occup Environ Med 2010 Dec;67(12):845-852. [doi: 10.1136/oem.2009.051730] [Medline: 20798020]
34. Groeneveld IF, Proper KI, van der Beek AJ, Hildebrandt VH, van Mechelen W. Factors associated with non-participation and drop-out in a lifestyle intervention for workers with an elevated risk of cardiovascular disease. Int J Behav Nutr Phys Act 2009;6:80 [FREE Full text] [doi: 10.1186/1479-5868-6-80] [Medline: 19951417]
35. Fry JP, Neff RA. Periodic prompts and reminders in health promotion and health behavior interventions: systematic review. J Med Internet Res 2009;11(2):e16 [FREE Full text] [doi: 10.2196/jmir.1138] [Medline: 19632970]
36. Binks M, van Mierlo T. Utilization patterns and user characteristics of an ad libitum Internet weight loss program. J Med Internet Res 2010;12(1):e9 [FREE Full text] [doi: 10.2196/jmir.1347] [Medline: 20350926]
37. Brouwer W, Kroeze W, Crutzen R, de Nooijer J, de Vries NK, Brug J, et al. Which intervention characteristics are related to more exposure to internet-delivered healthy lifestyle promotion interventions? A systematic review. J Med Internet Res 2011;13(1):e2 [FREE Full text] [doi: 10.2196/jmir.1639] [Medline: 21212045]
38. Ferney SL, Marshall AL. Website physical activity interventions: preferences of potential users. Health Educ Res 2006 Aug;21(4):560-566 [FREE Full text] [doi: 10.1093/her/cyl013] [Medline: 16702194]

Abbreviations

BMI: body mass index
CI: confidence interval
GEE: general estimating equations
n/a: not available
OR: odds ratio
PA: Physical activity

Edited by G Eysenbach; submitted 28.02.11; peer-reviewed by C Richardson, S Martinez; comments to author 27.07.11; revised version received 18.10.11; accepted 16.01.12; published 05.03.12.

Please cite as:
Robroek SJW, Lindeboom DEM, Burdorf A
Initial and Sustained Participation in an Internet-delivered Long-term Worksite Health Promotion Program on Physical Activity and Nutrition
J Med Internet Res 2012;14(2):e43
URL: http://www.jmir.org/2012/2/e43/
doi:10.2196/jmir.1788
PMID:22390886

©Suzan JW Robroek, Dennis EM Lindeboom, Alex Burdorf. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 05.03.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original paper

Program Completion of a Web-Based Tailored Lifestyle Intervention for Adults: Differences between a Sequential and a Simultaneous Approach

Daniela N Schulz[1], MSc; Francine Schneider[1], MSc; Hein de Vries[1], PhD; Liesbeth ADM van Osch[1], PhD; Peter WM van Nierop[2], MSc; Stef PJ Kremers[3], PhD

[1]CAPHRI School for Public Health and Primary Care, Department of Health Promotion, Maastricht University, Maastricht, Netherlands

[2]Municipal Health Services, Department of Health Promotion, Helmond, Netherlands

[3]Nutrition and Toxicology Research Institute Maastricht (NUTRIM), Department of Health Promotion, Maastricht University, Maastricht, Netherlands

Corresponding Author:
Daniela N Schulz, MSc
CAPHRI School for Public Health and Primary Care
Department of Health Promotion
Maastricht University
P.O. Box 616
Maastricht, 6200 MD
Netherlands
Phone: 31 43 3882832
Fax: 31 43 3671032
Email: dn.schulz@maastrichtuniversity.nl

Abstract

Background: Unhealthy lifestyle behaviors often co-occur and are related to chronic diseases. One effective method to change multiple lifestyle behaviors is web-based computer tailoring. Dropout from Internet interventions, however, is rather high, and it is challenging to retain participants in web-based tailored programs, especially programs targeting multiple behaviors. To date, it is unknown how much information people can handle in one session while taking part in a multiple behavior change intervention, which could be presented either sequentially (one behavior at a time) or simultaneously (all behaviors at once).

Objectives: The first objective was to compare dropout rates of 2 computer-tailored interventions: a sequential and a simultaneous strategy. The second objective was to assess which personal characteristics are associated with completion rates of the 2 interventions.

Methods: Using an RCT design, demographics, health status, physical activity, vegetable consumption, fruit consumption, alcohol intake, and smoking were self-assessed through web-based questionnaires among 3473 adults, recruited through Regional Health Authorities in the Netherlands in the autumn of 2009. First, a health risk appraisal was offered, indicating whether respondents were meeting the 5 national health guidelines. Second, psychosocial determinants of the lifestyle behaviors were assessed and personal advice was provided, about one or more lifestyle behaviors.

Results: Our findings indicate a high non-completion rate for both types of intervention (71.0%; n = 2167), with more incompletes in the simultaneous intervention (77.1%; n = 1169) than in the sequential intervention (65.0%; n = 998). In both conditions, discontinuation was predicted by a lower age (sequential condition: OR = 1.04; $P < .001$; CI = 1.02-1.05; simultaneous condition: OR = 1.04; $P < .001$; CI = 1.02-1.05) and an unhealthy lifestyle (sequential condition: OR = 0.86; $P = .01$; CI = 0.76-0.97; simultaneous condition: OR = 0.49; $P < .001$; CI = 0.42-0.58). In the sequential intervention, being male (OR = 1.27; $P = .04$; CI = 1.01-1.59) also predicted dropout. When respondents failed to adhere to at least 2 of the guidelines, those receiving the simultaneous intervention were more inclined to drop out than were those receiving the sequential intervention.

Conclusion: Possible reasons for the higher dropout rate in our simultaneous intervention may be the amount of time required and information overload. Strategies to optimize program completion as well as continued use of computer-tailored interventions should be studied.

Trial Registration: Dutch Trial Register NTR2168

XSL•FO
RenderX

(J Med Internet Res 2012;14(2):e26) doi:10.2196/jmir.1968

KEYWORDS

Internet; dropout; computer tailoring; multiple health behavior change intervention; sequential; simultaneous; lifestyle

Introduction

Unhealthy lifestyle behaviors, such as physical inactivity, insufficient fruit and vegetable intake, high alcohol consumption, and smoking, often co-occur [1-4] and are related to chronic diseases like cardiovascular diseases and cancer [5]. In view of this co-occurrence, various studies have emphasized the need to develop interventions addressing more than one risk behavior.

One method to change lifestyle behavior is the use of computer tailoring. Positive aspects of web-based computer-tailored programs are that these can be administered in privacy and at a time that suits the respondent [6], and that they can be integrated in larger multicomponent interventions [7]. In addition to their positive effects on health behavior change [e.g. 7-10], numerous studies have shown that (web-based) tailored messages attract the public's attention [11,12], are perceived as personally relevant [13], and are usually better read, saved, remembered, and discussed with others than non-tailored materials [7,9,14-16].

The public health impact of an intervention is defined by the program's efficacy multiplied by its reach [7,17]. Thus, the impact is highest when an intervention is effective and has a wide reach. In view of the high rate of Internet access these days (91% in the Netherlands) [18], Internet-based programs may have the potential to reach large numbers of people. However, various studies have pointed out that the actual use of web-based interventions may be limited [19-21] and that leaving an Internet intervention prematurely is common [e.g. 22-24]. Brouwer et al. [25] reported that more than half of the visitors (Dutch adults) of their online intervention left the website within 30 seconds, while 10.5% stayed for more than 15 minutes. Hence, there is a need to identify factors associated with early discontinuation or continuation of participation in web-based programs promoting the adoption of healthy lifestyles.

Various tailoring strategies can be used to address multiple behaviors with computer-tailored interventions, such as a sequential or a simultaneous strategy. A simultaneous strategy concurrently targets multiple behaviors for intervention, while a sequential strategy targets a single behavior at a time. The few studies that have investigated the effects on behavioral change of sequential versus simultaneous strategies to provide multiple health-behavior change interventions reported inconsistent findings [26-28]. According to Vandelanotte et al. [28], the sequential strategy may be more effective than the simultaneous strategy when participants can choose the behavior on which they would prefer to receive personal feedback first, and can start with this part of the intervention, instead of the lifestyle modules being presented in a predefined order [see also 29].

In any case, behavioral change will be more likely when someone completes the whole intervention program [30], as early dropout is a hazard to the effectiveness of any intervention. Hence, when considering the use of a sequential or simultaneous approach for web-based computer-tailored interventions, it is important to study continuation rates. In both types of intervention, people receive only the modules about health behavior topics for which they are at risk in order to increase the relevance of the intervention [31]. When being at risk for at least two behaviors, people in the simultaneous intervention receive, and thus have to handle, more information at one point in time compared to a sequential intervention, in which the same amount of information is spread over time. Therefore, a simultaneous strategy, including a more complex program, is likely to require more time from the respondents and to increase the behavior change demands [31], especially when respondents fail to meet multiple guidelines. Hence, because a simultaneous approach may lead to an overload of information, such a strategy may potentially lead to higher dropout rates than a sequential strategy [31-32]. Respondents may become overwhelmed by the amount of information [33] and may perceive ego depletion, leading to a reduced capacity to change [34]. Furthermore, tailoring multiple behaviors simultaneously could fail to address any single behavior in sufficient depth [3,31,35]. On the other hand, addressing various behaviors simultaneously may optimize the occurrence of synergistic effects [36-40]. Hence, both strategies may have advantages as well as disadvantages. To our knowledge, there is no literature about the difference in completion and dropout rates between users of sequential and those of simultaneous behavior change interventions.

In addition to the problem of dropout, another important aspect is that high-risk populations (such as the less-educated and people with many unhealthy behaviors) are often insufficiently reached [e.g. 41], and it is especially those with unhealthy behavior who should engage in online health interventions and spend enough time on the website [42]. It is essential to identify the characteristics of people who complete or fail to complete online health interventions. In a study by Brouwer et al. [25], respondents who completed the program were mostly female, middle-aged (40 to 50 years), and medium-educated, and had a healthier lifestyle. This information about completers' characteristics can be used to improve tailored programs by making them more attractive to the individual user.

In conclusion, computer-tailored technology addressing multiple behaviors is still in its infancy [43-45]. It is unknown how much information people can and will handle in multiple behavior change interventions. In this study, we investigated the level of completion of a web-based tailored intervention addressing 5 lifestyle behaviors (physical activity, fruit consumption, vegetable consumption, alcohol intake, and smoking), and tested potential information overload by comparing dropout rates for two versions of the program, one offering a single behavior change module as part of a sequential program and one providing simultaneous tailored feedback on different behaviors. In addition, this study investigated personal predictors of dropout for the two versions of our computer-tailored program.

XSL•FO
RenderX

Methods

Design

In this study, which was part of a randomized controlled trial (Dutch Trial Register NTR2168), tailored information was provided to two groups, one receiving a sequential behavior tailoring condition (referred to below as sequential condition) and one receiving a simultaneous behavior tailoring condition (simultaneous condition) [46]. The only difference between the conditions was that in the sequential condition, respondents were invited to focus their attention first on a single behavior for which they failed to meet the Dutch national recommendations, whereas the simultaneous condition addressed all behaviors for which they failed to meet the Dutch recommendations at once. A detailed description of the study protocol has been published elsewhere [46].

Participants and Procedure

In the autumn of 2009, several Dutch Regional Health Authorities in the provinces of North-Brabant and Zeeland conducted an *Adult Health Monitor* study among adults (19-64 years) living in these provinces. This web-based questionnaire included demographics, aspects of general health and health-related topics. It also included questions regarding the respondents' lifestyle behaviors (physical activity, fruit and vegetable consumption, alcohol intake, and smoking). Completion took an average of 36 minutes (SD = 15.8). At the end of the questionnaire, respondents received information about the tailored program. When interested in this program, they could fill in their e-mail address. The eligibility criteria were participation in the *Adult Health Monitor* study, a valid e-mail address, and computer / Internet literacy. Approximately 3 weeks after completing the monitor questionnaire, participants interested in receiving tailored feedback received an e-mail enabling them to log on to the computer tailored program (see Figure 1). After approximately one month, people who did not respond to this e-mail received a reminder e-mail.

Figure 1. Screenshot of the homepage of the intervention program.



Intervention

The aim of the intervention was to stimulate participants to improve their lifestyle, focusing on 5 health behaviors. Based on the respondents' answers to the different questions, an expert system selected the appropriate feedback messages from a large database and presented these directly on the respondent's computer screen [46]. The I-Change model [47] was used as a theoretical framework for the questionnaires and the tailored advice.

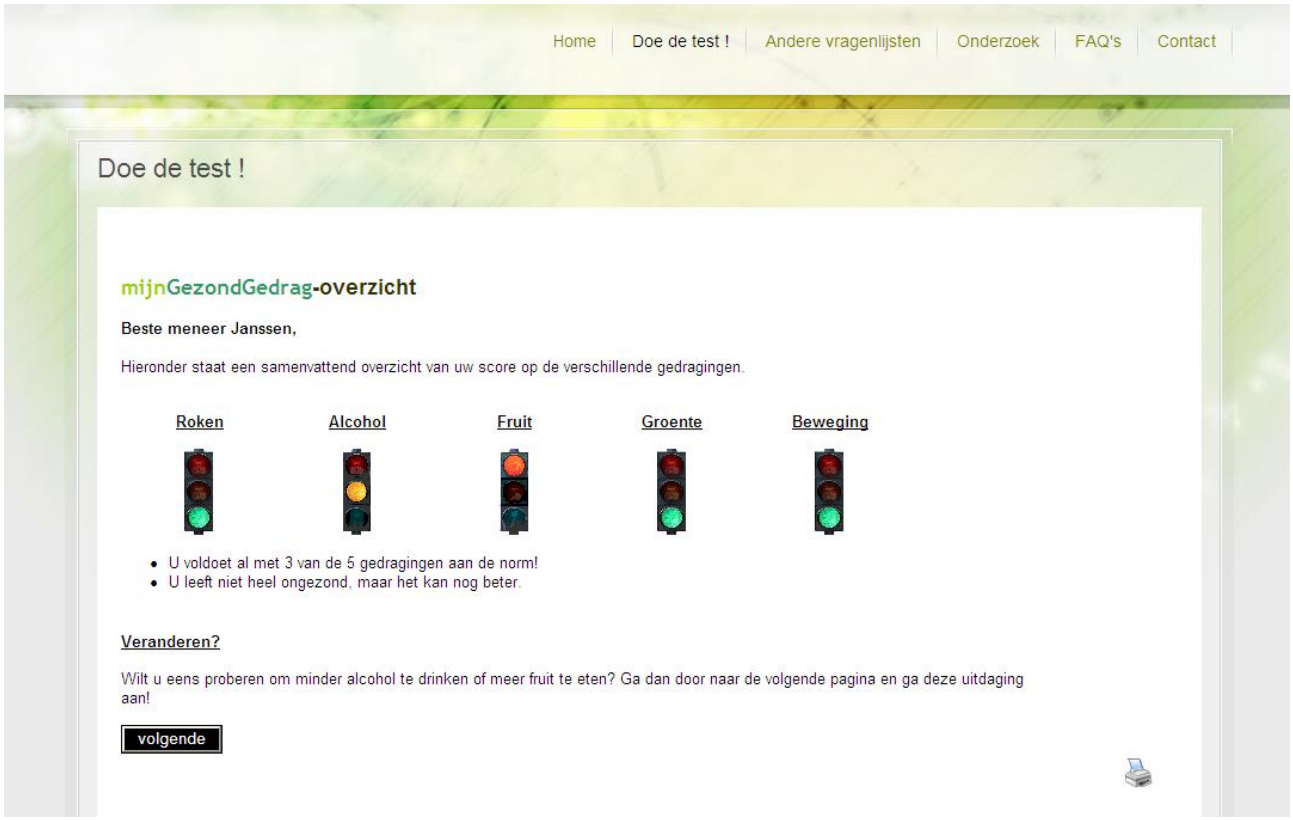
The first part of the feedback consisted of a health risk appraisal. Based on their answers on the *Adult Health Monitor* questionnaire, respondents received feedback concerning their lifestyle and information about whether they were meeting the public health guidelines defined for the 5 health behaviors, namely being moderately physically active for 30 minutes on at least five days a week; eating 200 g of vegetables per day; eating 2 pieces of fruit per day; not drinking more than 1 (women) or 2 (men) glasses of alcohol a day; and not smoking. In addition to more detailed information about the guidelines and the specific health behavior, respondents' scores were depicted graphically in the form of a traffic light (indicating whether they met, almost met, or did not meet the guideline) as well a bar chart comparing the respondents' behavior with the guideline for this behavior. At the end of the health risk

XSL•FO
RenderX

appraisal, respondents received an overview illustrating their lifestyle behavior status (see Figure 2).

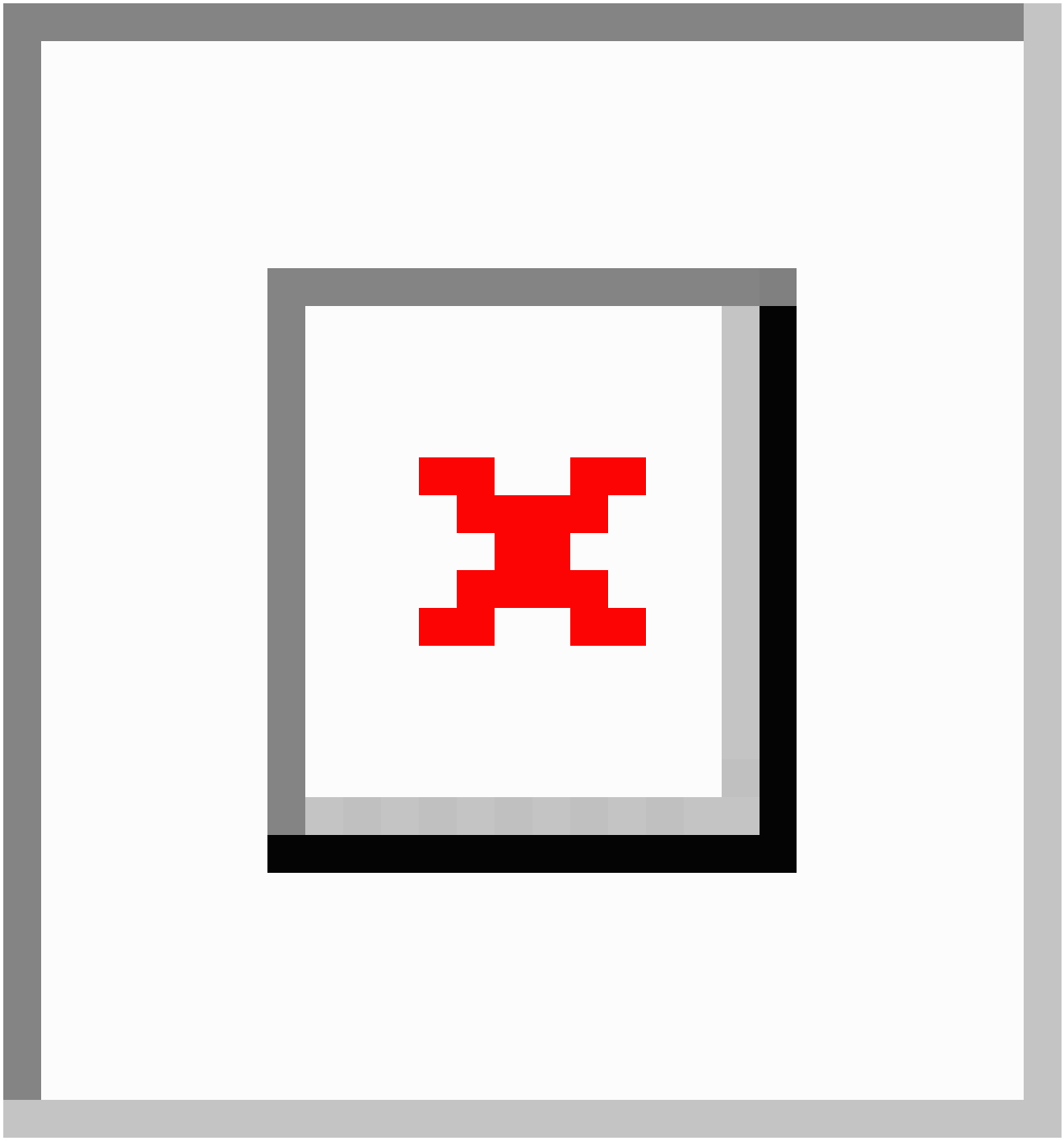
Afterwards, in the second part of the program, personal advice was provided, based on additional questions about psychosocial determinants (ie, attitude, social influence, preparatory action plans, self-efficacy, and coping plans; see Figures 3 and 4), on one or more lifestyle behaviors, depending on the tailoring condition.

Figure 2. Screenshot of the health risk appraisal.



XSL•FO
RenderX

Figure 3. Screenshot of items regarding the pros and cons of alcohol intake.



XSL•FO
RenderX

Figure 4. Screenshot of a personal advice regarding the pros of alcohol intake.



Sequential Condition

After receiving the health risk appraisal, individuals in the sequential condition were invited to choose one of the health behaviors for which they were currently failing to meet the guideline. Respondents were encouraged to select the behavior that they were most motivated to change. This was followed by a progressive scheme consisting of 4 steps, in which respondents received personal advice based on various psychosocial constructs: (1) attitude, (2) social influence, (3) preparatory plans, and (4) self-efficacy and coping plans regarding the lifestyle behavior that they had chosen. Personal advice was given after the questions about each psychosocial construct (ie, attitude questions were followed by personal feedback about these items).

Simultaneous Condition

After receiving the health risk appraisal, participants in the simultaneous condition received feedback on all behaviors for which they failed to adhere to the public health guidelines in a predefined order. At random, half of the respondents started with the modules addressing preventive health behaviors (ie, (1) physical activity, (2) vegetable consumption, (3) fruit consumption) and ended with the modules addressing addiction behaviors (ie, (4) alcohol intake, (5) smoking), whereas the other half passed through the modules in reversed order. Respondents were presented with additional questions concerning psychosocial constructs, as well as personal advice on all behaviors for which they failed to adhere to the lifestyle recommendations. The 4-step progressive scheme ((1) attitude, (2) social influence, (3) preparatory plans, and (4) self-efficacy and coping plans) was used for all relevant lifestyle behaviors. Again, questions and personal advice were presented alternately.

Measures

Demographic Information

The following demographic variables were assessed: age, gender, educational level (no education, primary, or lower vocational school (low); secondary vocational school or high school (medium); or higher professional education or university (high)), income, current job status, marital status, number of persons in the household, and country of origin.

Health Status

Quality of life was assessed using the SF-12 Health Survey [48,49]. Symptoms of depression and anxiety were assessed by the Kessler Psychological Distress Scale (K10) [50]. Body mass index (BMI) was estimated from questions about height and weight.

Lifestyle Behaviors

Five lifestyle behaviors were assessed using validated questionnaires: (1) physical activity, (2) fruit consumption, (3) vegetable consumption, (4) alcohol intake, and (5) smoking.

Physical activity was measured by the Short QUestionnaire to ASsess Health-enhancing physical activity (SQUASH) [51], and guideline adherence was assessed using procedures developed by Ainsworth et al. [52].

Fruit consumption was measured using a 4-item Food Frequency Questionnaire (FFQ) assessing weekly fruit and fruit juice intake [53].

XSL•FO
RenderX

Vegetable consumption was measured using a 4-item FFQ assessing the weekly consumption of boiled or baked vegetables, as well as salads or raw vegetables [53].

Alcohol intake was measured by the 5-item Dutch Quantity-Frequency-Variability (QFV) questionnaire [54].

Smoking was assessed by asking participants if they smoked, what they smoked (cigarettes, cigars, or pipe tobacco), and how much they smoked per day (cigarettes) or per week (cigars or pipe tobacco).

Psychosocial Determinants

The following description of the psychosocial determinants that were assessed is presented here to provide an overview of the program; the data on these items were not included in the analysis. Based on earlier studies [15], various psychosocial factors were assessed for the five different lifestyle behaviors: *attitude* (6 items, such as "Eating 2 pieces of fruit every day is good for my health" – totally disagree to totally agree); *social influence* (3 items, such as "How many people in your direct environment smoke?" – nobody to everybody); *self-efficacy* (6 items, such as "I am able to eat sufficient vegetables when I have other delicious food at home" – no, definitely not to yes, definitely); *preparatory plans* (3 items, such as "I intend to allow time for physical activity" – no, definitely not to yes, definitely); and *coping plans* (6 items, such as "I have made a plan to drink no more than 2 glasses of alcohol when I feel stressed or nervous" – totally disagree to totally agree).

Program Use

We counted the time respondents spent on the website during their first visit (ie, from logging in to the program until logging out or closing the website). Furthermore, we assessed the number of respondents who started with the first module and the number of respondents who filled out the program completely.

Statistical Analyses

The data was analyzed using SPSS software, version 17.0. Descriptive statistics were used to describe the characteristics of the study sample and to calculate the dropout rates for the 2 tailoring conditions. In the sequential condition, a completer was defined as someone who filled in one module from start to finish (ie, including the final question) since the aim of the first visit was that respondents of this condition complete one module relating to a lifestyle behavior for which they failed to adhere to the guideline. In the simultaneous condition, a completer was defined as someone who completed all modules relating to the lifestyle behaviors for which they failed to adhere to the guidelines. The groups (ie, completers versus non-completers) were compared in terms of their demographics and lifestyle behaviors by means of Chi-square tests for discrete variables and independent-samples *t* tests for continuous variables. In addition, effect sizes (ES) were calculated based on means (Cohen's *d*) and percentages (categorical variables). Effect sizes below 0.30 are considered small, while those between 0.30 and 0.80 are considered medium, and those larger than 0.80 are considered large [55]. Chi-square tests as well as effect size calculations were also used to explore differences between the tailoring conditions in terms of their completion rates, based on the number of guidelines that respondents failed to meet. Logistic regression analyses, using the Enter method, were used to identify predictors of program completion (demographics, health status, lifestyle behaviors and condition) within the entire sample. To identify interaction effects of tailoring condition and possible predictors, interaction terms were added to the regression equation. In the case of a significant interaction, logistic regression analyses were done separately for the two tailoring conditions to identify the predictors (demographics, health status, lifestyle behaviors).

Results

Participants' Characteristics

A total of 3473 individuals participated in the present study. The mean age of the participants was 44 years. Slightly more men than women took part. With regard to the participants' lifestyle, 17.4% (n = 608) failed to meet the physical activity guidelines, 67.4% (n = 2323) did not eat enough vegetables, 54.6% (n = 1873) did not eat enough fruit, 28.2% (n = 978) drank too much alcohol, and 19.0% (n = 660) reported that they smoked. Almost two-thirds did not adhere to two or more health behavior guidelines (n = 2106; 61.7%). The characteristics of the total sample are listed in Table 1.

XSL•FO
RenderX

Table 1. Demographics, health status and lifestyle of the study sample (N = 3473)

Variable	Total group
Age, n = 3473	43.61 (19-64; SD = 12.60)
Gender, n = 3473	
Male	1849 (53.2%)
Female	1624 (46.8%)
Education, n = 3458	
Low	367 (10.6%)
Medium	1607 (46.5%)
High	1483 (42.9%)
Income per month, n = 3468	
< € 1000	226 (6.5%)
€ 1001 - € 1350	228 (6.6%)
€ 1351 - € 1750	373 (10.8%)
€ 1750 - € 3050	1177 (33.9%)
> € 3051	976 (28.1%)
“I don’t want to say”	488 (14.1%)
Employment situation, n = 3467	
Employed	2655 (76.6%)
Studying	229 (6.6%)
Homemaker	176 (5.1%)
Not currently in employment	407 (11.7%)
Marital status, n = 3457	
Married	2092 (60.5%)
Living together	528 (15.3%)
Unmarried	639 (18.5%)
Divorced	170 (4.9%)
Widowed	28 (0.8%)
# persons in household n = 3473	2.91 (1-20; SD = 1.42)
Native country, n = 3471	
The Netherlands	3300 (95.1%)
Other	171 (4.9%)
BMI, n = 3445	25.17 (15.03-58.11; SD = 3.96)
Quality of Life, n = 3452	40.11 (16-48; SD = 5.15)
K10 (psychological distress), n = 3461	44.78 (12-50; SD = 5.70)
Number of guidelines complied with, n = 3411	
0	25 (0.7%)
1	226 (6.6%)
2	681 (20.0%)
3	1174 (34.4%)
4	947 (27.8%)
5	358 (10.5%)
Physical activity, n = 3473	

XSL•FO
RenderX

Variable	Total group
Compliance	2865 (82.5%)
Non-compliance	608 (17.4%)
Vegetable consumption, n = 3446	
Compliance	1123 (32.6%)
Non-compliance	2323 (67.4%)
Fruit consumption, n = 3433	
Compliance	1560 (45.4%)
Non-compliance	1873 (54.6%)
Alcohol intake, n = 3473	
Compliance	2495 (71.8%)
Non-compliance	978 (28.2%)
Smoking, n = 3473	
Compliance	2813 (81.0%)
Non-compliance	660 (19.0%)

Completion and Dropout

As shown in Figure 5, the 3473 people who logged on to the program were evenly randomized to the 2 tailoring conditions. A total of 358 respondents (10.3%) adhered to all 5 health guidelines. These people were not included in our further analyses, as no specific completion moment could be defined for this group. Of the remaining 3115 respondents, 1325 (42.5%) logged out immediately after receiving the health risk appraisal, and 62 (2.0%) even before receiving the health risk appraisal: in the sequential condition, 53.5% (n = 821) started one lifestyle module, while in the simultaneous condition, 59.8% (n = 907) started at least the first lifestyle module ($\chi^2_1 = 12.48$; $P < .001$). Of the 821 starters in the sequential condition, 65.5% (n = 538) completed the module, while of the 907 starters in the simultaneous condition, 38.4% (n = 348) completed the whole program ($\chi^2_1 = 127.25$; $P < .001$).

On average, respondents in the sequential condition spent 10 minutes and 8 seconds on the web-based tailored program, while respondents in the simultaneous condition spent an average of 9 minutes and 47 seconds. In the sequential condition, respondents completed the program on average within 18 minutes and 10 seconds, while non-completers spent an average of 6 minutes and 20 seconds on the program. In the simultaneous condition, respondents completed the program within 20 minutes and 52 seconds, while non-completers left the program on average after 6 minutes and 16 seconds.

The Influence of Guideline Adherence Level on Dropout

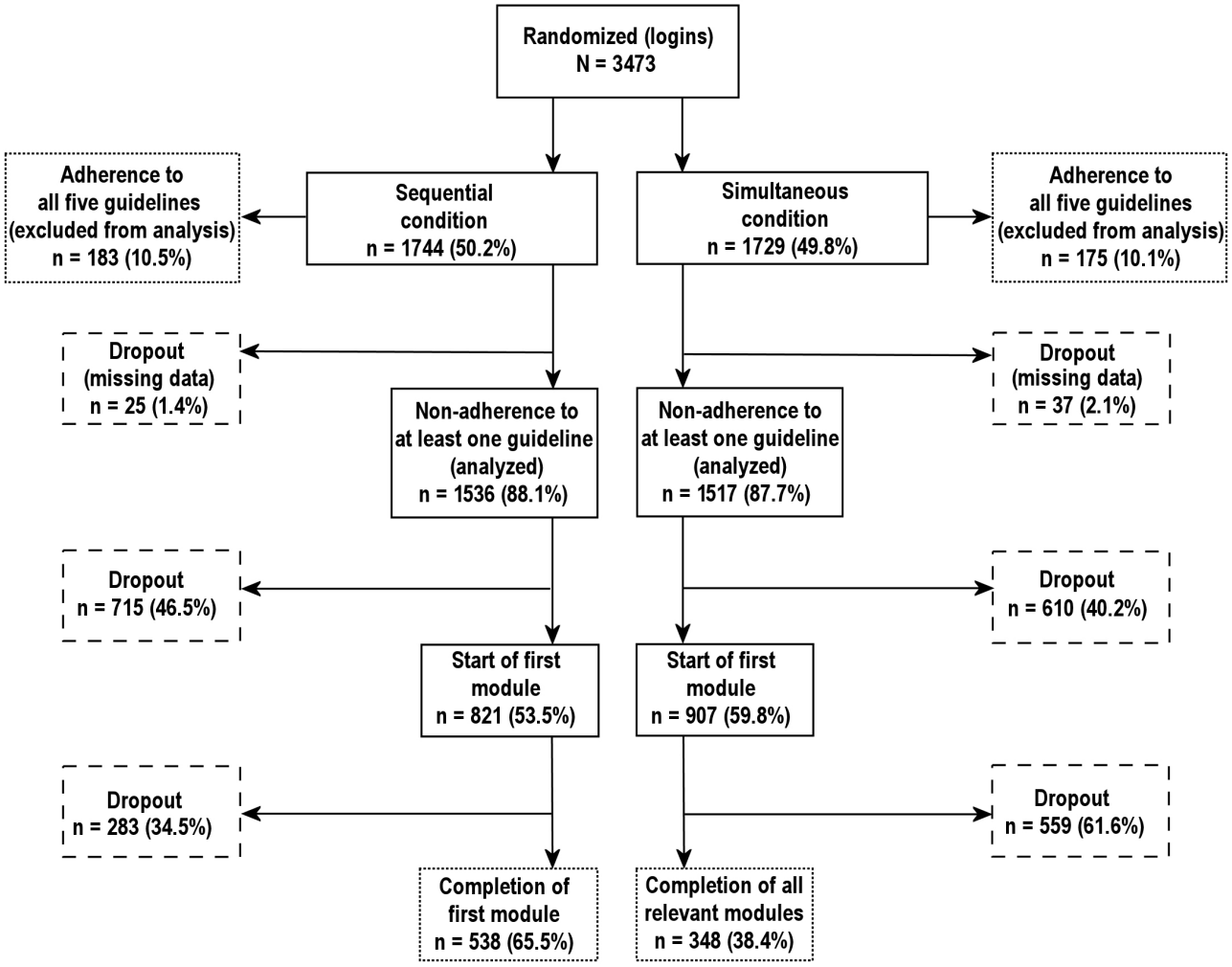
The completion rate generally decreased as the number of guidelines that the respondents failed to meet increased (see Figure 6). However, this decline of the completion rates differed between the two conditions. Respondents in the simultaneous condition who failed to adhere to 2 or more guidelines were more likely to leave the site prematurely than those in the sequential condition who failed to adhere to the same number of guidelines.

Differences between Completers and Non-Completers

The 2 tailoring groups did not differ in terms of their demographics, health status or lifestyle behaviors, indicating that randomization had been successful. A comparison of respondents who filled in the entire program (ie, completers) with respondents who prematurely left the site (ie, non-completers) showed that the two groups differed on all variables, except for income, native country, K10 and alcohol intake (see Table 2). Medium effect sizes regarding these differences concerned age and the number of guidelines respondents adhered to. Completers were older than non-completers were and completers adhered to more health guidelines than non-completers did.

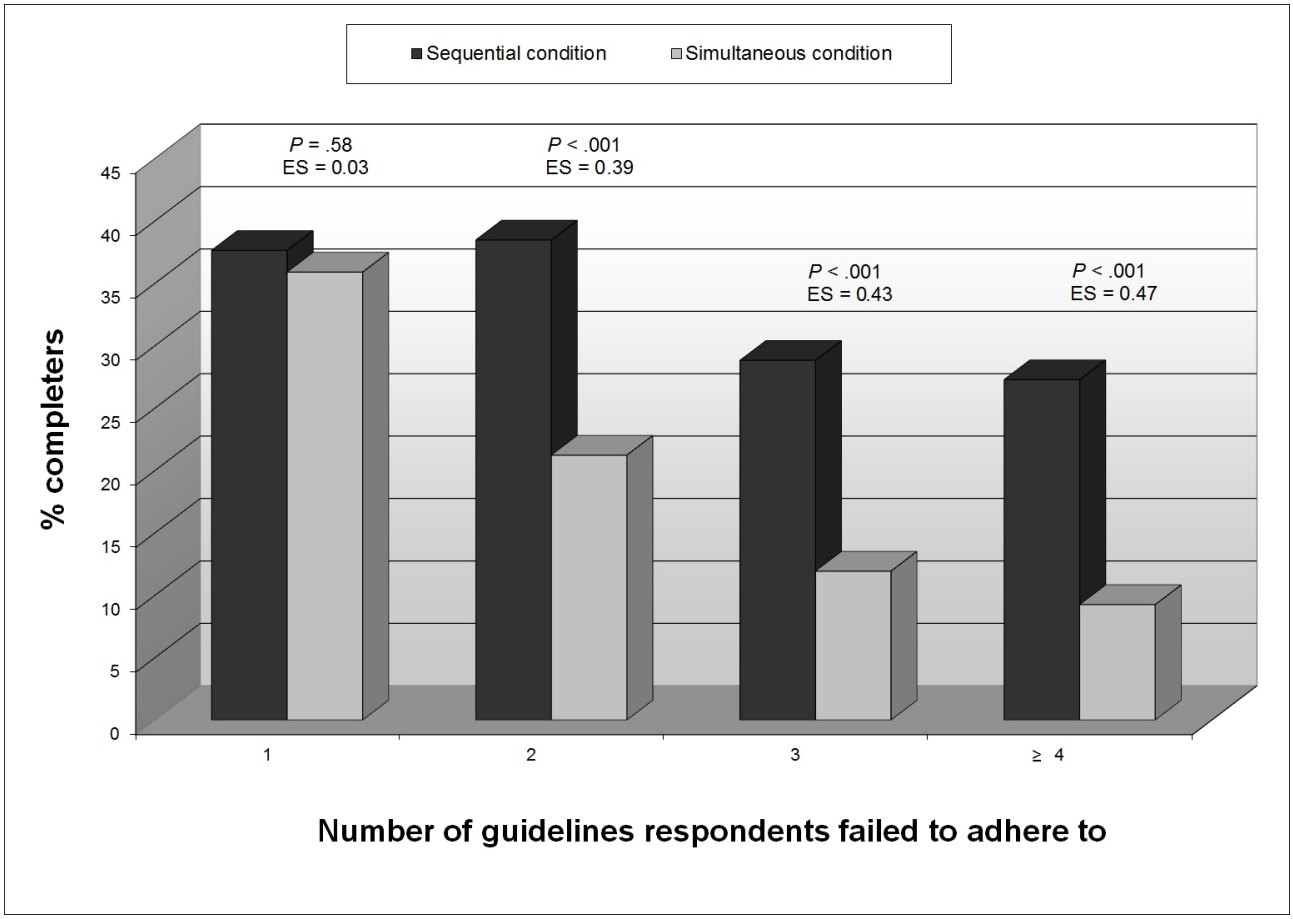
XSL•FO
RenderX

Figure 5. Attrition diagram.



XSL•FO
RenderX

Figure 6. Number of guidelines respondents failed to adhere to against the number of completers in the sequential condition (n = 1536) and the simultaneous condition (n = 1517).



XSL•FO
RenderX

Table 2. Differences in demographics, health status and lifestyle between non-completers and completers (N = 3053)

Variable	Non-completer n = 2167	Completers n = 886	*T (P)*	χ^2 *(P)*	*ES*
Age	41.85 (SD = 12.64)	47.21 (SD = 11.96)	11.07 (*P* < .001)		0.43
Gender					
Male	1202 (55.5%)	450 (50.8%)			
Female	965 (44.5%)	435 (49.2%)		6.58 (*P* = .037)	0.09
Education					
Low	212 (9.8%)	120 (13.6%)			
Medium	1007 (46.7%)	424 (48.0%)			
High	938 (43.5%)	339 (38.4%)		13.35 (*P* = .010)	0.13
Income per month [a]					
< € 1750	504 (23.3%)	221 (25.0%)			
€ 1751 - € 3050	1040 (48.0%)	437 (49.5%)			
> € 3051	621 (28.7%)	225 (25.5%)		4.46 (*P* = .347)	0.08
Employment situation					
Job	1852 (85.6%)	686 (77.7%)			
No job	311 (14.4%)	197 (22.3%)		33.34 (*P* < .001)	0.21
Relationship status					
Single	557 (25.8%)	191 (21.8%)			
In relationship	1602 (74.2%)	687 (78.2%)		8.56 (*P* = .014)	0.11
# persons in household	2.99 (SD = 1.45)	2.74 (SD = 1.25)	-4.86 (*P* < .001)		0.18
Native country					
The Netherlands	2075 (95.8%)	838 (94.7%)			
Other	91 (4.2%)	46 (5.3%)		1.52 (*P* = .468)	0.05
BMI	25.00 (SD = 3.93)	25.54 (SD = 3.84)	3.47 (*P* = .001)		0.14
Quality of Life	40.19 (SD = 5.06)	39.39 (SD = 5.64)	-3.64 (*P* < .001)		0.15
K10	44.71 (SD = 5.75)	44.41 (SD = 6.12)	-1.27 (*P* = .203)		0.05
Adherence to guidelines	2.83 (SD = .96)	3.12 (SD = .88)	8.22 (*P* < .001)		0.31
Physical activity					
Compliance	1698 (78.4%)	761 (86.0%)			
Non-compliance	469 (21.6%)	124 (14.0%)		23.62 (*P* < .001)	0.18
Vegetable consumption					
Compliance	501 (23.1%)	253 (28.6%)			
Non-compliance	1666 (76.9%)	632 (71.4%)		10.43 (*P* = .005)	0.12
Fruit consumption					
Compliance	801 (37.0%)	388 (43.8%)			
Non-compliance	1366 (63.0%)	497 (56.2%)		13.14 (*P* = .001)	0.13
Alcohol intake					
Compliance	1459 (67.3%)	632 (71.4%)			
Non-compliance	708 (32.7%)	253 (28.6%)		5.32 (*P* = .070)	0.08
Smoking					
Compliance	1671 (77.1%)	731 (82.5%)			

XSL•FO
RenderX

Variable	Non-completer n = 2167	Completers n = 886	*T (P)*	χ^2 *(P)*	*ES*
Non-compliance	496 (22.9%)	154 (17.4%)		11.56 (*P* = .003)	0.12
Condition					
Sequential	998 (46.1%)	537 (60.7%)			
Simultaneous	1169 (53.9%)	348 (39.3%)		54.74 (*P* < .001)	0.27

[a] Note: Respondents who did not want to report their income were classified in the category "€ 1751 - € 3050"

Predictors of Program Completion

We performed a logistic regression analysis to identify predictors of program completion. After the various interaction terms had been added, the interaction term 'tailoring condition*non-adherence to guidelines' emerged as statistically significant (B = -.620; *P* < .001) indicating that the effect of the number of guidelines respondents failed to adhere to on their completion status depended on the tailoring condition. Hence, separate analyses were performed for the 2 tailoring conditions. The results are presented in Table 3 (sequential condition) and Table 4 (simultaneous condition).

In model 1 of both conditions, the factors significantly associated with non-completion were a lower age and being male. In the simultaneous condition, Dutch nationality was also significantly associated with dropout. In model 2, the effect of age remained significant in both conditions. In the sequential condition, being male continued to make a significant contribution, whereas in the simultaneous condition, the gender and native country variables became non-significant. In both conditions, discontinuation of the program was predicted by the number of guidelines respondents failed to adhere to (in addition to a younger age). This means that people with a less healthy lifestyle were more likely to drop out than those with a healthier lifestyle. The second model of the sequential condition explained 8.2% of the total variance for program completion, whereas the second model of the simultaneous condition explained 15.1% of the total variance.

XSL•FO
RenderX

Table 3. Results of logistic regression analyses (Enter method) among the sequential condition on demographics and health status (model 1) and number of guidelines respondents failed to adhere to (model 2), with completion status (non-completers = 0; completers = 1) as dependent variable (N = 1496)

	Model 1			Model 2		
Variable	OR	*P*	CI	OR	*P*	CI
Demographics						
Age	1.04	< .001	1.02-1.05	1.04	< .001	1.02-1.05
Gender						
Male (ref.)	1.00			1.00		
Female	1.30	.02	1.04-1.63	1.27	.04	1.01-1.59
Education						
Low	1.42	.99	0.98-2.05	1.03	.90	0.69-1.53
Medium	1.13	.36	0.86-1.50	1.14	.30	0.89-1.45
High (ref.)	1.00			1.00		
Income [a] per month						
< € 1750	1.42	.06	0.98-2.05	1.42	.07	0.98-2.05
€ 1751 - € 3050	1.13	.38	0.86-1.50	1.13	.40	0.84-1.49
> € 3051 (ref.)	1.00			1.00		
Employment situation						
Job (ref.)	1.00			1.00		
No job	1.01	.96	0.74-1.38	1.01	.97	0.73-1.38
Relationship status						
In relationship (ref.)	1.00			1.00		
Single	0.94	.71	0.68-1.30	0.97	.83	0.70-1.33
# persons in household	0.94	.18	0.87-1.03	0.94	.16	0.87-1.02
Native country						
The Netherlands (ref.)	1.00			1.00		
Other	0.99	.93	0.57-1.66	0.99	.96	0.58-1.68
Health status						
BMI	1.01	.57	0.98-1.04	1.01	.62	0.98-1.04
Quality of Life	0.97	.07	0.94-1.00	0.97	.05	0.94-1.00
K10	1.00	.75	0.98-1.03	1.00	.78	0.98-1.04
Non-adherence to guidelines						
Number of guidelines				.86	.01	0.76-0.97
Nagelkerke's R^2			.076			.082

[a] Note: Respondents who did not want to report their income were classified in the category "€ 1751 - € 3050"

XSL•FO
RenderX

Table 4. Results of logistic regression analyses (Enter method) among the simultaneous condition on demographics and health status (model 1) and number of guidelines respondents failed to adhere to (model 2), with completion status (non-completers = 0; completers = 1) as dependent variable (N = 1473)

	Model 1			Model 2		
Variable	OR	*P*	CI	OR	*P*	CI
Demographics						
Age	1.04	< .001	1.02-1.05	1.04	< .001	1.02-1.05
Gender						
Male (ref.)	1.00			1.00		
Female	1.35	.03	1.04-1.74	1.13	.36	0.87-1.48
Education						
Low	1.30	.22	0.86-1.95	1.41	.11	0.92-2.16
Medium	1.02	.88	0.77-1.35	1.09	.55	0.82-1.46
High (ref.)	1.00			1.00		
Income [a] per month						
< € 1750	0.91	.65	0.60-1.38	0.87	.51	0.56-1.33
€ 1751 - € 3050	0.89	.44	0.65-1.21	0.90	.51	0.65-1.24
> € 3051 (ref.)	1.00			1.00		
Employment situation						
Job (ref.)	1.00			1.00		
No job	1.18	.35	0.84-1.66	1.11	.56	0.78-1.58
Relationship status						
In relationship (ref.)	1.00			1.00		
Single	1.10	.63	0.76-1.59	1.12	.55	0.77-1.65
# persons in household	0.92	.11	0.82-1.02	0.90	.06	0.81-1.01
Native country						
The Netherlands (ref.)	1.00			1.00		
Other	1.78	.04	1.03-3.08	1.54	.14	0.87-2.70
Health status						
BMI	1.00	.79	0.96-1.03	1.00	.82	0.96-1.03
Quality of Life	0.98	.35	0.95-1.02	0.98	.18	0.94-1.01
K10	1.00	.82	0.97-1.04	1.00	.87	0.96-1.03
Non-adherence to guidelines						
Number of guidelines				0.49	< .001	0.42-0.58
Nagelkerke's R^2			.073			.151

[a] Note: Respondents who did not want to report their income were classified in the category "€ 1751 - € 3050"

Discussion

In view of the high number of people with an unhealthy lifestyle, there is a widely recognized need for interventions to change multiple behaviors. However, the best strategy to deliver such web-based interventions remains unclear. Addressing multiple health behaviors in one intervention leads to more extensive programs, which require more time and effort from the respondents [eg, 31]. We compared dropout rates of a sequential and a simultaneous version of a computer-tailored intervention regarding physical activity, fruit consumption, vegetable consumption, alcohol intake, and smoking, and investigated the predictive value of personal characteristics and lifestyle behaviors on completion and dropout rates for the 2 strategies.

Our first finding was that there were more non-completers in the simultaneous intervention than in the sequential intervention. The most important factor explaining the difference in dropout rate between these two conditions may be the difference in the length of the questionnaires and the computer-tailored advice that respondents received after the initial health risk appraisal.

XSL•FO
RenderX

For example, if a respondent failed to adhere to 2 guidelines, the sequential intervention consisted of approximately 25 questions (average 10 minutes completion time), whereas the simultaneous intervention in such cases consisted of 50 questions, with an average completion time of 20 minutes. The advice also became twice as long, since the respondent had to fill in 2 modules in this case. Earlier research has also shown that the length of the program may be a primary reason to leave a website prematurely [22]. Another possible reason may be information overload [43]. Since each psychosocial construct is measured and tailored for each relevant behavior, this integrative approach is very demanding. An additional explanation that may need further research could be that in the simultaneous intervention, the 5 lifestyle modules had a predefined order, so respondents in this condition could not select the module they preferred to fill in first. Respondents in the sequential condition may have perceived more freedom of choice, since they could choose the lifestyle behavior about which they wanted to receive personal feedback. This hypothesis could be tested in follow-up studies, including qualitative interviews.

Although the dropout rate was higher in the simultaneous intervention than in the sequential intervention, our findings revealed a high rate of non-completion in both types of intervention. One possible reason might be the recruitment strategy used. Completing the health risk appraisal took approximately 5 minutes in both conditions. The health risk appraisal was based on the *Adult Health Monitor* questionnaire that the respondents in our study had filled in at an earlier point in time. These respondents may not have wanted to make the effort of filling in a long questionnaire again. Hence, a considerable number of interested respondents of the potential target group may already have decided not to participate in the program after receiving the health risk appraisal. A second possible reason for the high dropout rate might be the study sample. Our study sample consisted of people from the general population, who were primarily invited simply to fill in a health-related questionnaire. Our study might have shown different results in terms of dropout rates in a group that would have been included based on their motivation to learn something about their lifestyle and/or to change lifestyle behaviors. This means that lack of motivation to change lifestyle may have been a reason for dropping out in both conditions [56,57]. Additionally, technical problems [58,59], e.g. disruption of the Internet connection or errors on the website, as well as problems navigating through the website, could have played a role – as was suggested by several e-mails received from respondents.

In terms of personal characteristics that were predictive of completion or non-completion of the program, significant influences were found of age and gender. Older people and women were more likely to complete the program, which is in line with earlier findings [25]. Furthermore, an unhealthy lifestyle was associated with higher dropout rates in both conditions. Earlier studies reported lower adherence to public health guidelines (ie, an unhealthier lifestyle) among people with a low socioeconomic status compared to people with a higher socioeconomic status [60,61], which means that this (high-risk) group in particular should be a target group for health promotion efforts. We found no difference in educational level, income, or employment status between respondents who dropped out at their first visit and those who did not. This is a relevant and promising finding, as it suggests that this tailored program is equally accepted and appreciated by both groups.

Our findings – with dropout rates being higher in the simultaneous condition than in the sequential condition – suggest that a sequential tailoring strategy might be able to reach the largest group of participants. However, since approximately 60-70% of the population fails to adhere to multiple public health guidelines, people may need information about more than one lifestyle behavior. The sequential strategy used in our intervention may therefore be insufficient to meet the needs of a large part of the population, especially those of people who are interested in several health behaviors and who are motivated to change multiple lifestyle behaviors. In our sequential intervention, respondents received the health risk appraisal, including information about the 5 health behaviors. Yet respondents were limited to one single module in the second part of the program at their first visit. In the long term, this approach can be regarded as a multiple behavior change intervention using a sequential strategy, but in the short term, detailed information is made available about one behavior only. Since the dropout rate at the very first visit was high, future research should first concentrate on prolonged use (ie, continuing the intervention for a substantial period of time) and possible information overload. To date, it seems to be a challenge to hold respondents' attention in online interventions. Since the dropout rate even in the sequential condition is rather high, the number of psychosocial constructs as well as the tailored texts could be shortened, spread over time or delivered in different forms. Including more interactive elements, such as videos or games, may improve the attractiveness of eHealth programs, which in turn may result in longer visits [62-64]. Stimulating re-visits, which are necessary in our sequential approach, poses a second challenge for future research.

The simultaneous tailoring strategy has advantages as well, insofar as people may receive tailored feedback on more than one lifestyle behavior at once. However, it may be better not to offer the modules in a predefined order. A study by Brouwer et al. [25] shows that when people have a choice to select more than one behavior, they make use of this option and choose different behavior modules.

Another option to explore is a mixture of both tailoring strategies, called preference-based tailoring [39,65] in which respondents can select the behavior modules which they want to fill in (not limited to only one module). This may make respondents perceive a higher level of autonomy [66,67] since they would not have to limit themselves to one single behavior at first, and could receive as much information as they wish.

Strengths, Limitations, and Recommendations

To our knowledge, this is the first study to compare sequential and simultaneous interventions addressing the 5 lifestyle behaviors of physical activity, fruit consumption, vegetable consumption, alcohol intake, and smoking, in terms of dropout rates. The study has yielded new information about predictors of completion of the 2 intervention types.

XSL•FO
RenderX

The findings of this study should be interpreted keeping several limitations in mind. Our findings were based on self-reports, which could have led to recall bias (e.g., the high proportion of people who reported to meet the physical activity guideline may represent an overestimation of their actual level of physical activity); and the amounts of variance explained by our regression models were relatively low, indicating that other factors might play a role in determining program completion. Future research is necessary to identify additional relevant factors, for example, motivation to change, available time, interest in the topic, program evaluation (in terms of, eg, user-friendliness and attractiveness), and expectations from the program.

The present study provides initial evidence for higher attrition rates in the simultaneous intervention strategy. Although this is likely to result in lower effectiveness of this intervention, future studies need to address the relative efficacy and effectiveness of simultaneous versus sequential tailoring. Hence, re-visiting rates for the two types of interventions should be compared, and the differences in effectiveness in terms of successful behavior change should be tested. It is imaginable that despite the higher dropout in the simultaneous condition, more respondents in this condition received all relevant information compared to those in the single/sequential condition who possibly only read information about the most preferred behavior module and/or never return to the intervention program. More research remains to be done to study in which condition more modules are opened and/or completed by the respondents during the duration of the project.

Conclusions

Our findings indicate a high rate of non-completion in both types of intervention, with more incompletes in the simultaneous intervention and among respondents with unhealthier lifestyles. In both conditions, discontinuation of the program was related to a younger age of the respondent, and in the sequential condition, being male was also associated with non-completion of the program. The results of this study suggest opportunities for optimizing online tailored lifestyle interventions: such programs should be tailored to all individual users; their efficiency should be improved; their attractiveness should be enhanced by integrating interactive elements; and their content and length or duration should be balanced.

Acknowledgments

This study was funded by ZonMw, the Netherlands Organization for Health Research and Development (grant number: 120610012). Intervention development and implementation took place at Maastricht University. Data collection and data analysis were done in collaboration with the Regional Health Authorities of the Dutch provinces of North-Brabant (*GGD Brabant-Zuidoost; GGD Hart voor Brabant; and GGD West-Brabant*) and Zeeland (*GGD Zeeland*).

Conflicts of Interest

Hein de Vries is the scientific director of Vision2Health, a company that licenses evidence-based innovative computer-tailored health communication tools. No other authors reported conflicts of interest.

Multimedia Appendix 1

CONSORT EHEALTH checklist V1.6 [68].

[PDF File (Adobe PDF File), 807KB - jmir_v14i2e26_app1.pdf]

References

1. Orleans CT. Addressing multiple behavioral health risks in primary care. Broadening the focus of health behavior change research and practice. Am J Prev Med 2004 Aug;27(2 Suppl):1-3. [doi: 10.1016/j.amepre.2004.05.001] [Medline: 15275668]
2. Pronk NP, Peek CJ, Goldstein MG. Addressing multiple behavioral risk factors in primary care. A synthesis of current knowledge and stakeholder dialogue sessions. Am J Prev Med 2004 Aug;27(2 Suppl):4-17. [doi: 10.1016/j.amepre.2004.04.024] [Medline: 15275669]
3. Strecher V, Wang C, Derry H, Wildenhaus K, Johnson C. Tailored interventions for multiple risk behaviors. Health Educ Res 2002 Oct;17(5):619-626 [FREE Full text] [Medline: 12408206]
4. de Vries H, van 't Riet J, Spigt M, Metsemakers J, van den Akker M, Vermunt JK, et al. Clusters of lifestyle behaviors: results from the Dutch SMILE study. Prev Med 2008 Mar;46(3):203-208. [doi: 10.1016/j.ypmed.2007.08.005] [Medline: 17904212]
5. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ, Comparative Risk Assessment Collaborating Group. Selected major risk factors and global and regional burden of disease. Lancet 2002 Nov 2;360(9343):1347-1360. [doi: 10.1016/S0140-6736(02)11403-6] [Medline: 12423980]
6. Riper H, Kramer J, Smit F, Conijn B, Schippers G, Cuijpers P. Web-based self-help for problem drinkers: a pragmatic randomized trial. Addiction 2008 Feb;103(2):218-227. [doi: 10.1111/j.1360-0443.2007.02063.x] [Medline: 18199300]
7. de Vries H, Brug J. Computer-tailored interventions motivating people to adopt health promoting behaviours: introduction to a new approach. Patient Educ Couns 1999 Feb;36(2):99-105. [Medline: 10223015]

XSL•FO
RenderX

8. Brug J, Campbell M, van Assema P. The application and impact of computer-generated personalized nutrition education: a review of the literature. Patient Educ Couns 1999 Feb;36(2):145-156. [Medline: 10223019]
9. Campbell MK, DeVellis BM, Strecher VJ, Ammerman AS, DeVellis RF, Sandler RS. Improving dietary behavior: the effectiveness of tailored messages in primary care settings. Am J Public Health 1994 May;84(5):783-787. [Medline: 8179049]
10. Krebs P, Prochaska JO, Rossi JS. A meta-analysis of computer-tailored interventions for health behavior change. Prev Med 2010;51(3-4):214-221. [doi: 10.1016/j.ypmed.2010.06.004] [Medline: 20558196]
11. Kreuter MW, Oswald DL, Bull FC, Clark EM. Are tailored health education materials always more effective than non-tailored materials? Health Educ Res 2000 Jun;15(3):305-315 [FREE Full text] [Medline: 10977378]
12. Ruiter RA, Kessels LT, Jansma BM, Brug J. Increased attention for computer-tailored health communications: an event-related potential study. Health Psychol 2006 May;25(3):300-306. [doi: 10.1037/0278-6133.25.3.300] [Medline: 16719601]
13. Oenema A, Tan F, Brug J. Short-term efficacy of a web-based computer-tailored nutrition intervention: main effects and mediators. Ann Behav Med 2005 Feb;29(1):54-63. [doi: 10.1207/s15324796abm2901_8] [Medline: 15677301]
14. Skinner CS, Campbell MK, Rimer BK, Curry S, Prochaska JO. How effective is tailored print communication? Ann Behav Med 1999;21(4):290-298. [Medline: 10721435]
15. Smeets T. Towards a Healthy Lifestyle: the Development and Evaluation of a Computer-Tailored Lifestyle Intervention. Maastricht: PhD thesis Maastricht University; 2006.
16. Spittaels H, de Bourdeaudhuij I, Brug J, Vandelanotte C. Effectiveness of an online computer-tailored physical activity intervention in a real-life setting. Health Educ Res 2007 Jun;22(3):385-396 [FREE Full text] [doi: 10.1093/her/cyl096] [Medline: 16971674]
17. Abrams DB, Orleans CT, Niaura RS, Goldstein MG, Prochaska JO, Velicer W. Integrating individual and public health perspectives for treatment of tobacco dependence under managed health care: a combined stepped-care and matching model. Ann Behav Med 1996;18(4):290-304. [doi: 10.1007/BF02895291] [Medline: 18425675]
18. Statistics Netherlands [Centraal Bureau voor de Statistiek]. ICT gebruik van huishoudens naar huishoudkenmerken [ICT use of households by household characteristics]. 2011 URL: http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=71102ned&D1=a&D2=0&D3=(l-11)-l&HD=080901-1401 [accessed 2011-10-13] [WebCite Cache ID 62OpQjsDy]
19. de Nooijer J, Oenema A, Kloek G, Brug H, de Vries H. Bevordering van gezond gedrag via het internet: nu en in de toekomst [Promotion of healthy behavior through the Internet: Now and in the future]. Rotterdam: Optima Grafische Communicatie; 2005.
20. Glasgow RE. eHealth evaluation and dissemination research. Am J Prev Med 2007 May;32(5 Suppl):S119-S126. [doi: 10.1016/j.amepre.2007.01.023] [Medline: 17466816]
21. Leslie E, Marshall AL, Owen N, Bauman A. Engagement and retention of participants in a physical activity website. Prev Med 2005 Jan;40(1):54-59. [doi: 10.1016/j.ypmed.2004.05.002] [Medline: 15530581]
22. Brouwer W, Oenema A, Crutzen R, de Nooijer J, de Vries N, Brug J. What makes people decide to visit and use an internet-delivered behavior-change intervention? Health Education 2009;109:460-473. [doi: 10.1108/09654280911001149]
23. Evers KE, Cummins CO, Prochaska JO, Prochaska JM. Online health behavior and disease management programs: are we ready for them? Are they ready for us? J Med Internet Res 2005 Jul 1;7(3):e27 [FREE Full text] [doi: 10.2196/jmir.7.3.e27] [Medline: 15998618]
24. Glasgow RE, Nelson CC, Kearney KA, Reid R, Ritzwoller DP, Strecher VJ, et al. Reach, engagement, and retention in an Internet-based weight loss program in a multi-site randomized controlled trial. J Med Internet Res 2007;9(2):e11 [FREE Full text] [doi: 10.2196/jmir.9.2.e11] [Medline: 17513282]
25. Brouwer W, Oenema A, Raat H, Crutzen R, de Nooijer J, de Vries NK, et al. Characteristics of visitors and revisitors to an Internet-delivered computer-tailored lifestyle intervention implemented for use by the general public. Health Educ Res 2010 Aug;25(4):585-595 [FREE Full text] [doi: 10.1093/her/cyp063] [Medline: 19897515]
26. Spring B, Pagoto S, Pingitore R, Doran N, Schneider K, Hedeker D. Randomized controlled trial for behavioral smoking and weight control treatment: effect of concurrent versus sequential intervention. J Consult Clin Psychol 2004 Oct;72(5):785-796. [doi: 10.1037/0022-006X.72.5.785] [Medline: 15482037]
27. Hyman DJ, Pavlik VN, Taylor WC, Goodrick GK, Moye L. Simultaneous vs sequential counseling for multiple behavior change. Arch Intern Med 2007 Jun 11;167(11):1152-1158 [FREE Full text] [doi: 10.1001/archinte.167.11.1152] [Medline: 17563023]
28. Vandelanotte C, Reeves MM, Brug J, de Bourdeaudhuij I. A randomized trial of sequential and simultaneous multiple behavior change interventions for physical activity and fat intake. Prev Med 2008 Mar;46(3):232-237. [doi: 10.1016/j.ypmed.2007.07.008] [Medline: 17707079]
29. Glasgow RE, Goldstein MG, Ockene JK, Pronk NP. Translating what we have learned into practice. Principles and hypotheses for interventions addressing multiple behaviors in primary care. Am J Prev Med 2004 Aug;27(2 Suppl):88-101. [doi: 10.1016/j.amepre.2004.04.019] [Medline: 15275677]

XSL•FO
RenderX

30. Strecher VJ, McClure J, Alexander G, Chakraborty B, Nair V, Konkel J, et al. The role of engagement in a tailored web-based smoking cessation program: randomized controlled trial. J Med Internet Res 2008;10(5):e36 [FREE Full text] [doi: 10.2196/jmir.1002] [Medline: 18984557]
31. Prochaska JJ, Spring B, Nigg CR. Multiple health behavior change research: an introduction and overview. Prev Med 2008 Mar;46(3):181-188. [doi: 10.1016/j.ypmed.2008.02.001] [Medline: 18319098]
32. Meichenbaum D, Turk DC. Facilitating treatment adherence: a practitioner's guidebook. New York: Plenum Press; 1987.
33. Baumeister RF, Bratslavsky E, Muraven M, Tice DM. Ego depletion: is the active self a limited resource? J Pers Soc Psychol 1998 May;74(5):1252-1265. [Medline: 9599441]
34. Hagger MS, Wood C, Stiff C, Chatzisarantis NL. Ego depletion and the strength model of self-control: a meta-analysis. Psychol Bull 2010 Jul;136(4):495-525. [doi: 10.1037/a0019486] [Medline: 20565167]
35. Taylor WC, Hepworth JT, Lees E, Cassells A, Gousse Y, Sweeney MM, et al. Readiness to change physical activity and dietary practices and willingness to consult healthcare providers. Health Res Policy Syst 2004 Jun 10;2(1):2 [FREE Full text] [doi: 10.1186/1478-4505-2-2] [Medline: 15191611]
36. Dunn CL, Hannan PJ, Jeffery RW, Sherwood NE, Pronk NP, Boyle R. The comparative and cumulative effects of a dietary restriction and exercise on weight loss. Int J Obes (Lond) 2006 Jan;30(1):112-121. [doi: 10.1038/sj.ijo.0803046] [Medline: 16231038]
37. Jakicic JM, Wing RR, Winters-Hart C. Relationship of physical activity to eating behaviors and weight loss in women. Med Sci Sports Exerc 2002 Oct;34(10):1653-1659. [doi: 10.1249/01.MSS.0000031483.65271.FD] [Medline: 12370568]
38. Kremers SPJ, de Bruijn GJ, Schaalma H, Brug J. Clustering of energy balance-related behaviors and their intrapersonal determinants. Psychology & Health 2004;19:595-606. [doi: 10.1080/08870440412331279630]
39. Kwak L, Kremers SP, Werkman A, Visscher TL, van Baak MA, Brug J. The NHF-NRG In Balance-project: the application of Intervention Mapping in the development, implementation and evaluation of weight gain prevention at the worksite. Obes Rev 2007 Jul;8(4):347-361. [doi: 10.1111/j.1467-789X.2006.00304.x] [Medline: 17578384]
40. Mata J, Silva MN, Vieira PN, Carraça EV, Andrade AM, Coutinho SR, et al. Motivational spill-over during weight control: increased self-determination and exercise intrinsic motivation predict eating self-regulation. Health Psychol 2009 Nov;28(6):709-716. [doi: 10.1037/a0016764] [Medline: 19916639]
41. Spittaels H, de Bourdeaudhuij I, Vandelanotte C. Evaluation of a website-delivered computer-tailored intervention for increasing physical activity in the general population. Prev Med 2007 Mar;44(3):209-217. [doi: 10.1016/j.ypmed.2006.11.010] [Medline: 17197015]
42. Crutzen R. Hard to Get, Hard to Keep. Dissemination of and Exposure to Internet-Delivered Health Behavior Change Interventions Aimed at Adolescents. Maastricht: PhD thesis Maastricht University; 2009.
43. Prochaska JO. Multiple Health Behavior Research represents the future of preventive medicine. Prev Med 2008 Mar;46(3):281-285. [doi: 10.1016/j.ypmed.2008.01.015] [Medline: 18319100]
44. Prochaska JJ, Nigg CR, Spring B, Velicer WF, Prochaska JO. The benefits and challenges of multiple health behavior change in research and in practice. Prev Med 2010;50(1-2):26-29. [doi: 10.1016/j.ypmed.2009.11.009] [Medline: 19948184]
45. Noar SM, Chabot M, Zimmerman RS. Applying health behavior theory to multiple behavior change: considerations and approaches. Prev Med 2008 Mar;46(3):275-280. [doi: 10.1016/j.ypmed.2007.08.001] [Medline: 17825898]
46. Schulz DN, Kremers SP, van Osch LA, Schneider F, van Adrichem MJ, de Vries H. Testing a Dutch web-based tailored lifestyle programme among adults: a study protocol. BMC Public Health 2011;11:108 [FREE Full text] [doi: 10.1186/1471-2458-11-108] [Medline: 21324181]
47. de Vries H, Mudde A, Leijs I, Charlton A, Vartiainen E, Buijs G, et al. The European Smoking Prevention Framework Approach (EFSA): an example of integral prevention. Health Educ Res 2003 Oct;18(5):611-626 [FREE Full text] [Medline: 14572020]
48. Ware JE, Kosinski M, Keller SD. SF-12: How to Score the SF-12 Physical and Mental Health Summary Scales. Boston: The Health Institute, New England Medical Center; 1995.
49. Ware J, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care 1996 Mar;34(3):220-233. [Medline: 8628042]
50. Kessler, R, Mroczek, D. Final Versions of our Non-Specific Psychological Distress Scale (memo dated 10/3/94). Ann Arbor: Survey Research Center of the Institute for Social Research, University of Michigan; 1994.
51. Wendel-Vos GC, Schuit AJ, Saris WH, Kromhout D. Reproducibility and relative validity of the short questionnaire to assess health-enhancing physical activity. J Clin Epidemiol 2003 Dec;56(12):1163-1169. [Medline: 14680666]
52. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc 2000 Sep;32(9 Suppl):S498-S504. [Medline: 10993420]
53. RIVM. Lokale en nationale Monitor gezondheid. Indicatoren voor de Monitor Volksgezondheid [Local and national Health Monitor. Indicators of the Public Health Monitor]. 2005 URL: https://www.monitorgezondheid.nl/volksindicatoren.aspx [accessed 2011-10-13] [WebCite Cache ID 62OpsEkiG]
54. Lemmens P, Tan ES, Knibbe RA. Measuring quantity and frequency of drinking in a general population survey: a comparison of five indices. J Stud Alcohol 1992 Sep;53(5):476-486. [Medline: 1405641]
55. Cohen J. Statistical Power Analysis for the Behavioral Sciences (second ed.). Hillsdale, N.J.: L. Erlbaum Associates; 1988.

XSL•FO
RenderX

56. Brouwer W. Improving Exposure to Internet-Delivered Health Behavior Change Interventions. An Exploration of Determinants and Dissemination Strategies. Rotterdam: PhD thesis, Erasmus Universiteit Rotterdam; 2011.
57. van 't Riet J, Crutzen R, de Vries H. Investigating predictors of visiting, using, and revisiting an online health-communication program: a longitudinal study. J Med Internet Res 2010;12(3):e37 [FREE Full text] [doi: 10.2196/jmir.1345] [Medline: 20813716]
58. Booth AO, Nowson CA, Matters H. Evaluation of an interactive, Internet-based weight loss program: a pilot study. Health Educ Res 2008 Jun;23(3):371-381 [FREE Full text] [doi: 10.1093/her/cyn007] [Medline: 18349032]
59. Kypri K, McAnally HM. Randomized controlled trial of a web-based primary care intervention for multiple health risk behaviors. Prev Med 2005;41(3-4):761-766. [doi: 10.1016/j.ypmed.2005.07.010] [Medline: 16120456]
60. Harris JR, Huang Y, Hannon PA, Williams B. Low-socioeconomic status workers: their health risks and how to reach them. J Occup Environ Med 2011 Feb;53(2):132-138. [doi: 10.1097/JOM.0b013e3182045f2c] [Medline: 21270663]
61. Lampert T. Smoking, physical inactivity, and obesity: associations with social status. Dtsch Arztebl Int 2010 Jan;107(1-2):1-7 [FREE Full text] [doi: 10.3238/arztebl.2010.0001] [Medline: 20090874]
62. Severson HH, Gordon JS, Danaher BG, Akers L. ChewFree.com: evaluation of a Web-based cessation program for smokeless tobacco users. Nicotine Tob Res 2008 Feb;10(2):381-391. [doi: 10.1080/14622200701824984] [Medline: 18236303]
63. Stoddard JL, Augustson EM, Moser RP. Effect of adding a virtual community (bulletin board) to smokefree.gov: randomized controlled trial. J Med Internet Res 2008;10(5):e53 [FREE Full text] [doi: 10.2196/jmir.1124] [Medline: 19097974]
64. Vandelanotte C, Mummery WK. Qualitative and quantitative research into the development and feasibility of a video-tailored physical activity intervention. Int J Behav Nutr Phys Act 2011;8(1):70 [FREE Full text] [doi: 10.1186/1479-5868-8-70] [Medline: 21718546]
65. Kwak L, Kremers SP, Candel MJ, Visscher TL, Brug J, van Baak MA. Changes in skinfold thickness and waist circumference after 12 and 24 months resulting from the NHF-NRG In Balance-project. Int J Behav Nutr Phys Act 2010;7:26 [FREE Full text] [doi: 10.1186/1479-5868-7-26] [Medline: 20370934]
66. Markland D, Vansteenkiste M. Self determination theory and motivational interviewing in exercise. In: Hagger MS, Chatzisarantis NLD, editors. Intrinsic Motivation and Self-Determination in Exercise and Sport. Champaign, IL: Human Kinetics; 2007:87-99.
67. Zuckerman M, Porac J, Lathin D, Smith R, Deci EL. On the importance of self-determination for intrinsically motivated behavior. Personality and Social Psychology Bulletin 1978;4:443-446. [doi: 10.1177/014616727800400317]
68. Eysenbach G, CONSORT-EHEALTH Group. CONSORT-EHEALTH: Improving and Standardizing Evaluation Reports of Web-based and Mobile Health Interventions. J Med Internet Res 2011;13(4):e126 [FREE Full text] [doi: 10.2196/jmir.1923] [Medline: 22209829]

Edited by G Eysenbach; submitted 18.10.11; peer-reviewed by C Vandelanotte, L Donkin; comments to author 26.10.11; revised version received 09.12.11; accepted 06.01.12; published 08.03.12.

Please cite as:
Schulz DN, Schneider F, de Vries H, van Osch LADM, van Nierop PWM, Kremers SPJ
Program Completion of a Web-Based Tailored Lifestyle Intervention for Adults: Differences between a Sequential and a Simultaneous Approach
J Med Internet Res 2012;14(2):e26
URL: http://www.jmir.org/2012/2/e26/
doi:10.2196/jmir.1968
PMID:22403770

©Daniela N Schulz, Francine Schneider, Hein de Vries, Liesbeth ADM van Osch, Peter WM van Nierop, Stef PJ Kremers. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 08.03.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

The Role of User Control in Adherence to and Knowledge Gained from a Website: Randomized Comparison Between a Tunneled Version and a Freedom-of-Choice Version

Rik Crutzen[1]; Dianne Cyr[2]; Nanne K de Vries[1]

[1]Department of Health Promotion, Maastricht University/CAPHRI, Maastricht, Netherlands

[2]Beedie School of Business, Simon Fraser University, Surrey, BC, Canada

Corresponding Author:
Rik Crutzen
Department of Health Promotion
Maastricht University/CAPHRI
P.O. Box 616
Maastricht, 6200 MD
Netherlands
Phone: 31 433882828
Fax: 31 433671032
Email: rik.crutzen@maastrichtuniversity.nl

Abstract

Background: Internet-delivered interventions can effectively change health risk behaviors and their determinants, but adherence to these interventions once they are accessed is very low. Therefore, it is relevant and necessary to systematically manipulate website characteristics to test their effect on website use. This study focuses on user control as a website characteristic.

Objective: To test whether and how user control (the freedom of choice to skip pages) can increase website use and knowledge gained from the website.

Methods: Participants older than 18 years were drawn from the Dutch Internet population (in June 2011) and completed a hepatitis knowledge questionnaire. Subsequently, they were randomly assigned to three groups: (1) a tunneled version of the website with less user control; (2) a high user control version of the website where visitors had the freedom of choice to skip pages; and (3) a control group that was not exposed to the website. Participants completed (1) a questionnaire of validated measures regarding user perceptions immediately after exposure to the website (except for the control group), and (2) a hepatitis knowledge questionnaire after one week to test whether participants in the experimental groups only clicked through the website or actually processed and learned its content. Server registrations were used to assess website use. Analyses of covariance (ANCOVA) using all available data were conducted to determine whether user control increases website use. Structural equation models (SEM) using all available data were constructed to test how user control increases website use—a latent variable derived from number of pages visited and time on website.

Results: Of the 1044 persons invited to participate, 668 took part (668/1044, 64.0%). One half of participants (332/668 49.7%) were female and the mean age was 49 years (SD 16). A total of 571 participants completed the one-week follow-up measure regarding hepatitis knowledge (571/668, 85.5%). The findings demonstrate that having less user control (ie, a tunneled version of the website) had a negative effect on users' perception of efficiency ($F_{1,452} = 97.69$, $P < .001$), but a positive effect on number of pages visited ($F_{1,452} = 171.49$, $P < .001$), time on the website ($F_{1,452} = 6.32$, $P = .01$), and knowledge gained from the website ($F_{1,452} = 134.32$, $P < .001$). The direct effect of having less user control appeared to surpass the effect mediated by efficiency, because website use was higher among participants exposed to the tunneled version of the website in comparison with those having the freedom of choice to skip pages.

Conclusions: The key finding that visitors demonstrated increased website use in the tunneled version of the website indicates that visitors should be carefully guided through the intervention for future intervention websites.

(J Med Internet Res 2012;14(2):e45) doi:10.2196/jmir.1922

XSL•FO
RenderX

KEYWORDS

website use; user control; user perceptions; Internet; interventions

Introduction

Internet-delivered interventions can effectively change health risk behaviors and their determinants [1,2], but the actual use of these interventions by the target group once they access the website is very low [3,4]. For example, server statistics of a web-based intervention promoting heart-healthy behaviors showed that 285,146 visitors from unique IP addresses accessed the home page over a 36-month period, but 56.3% of visitors left the intervention website within 30 sec [5]. This finding touches upon the critical issue in Internet-delivered interventions: How can these interventions have a public health impact if people use the actual intervention so briefly? Therefore, it is relevant and necessary to focus on factors related to use of an intervention once people arrive at the intervention website (ie, website use) [6]. These factors relate to the *visitor* (eg, people's motivation to be healthy [7,8]) as well as the *intervention* website (eg, offering tailored information [9-11]).

The content of the website is important [12], but the specific characteristics of the website itself are also important. A previous study stressed the need for future research to systematically manipulate website characteristics and, subsequently, to link these manipulations to website use [13]. The current study follows this recommendation and focuses on user control as a website characteristic.

User control covers the voluntary and instrumental actions of the website visitor [14,15]. This is an important characteristic of a website that shapes the two-way online interaction and the exchange of information with website visitors resulting in a user experience [16,17]. User experience refers to what a person thinks and feels during and after exposure to a website [18]. The main idea is that a positive user experience increases website use. User experience consists of cognitive perceptions and affective perceptions [19]. Cognitive perceptions are rational in nature and induced by utilitarian or cognitive motives. Affective perceptions are emotional in nature and induced by hedonic or affective motives [20].

The key user perceptions are efficiency, effectiveness, enjoyment, and active trust [19]. These terms are derived from other fields, such as e-commerce. Although they can have a different meaning within public health, we chose to use the same terminology as in previous studies for consistency and to avoid confusion. *Efficiency* refers to easy search and access of information provided; *effectiveness* refers to the quality of that information (eg, in terms of relevance) [21]. These cognitive perceptions have parallels with perceived ease of use and perceived usefulness in the technology acceptance model, but are applicable in a broader context [22]. The idea that a positive user experience increases website use does not only apply to cognitive perceptions, but also to affective perceptions [23]. These affective perceptions are often referred to as *enjoyment* [24]. *Active trust* refers to the confidence in acting on the provided information on a website, which can result in increased website use [25]. The previous study that served as the basis for the present one consistently demonstrated that effectiveness and enjoyment both had a positive effect on intention to use, which was mediated by active trust [13]. Efficiency did not have an effect, but this could be explained by the goal of the websites being used in that study, which were aimed purely at behavioral change instead of providing information only (such as the websites used in the present study). Therefore, in this study, efficiency, effectiveness, and enjoyment were expected to increase website use (Hypothesis 1), which was expected to be mediated by active trust (Hypothesis 2).

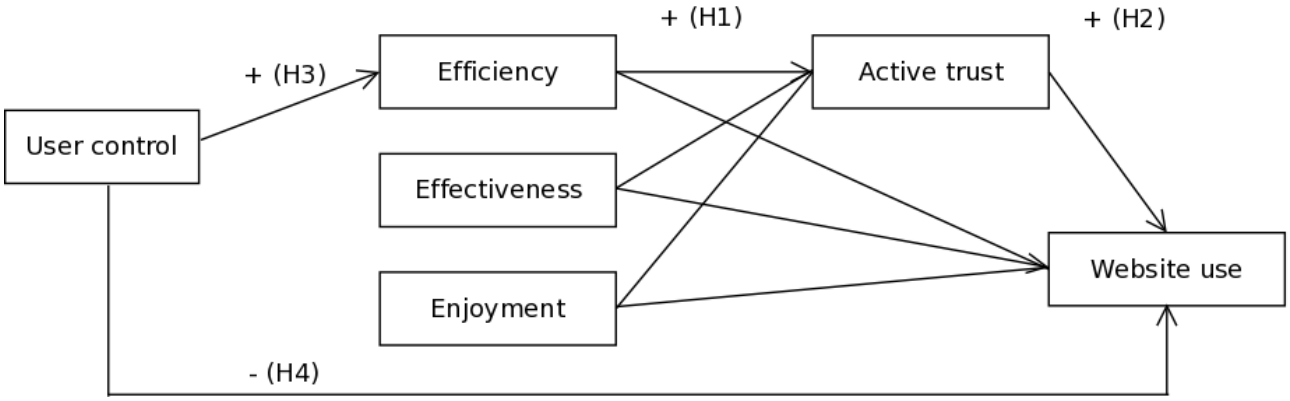
To gain more insight into *how* user control can help to increase website use, it is necessary to study the effect of user control on user perceptions. Since user control provides the ability to explore and to understand the structure of a website [26,27], it allows visitors to be involved in the cognitive processing of information. This is closely related to the concept of efficiency (ie, "easy search and access of information") and indicates a certain level of user involvement. Previous research revealed that the positive effect of freedom of choice (ie, high user control) on preference regarding websites was mediated by efficiency [28].

One of the most common issues for websites is the lack of user control [29], which might lead to a reactance effect [30]: A constrained freedom of choice results in a negative effect on preference for that website [28]. The visitor, however, can still decide whether or not to keep using the website. When a visitor has the freedom to decide whether to use the website, but at the same time has less influence on how to use it, this can be interpreted as a form of libertarian paternalism. To elaborate, this is a weak form of paternalism that guides people (eg, a tunneled version of a website with less user control) without necessarily restricting their choices (eg, the decision to keep using a website) [31]. The crux of libertarian paternalism is that by allowing choice, but designing it in such a way that skews outcomes toward particular directions (eg, increased website use), the visitor experiences a degree of free will [32]. Hence, user control was hypothesized to increase efficiency [33,34] (Hypothesis 3), but to decrease actual website use, because it is the opposite of libertarian paternalism (Hypothesis 4).

Hypothesis 4 may seem in opposition to Hypothesis 3: Although user control was expected to decrease website use, it was expected to increase efficiency. To answer the question *whether* user control can help to increase website use, we explored whether the possible direct effect of user control surpasses the possible effect mediated by efficiency. Figure 1 provides an overview of the conceptual model used in this study.

XSL•FO
RenderX

Figure 1. Conceptual model with four hypothesized paths (H1–H4).



Methods

The experimental condition for this study was a website about hepatitis A, B, and C virus (HAV, HBV, and HCV) infections. These infections all affect the liver, but each of the HAV, HBV, and HCV infections differs in terms of mode of transmission, consequences, and prevention. The website consisted of a home page plus four pages of information per hepatitis virus. The first page introduced the virus briefly and the other three pages outlined information about transmission, consequences, and prevention, respectively. This resulted in a total of twelve pages of website content (including all virus types) plus the home page. The content for these pages was based on information from the Dutch National Hepatitis Centre (eg, information leaflets) and was limited to mode of transmission, consequences, and prevention of HAV, HBV, and HCV infections. The content was text-based, purely informative, non-tailored, and very brief (ie, 5–10 lines of text per page).

Design and Procedure

Participants were randomly assigned to three groups (Fig 2), but were not informed about the existence of these three groups or that the focus of the study was on website use. Two groups were experimental groups in which user control was manipulated. In experimental group 1 (ie, tunneled group), participants viewed a tunneled version of the website [35]; in experimental group 2 (ie, freedom of choice group), participants had freedom of choice (eg, they could skip pages [36]). The third group was a control group who were not exposed to the website.

For the tunneled group, the web pages could be viewed only in a pre-determined order (introduction of the virus, transmission, consequences, and prevention for HAV, HBV, and HCV, respectively) and pages could not be skipped. This is in-line with libertarian paternalism: allowing choice to stop using the website, but designing it to skew toward increased website use. The number of pages and the content of both website versions for both experimental groups were identical. There was no human involvement (eg, health professional assistance); the website was fully automated. The third group was a control group that was not exposed to the website, but which was added to test whether participants in the experimental groups just clicked through the website or actually processed and learned its content (ie, by comparing between-group differences regarding hepatitis knowledge at follow-up). Participants in the control group were only required to complete the pre-test and follow-up measurements. Their access to other websites related to hepatitis was unable to be controlled during the study period due to participants completing the study remotely.

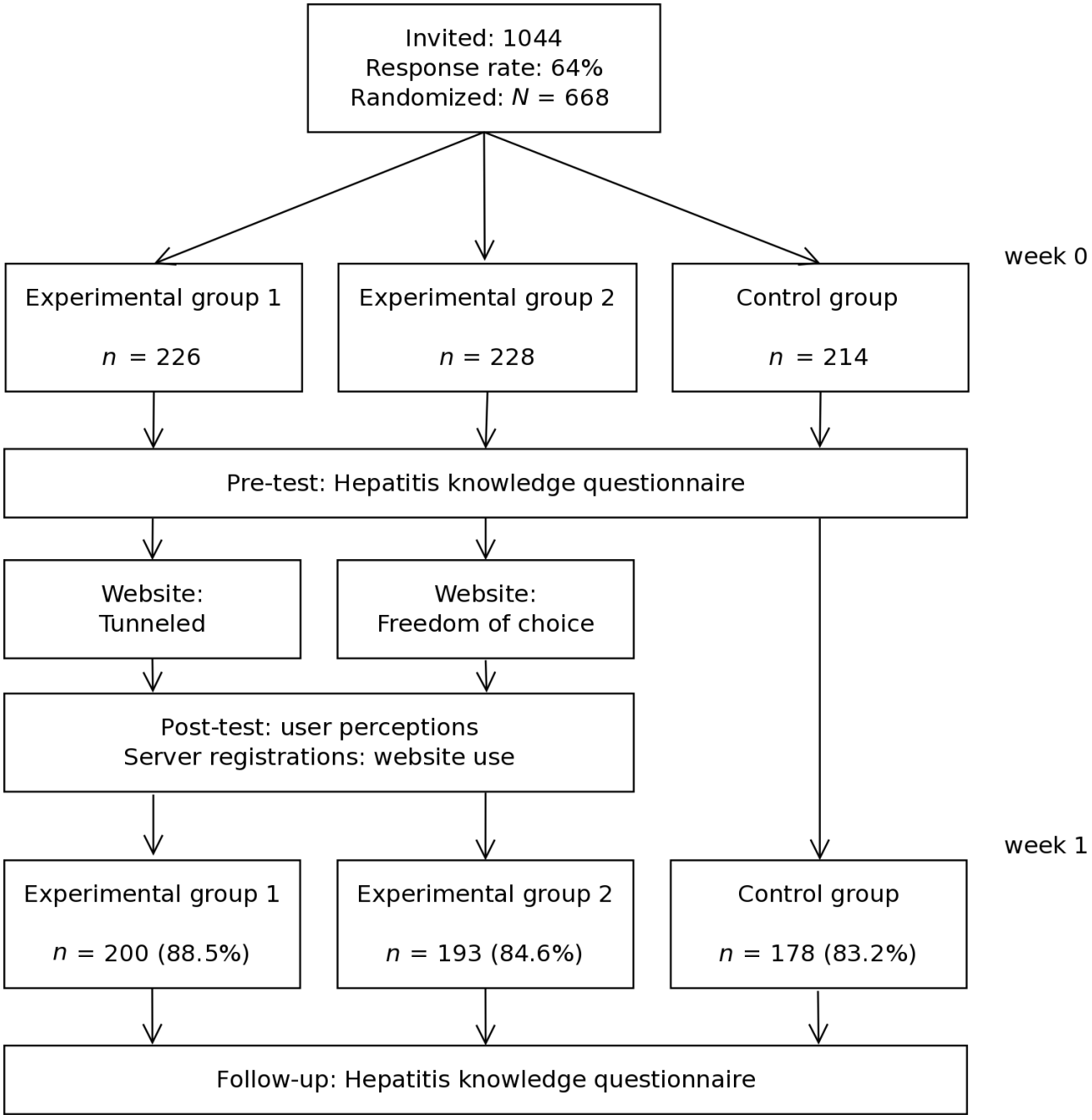
All three groups—the control group and the experimental groups before exposure to the website—took an initial questionnaire to establish their baseline hepatitis knowledge (“pre-test”). All measures are described in the measurements section. After the pre-test, the two experimental groups were directed to their assigned version of the website and participants knew they had to give their opinion about the website afterwards. Participants were asked to base their opinion about the website on their first impression and were told they could freely explore the website until they started completing the post-test immediately upon leaving the website. The objective was to prevent participants from thoroughly studying the website, and to mimic a real-life situation in which time and opportunity to invest in the website is limited [5].

The two experimental groups took another test immediately after exposure to the website (“post-test”) measuring user perceptions of the website and their perceptions of user control as a manipulation check. For these measures, it was stressed that there were no right or wrong answers. There was no post-test for the control group, since they were not exposed to the website.

One week later, participants were invited to complete the follow-up measure, which was a hepatitis knowledge questionnaire similar to the pre-test. The study was conducted in June 2011 and participants could complete the study at their own convenience (eg, at their own home). Participants received an incentive (ie, credit points for research panel members; as explained in the Participants section) to participate in the study, which represented a value of €1.39. Panel members can save credit points over time, which can be exchanged for online vouchers valid in several stores in the Netherlands. Relevant ethical safeguards regarding Dutch law were met for participant confidentiality and consent.

XSL•FO
RenderX

Figure 2. Flowchart of study design and attrition.



Participants

Participants were recruited through a research panel of a Dutch Internet research agency [37]; therefore, they could be considered computer literate. From this panel, a stratified sample of 1044 potential participants were invited to participate in a study about hepatitis through email. Informed consent was obtained online (ie, the regular procedure for this research panel). This sample was representative of the Dutch Internet population above 18 years, taking into account gender, age, and level of education. Of those invited, 668 participated in the study (668/1044, 64.0%). Half of the participants (332/668, 49.7%) were female and the mean age of participants was 49 years (SD 16). Of the participants, 35.5% had a low level of highest completed education (equivalent to primary school/junior high school), 38.2% an intermediate level (equivalent to senior high school/junior college), and 26.3% a high level (equivalent to college/university). Those 668 that participated were invited to complete the follow-up measure and 571 of them did so (571/668, 85.5%). There was no selective dropout regarding gender ($\chi^2 = 1.3$, $P = .25$), age ($F_{1,666} = 0.08$, $P = .77$), level of education ($\chi^2 = 1.3$, $P = .52$) or hepatitis knowledge at baseline ($F_{1,666} = 3.53$, $P = .06$). Furthermore, dropout did not differ between the three groups ($\chi^2 = 2.7$, $P = .26$).

Measurements

Hepatitis Knowledge Questionnaire

Fifteen true/false items (including a “don’t know” option) about transmission, consequences, and prevention of HAV, HBV, and HCV infections were used to assess hepatitis knowledge. The

XSL•FO
RenderX

sum score of all correctly answered items was used in the analyses. The correct answer to these items was available on the website, but were only communicated to the participants after the study. The items concerned "how-to" knowledge: practical knowledge concerning how to do something [38].

Website Use

Server registrations were used to assess website use [39,40] which was operationalized by the number of pages visited (ranging from 0 to 12) [41]. Furthermore, time on the website was tracked to detect whether participants simply clicked from one page to the next, which would artificially boost the number of pages visited.

User Perceptions

Efficiency (Cronbach alpha = .94), effectiveness (Cronbach alpha = .90), enjoyment (Cronbach alpha = .97), and active trust (Cronbach alpha = .88) were assessed by three items each. Participants answered questions such as "I was able to access the information quickly on this website" (efficiency), "the website provided me with relevant information about..." (effectiveness), "I found my visit to this website enjoyable" (enjoyment), and "I would act upon the information presented on this website if needed" (active trust) using a 7-point Likert scale ranging from "strongly disagree" (= 1) to "strongly agree" (= 7).These measures were previously used and validated in the Dutch language [10]. Table 1 shows the correlations between these user perceptions.

Table 1. Correlation matrix of user perceptions.

User perception[a]	1	2	3	4
1. Efficiency	-	.55	.52	.56
2. Effectiveness		-	.63	.68
3. Enjoyment			-	.66
4. Active trust				-

[a] Pearson correlation coefficient has been used as a measure of correlation between user perceptions. All correlation coefficients were significant ($P < .001$).

Perceived User Control

Four items measured perceived user control (Cronbach alpha = .79) as a manipulation check [42]. Items such as "while I was on the website, I could choose freely what I wanted to see" were answered on a 7-point Likert scale ranging from "strongly disagree" (= 1) to "strongly agree" (= 7).

Analyses

First, using Predictive Analytics SoftWare Statistics 18.0 (International Business Machines Corporation, Armonk, NY), analyses of covariance (ANCOVA) using all available data were conducted (1) to test whether the manipulation was successful; (2) to test whether there were group differences regarding hepatitis knowledge at follow-up, taking into account hepatitis knowledge at the pre-test [43]; and (3) to test the direct effect of user control on number of pages visited, time on the website (ie, whether user control increases website use), and user perceptions. Number of pages visited and time on the website were square root transformed to meet assumptions of normality.

Second, using Mplus 5 (Muthén & Muthén, Los Angeles, CA), structural equation models (SEMs) using all available data were constructed to test the hypothesized conceptual model (ie, how user control increases website use). Efficiency was regressed on user control. Website use—a latent variable made up from number of pages visited and time on the website—was regressed on user control, efficiency, effectiveness, enjoyment, and active trust. Active trust was regressed on efficiency, effectiveness, and enjoyment. Subsequently, (1) non-significant paths were left out of the conceptual model for the sake of parsimony, and (2) additional paths were added to the conceptual model based on significant modification indices. The latter was done to explore whether unanticipated relationships might explain variance in website use (which was not the case). A level of significance of $P = .05$ was used for the relationships within the model.

Model fit indices used were the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Both CFI and TLI are goodness-of-fit indices where larger values signal better fit. Values over .95 indicate close fit. The RMSEA and SRMR are goodness-of-fit indices where larger values signal worse fit. Indicators of close fit are, respectively, RMSEA ≤ .05 and SRMR ≤ .09 [44,45].

Results

Perceived user control is higher (5.2 vs 3.9 on a 7-point Likert scale) if participants had freedom of choice (eg, could skip pages) instead of a tunneled version of the website ($F_{1,452} = 134.32$, $P < .001$), indicating that the manipulation of user control was successful. Table 2 shows hepatitis knowledge per group, both at the pre-test and follow-up. There are group differences regarding hepatitis knowledge at follow-up, after controlling for hepatitis knowledge at the pre-test ($F_{2,567} = 47.24$, $P < .001$). All pairwise comparisons are significant ($P < .001$) indicating that participants in the tunneled group score higher on hepatitis knowledge compared with the freedom of choice group. Both experimental groups score higher on hepatitis knowledge in comparison with the control group, indicating that participants do not only click through the website, but actually process and learned the content.

XSL•FO
RenderX

Table 2. Pre-test and follow-up hepatitis knowledge scores.

Group	Pre-test[a]	Follow-up[a]
	Mean (SD)	Mean (SD)
Tunneled group (*n* = 200)	5.0 (3.3)	8.2 (3.5)
Freedom of choice group (*n* = 193)	5.4 (3.1)	7.2 (3.5)
Control group (*n* = 178)	5.4 (3.2)	5.6 (3.3)

[a] Maximum score is 15 points.

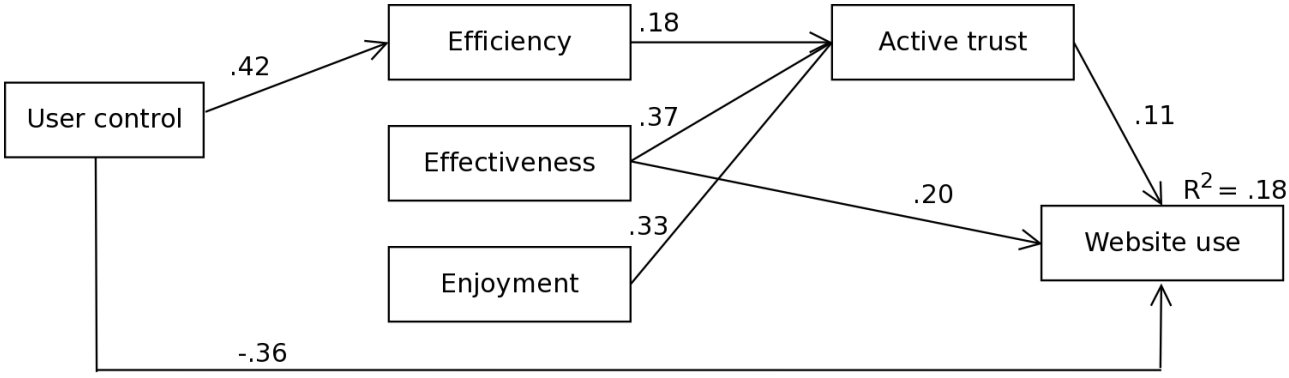
Table 3 shows that having a lesser degree of user control has a negative effect on efficiency, but a positive effect on number of pages visited (confirming Hypotheses 3 and 4). Participants do not simply click from one page to the next, since the time on the website is also longer in the tunneled group (3:50 min) compared with the freedom of choice group (2:38 min) ($F_{1,452}$ = 6.32, P = .01).

Table 3. The direct effect of user control on number of pages visited and user perceptions.

Measure	Range	Tunneled group (*n* = 226) Mean (SD)	Freedom of choice group (*n* = 288) Mean (SD)	$F_{1,452}$	*P* Value
Number of pages visited	0–12	11.4 (2.3)	7.4 (4.0)	171.49	< .001
Efficiency	1–7	4.8 (1.7)	6.1 (1.1)	97.69	< .001
Effectiveness	1–7	5.8 (1.2)	5.8 (1.1)	0.56	.46
Enjoyment	1–7	4.9 (1.5)	5.0 (1.4)	0.72	.40
Active trust	1–7	5.1 (1.4)	5.3 (1.4)	4.15	.04

Figure 3 illustrates the final structural equation model. User control has a positive effect on efficiency, but a negative effect on website use. The direct effect appears to surpass the effect mediated by efficiency because website use is higher in the tunneled group compared to the freedom of choice group. These findings also support Hypotheses 3 and 4. Efficiency has a positive effect on website use, but effectiveness and enjoyment do not have a direct effect on website use (only partly confirming Hypothesis 1). Therefore, these paths were removed from the final model. Active trust, however, mediates the relationship between efficiency, effectiveness, enjoyment, and active trust (confirming Hypothesis 2). Based on modification indices, no paths were added to the conceptual model, implying that user control is only related to efficiency and website use. The CFI and TLI are .97 and .96, respectively; RMSEA and SRMR are .08 and .03, respectively. All of these fit indices indicate a close fit for the final model.

Figure 3. Final model including standardized betas of significant paths within the model.



Discussion

A key finding of this study is that user control does not help to increase website use, which leads to a smaller effect on knowledge gain in comparison with the tunneled version of the website. Although visitors thought that having control made it easier to search and access information, this was negated by the direct negative effect that user control had on website use. In short, user control decreases website use. The increase in perception of efficiency, however, is in-line with the *idea* of freedom of choice as more important than its actual existence [46]. These findings indicate that, for future intervention websites, visitors should be carefully guided through the intervention (ie, less user control).

As an element of interaction design (ie, options involved in performing and completing tasks), it is proposed user control should fit the task of the user and the objectives of website

XSL•FO
RenderX

accessed [18]. For example, if a goal for a website is to encourage visitors to review all pages about self-management, then it would be useful for visitors to be guided through these pages. However, if the website is to serve as a data bank or encyclopedia that visitors may consult, then it would be more useful to add a search function and an effective menu structure [47].

Most of our hypotheses regarding user perceptions are confirmed and are in-line with the previous study [13]. Active trust mediates the positive effects of efficiency, effectiveness, and enjoyment on website use. The lack of a direct effect of enjoyment on website use was unanticipated. Based on previous research, an explanation could be that enjoyment is related to cognitive perceptions [48], and website use is fully mediated by active trust. Thus, cognitive perceptions might be a catalyst for the positive effect of enjoyment on website use. The lack of a direct effect of efficiency on website use is puzzling. Since previous research demonstrated that active trust is a mediating variable associated with intention to use a website [49,50], it might be that active trust reduces the possible direct impact of efficiency since the explained variance of active trust overlaps with the explained variance of efficiency. Future research is needed to investigate the plausibility of this explanation.

Another avenue for future research is to examine factors related to the visitor given that the direct effect resulting from the manipulation of a website characteristic (ie, user control) surpassed the effect mediated by user perceptions (ie, efficiency). Hence, it is worthwhile to investigate whether the impact of website characteristics is greater for certain visitors than for others. Knowing something about the personalities of those who favor certain website characteristics will provide better insight into factors behind website use [51]. Ross and colleagues [52] took a first step in this direction by linking personality factors to the use of Facebook features.

Contrary to previous research [13,19,33], a positive characteristic of this study is that actual website use was tracked and measured instead of using self-reported data only. More specifically, website use was tracked by means of server registrations, which in contrast to self-reports, is independent of visitors' memory, interpretation, or social desirability [53,54]. Moreover, within the setting of a research panel in which participants could complete the study at their own convenience (eg, at their own home), a real-life situation has been mimicked. Participants could freely explore the website, without the limitations of a laboratory setting (eg, standardized environment, forced exposure), which enhanced the validity of the study (ie, in vivo versus in vitro testing). Finally, there was a relatively small dropout rate between pre-test and follow-up in this study, which was neither selective dropout nor differed between groups. Hence, there is still good variation in gender, age, and level of education of the participants to warrant generalizability of the findings to the Dutch Internet population above 18 years.

Finally, there are two additional points that evolved from this investigation. First, knowledge regarding hepatitis increased in both experimental conditions compared to the control group. This implies the hepatitis knowledge questionnaire is appropriate to assess whether participants processed and learned content of the website. This is the case even though participants were not necessarily looking for information on hepatitis, which is essential in primary prevention websites aimed at the general public. Nevertheless, it could be that participants were highly interested in hepatitis, since they agreed to participate in a study about this topic. The low scores regarding hepatitis knowledge at pre-test, however, do not support this possible explanation. Second, knowledge increased more in the tunneled group in which website use was higher. Since user control is not directly related to retention [55], this suggests website use increases the likelihood of changes in determinants of health risk behaviors—which is important from a public health point of view. Thus, as an element of interaction design, user control should be carefully considered during the development of Internet-delivered interventions. Our findings indicate future interventions should carefully guide visitors through the website (ie, less user control) to increase website use and subsequently elevate the public health impact of these interventions.

Acknowledgments

This study was supported by the Innovational Research Incentives Scheme Veni from NWO-MaGW (Netherlands Organisation for Scientific Research—Division for the Social Sciences) accredited to Rik Crutzen. There has been no involvement by the funding body in the review or approval of the manuscript for publication. Rik Crutzen would like to thank Kathelijne Bessems for her inspiring thoughts while discussing the initial ideas for this study.

Conflicts of Interest

None declared.

References

1. Portnoy DB, Scott-Sheldon LA, Johnson BT, Carey MP. Computer-delivered interventions for health promotion and behavioral risk reduction: a meta-analysis of 75 randomized controlled trials, 1988-2007. Prev Med 2008 Jul;47(1):3-16. [doi: 10.1016/j.ypmed.2008.02.014] [Medline: 18403003]
2. Cugelman B, Thelwall M, Dawes P. Online interventions for social marketing health behavior change campaigns: a meta-analysis of psychological architectures and adherence factors. J Med Internet Res 2011;13(1):e17 [FREE Full text] [doi: 10.2196/jmir.1367] [Medline: 21320854]

XSL•FO
RenderX

3. Bennett GG, Glasgow RE. The delivery of public health interventions via the Internet: actualizing their potential. Annu Rev Public Health 2009 Apr 29;30:273-292. [doi: 10.1146/annurev.publhealth.031308.100235] [Medline: 19296777]
4. Eysenbach G. The law of attrition. J Med Internet Res 2005;7(1):e11 [FREE Full text] [doi: 10.2196/jmir.7.1.e11] [Medline: 15829473]
5. Brouwer W, Oenema A, Raat H, Crutzen R, de Nooijer J, de Vries NK, et al. Characteristics of visitors and revisitors to an Internet-delivered computer-tailored lifestyle intervention implemented for use by the general public. Health Educ Res 2010 Aug;25(4):585-595 [FREE Full text] [doi: 10.1093/her/cyp063] [Medline: 19897515]
6. Binks M, van Mierlo T. Utilization patterns and user characteristics of an ad libitum Internet weight loss program. J Med Internet Res 2010;12(1):e9 [FREE Full text] [doi: 10.2196/jmir.1347] [Medline: 20350926]
7. Van 't Riet J, Crutzen R, De Vries H. Investigating predictors of visiting, using, and revisiting an online health-communication program: a longitudinal study. J Med Internet Res 2010;12(3):e37 [FREE Full text] [doi: 10.2196/jmir.1345] [Medline: 20813716]
8. Crutzen R, de Nooijer J, Candel MJ, de Vries NK. Adolescents who intend to change multiple health behaviours choose greater exposure to an internet-delivered intervention. J Health Psychol 2008 Oct;13(7):906-911. [doi: 10.1177/1359105308095064] [Medline: 18809641]
9. Brouwer W, Kroeze W, Crutzen R, de Nooijer J, de Vries NK, Brug J, et al. Which intervention characteristics are related to more exposure to internet-delivered healthy lifestyle promotion interventions? A systematic review. J Med Internet Res 2011;13(1):e2 [FREE Full text] [doi: 10.2196/jmir.1639] [Medline: 21212045]
10. Crutzen R, de Nooijer J, Brouwer W, Oenema A, Brug J, de Vries NK. Strategies to facilitate exposure to internet-delivered health behavior change interventions aimed at adolescents or young adults: a systematic review. Health Educ Behav 2011 Feb;38(1):49-62. [doi: 10.1177/1090198110372878] [Medline: 21189422]
11. Nijland N, van Gemert-Pijnen JE, Kelders SM, Brandenburg BJ, Seydel ER. Factors influencing the use of a Web-based application for supporting the self-care of patients with type 2 diabetes: a longitudinal study. J Med Internet Res 2011;13(3):e71 [FREE Full text] [doi: 10.2196/jmir.1603] [Medline: 21959968]
12. Crutzen R. Is it time to start focusing on the content of computer-delivered interventions? Addiction 2011 Oct;106(10):1871. [doi: 10.1111/j.1360-0443.2011.03539.x] [Medline: 21793973]
13. Crutzen R, Cyr D, de Vries NK. Bringing loyalty to e-Health: theory validation using three internet-delivered interventions. J Med Internet Res 2011;13(3):e73 [FREE Full text] [doi: 10.2196/jmir.1837] [Medline: 21946128]
14. Liu Y, Schrum LJ. What is interactivity and is it always such a good thing? Implications of definition, person, and situation for the influence of interactivity on advertising effectiveness. J Advertising 2002;31:53-64.
15. Lowry PB, Spaulding T, Wells T, Moody G, Moffit K, Madariaga S. A theoretical model and empirical results linking website interactivity and usability satisfaction. System Sciences 2006;123a. [doi: 10.1109/HICSS.2006.33]
16. Van Oppen CAML. From Rags to Richness. Maastricht: Maastricht University; 2007.
17. Sundar SS. Theorizing interactivity's effects. The Information Society 2004;20:385-389. [doi: 10.1080/01972240490508072]
18. Crutzen R, de Nooijer J, Brouwer W, Oenema A, Brug J, de Vries NK. A conceptual framework for understanding and improving adolescents' exposure to Internet-delivered interventions. Health Promot Int 2009 Sep;24(3):277-284 [FREE Full text] [doi: 10.1093/heapro/dap018] [Medline: 19515716]
19. Cyr D, Head M, Ivanov A. Perceived interactivity leading to e-loyalty: development of a model for cognitive-affective user responses. International Journal of Human-Computer Studies 2009;67:850-869. [doi: 10.1016/j.ijhcs.2009.07.004]
20. Park CW, Young SM. Consumer response to television commercials: the impact of involvement and background music on brand attitude formation. J Marketing Res 1986;23:11-24.
21. Keeney R. The value of Internet commerce to the customer. Management Science 1999;45:533-542. [doi: 10.1287/mnsc.45.4.533]
22. Benbasat I, Barki H. Quo vadis, TAM? J Assoc Inf Syst 2007;8:211-218.
23. Sun Y, Wang N, Peng Z. Working for one penny: understanding why people would like to participate in online tasks with low payment. Computers in Human Behavior 2011;27:1033-1041. [doi: 10.1016/j.chb.2010.12.007]
24. Van der Heijden H. Factors influencing the usage of websites: the case of a generic portal in the Netherlands. Information & Management 2003;40:541-549. [doi: 10.1016/S0378-7206(02)00079-4]
25. Cugelman B, Thelwall M, Dawes P. The dimensions of web site credibility and their relation to active trust and behavioural impact. Communications of the Association for Information Systems 2009;24:455-472.
26. Ariely D. Controlling the information flow: effects on consumers' decision making and preferences. Journal of Consumer Research 2000;27:233-248. [doi: 10.1086/314322]
27. Danaher BG, McKay HG, Seeley JR. The information architecture of behavior change websites. J Med Internet Res 2005;7(2):e12 [FREE Full text] [doi: 10.2196/jmir.7.2.e12] [Medline: 15914459]
28. Murray KB, Häubl G. Freedom of choice, ease of use, and the formation of interface preferences. SSRN Electronic Journal 2010;35:955-976. [doi: 10.2139/ssrn.1698204]
29. Srinivasan SS, Anderson R, Ponnavolu K. The impact of perceptions of interactivity on customer trust and transaction intentions in mobile commerce. Journal of Retailing 2002;78:41-50. [doi: 10.1016/S0022-4359(01)00065-3]

XSL•FO
RenderX

30. Brehm SS, Brehm JW. Psychological Reactance: A Theory of Freedom and Control. New York, NY: Academic Press; 1981.
31. Thaler RH, Sunstein CR. Behavioral economics, public policy, and paternalism: libertarian paternalism. The American Economic Review 2003;93:175-179.
32. Ratner RK, Soman D, Zauberman G, Ariely D, Carmon Z, Keller PA, et al. How behavioral decision research can enhance consumer welfare: From freedom of choice to paternalistic intervention. Market Lett 2008;19:383-397. [doi: 10.1007/s11002-008-9044-3]
33. Lee T. The impact of perceptions of interactivity on customer trust and transaction intentions in mobile commerce. Journal of Electronic Commerce Research 2005;6:165-180.
34. Teo HH, Oh L, Liu C, Wei KK. An empirical study of the effects of interactivity on web user attitude. International Journal of Human-Computer Studies 2003;58:281-305. [doi: 10.1016/S1071-5819(03)00008-9]
35. Website Experimental group 1. 2011 URL: http://www.crutzen.net/hepatitis/nc/ [accessed 2011-09-29] [WebCite Cache ID 623qgW4kV]
36. Website Experimental group 2. 2011 URL: http://www.crutzen.net/hepatitis/uc/ [accessed 2011-09-29] [WebCite Cache ID 623qnoEWM]
37. FlyCatcher. 2011 URL: http://www.flycatcher.eu/ [accessed 2011-04-22] [WebCite Cache ID 5y8KQdYbW]
38. Rogers EM. Diffusion of Innovations. New York, NY: Free Press; 2003.
39. Crutzen R, Peters GJ, Portugal SD, Fisser EM, Grolleman JJ. An artificially intelligent chat agent that answers adolescents' questions related to sex, drugs, and alcohol: an exploratory study. J Adolesc Health 2011 May;48(5):514-519. [doi: 10.1016/j.jadohealth.2010.09.002] [Medline: 21501812]
40. Crutzen R, Mevissen FE. Just another manic monday: peaking sexual concerns after the weekend. Arch Sex Behav 2011 Dec;40(6):1105-1106. [doi: 10.1007/s10508-011-9833-2] [Medline: 21837516]
41. Donkin L, Christensen H, Naismith SL, Neal B, Hickie IB, Glozier N. A systematic review of the impact of adherence on the effectiveness of e-therapies. J Med Internet Res 2011;13(3):e52 [FREE Full text] [doi: 10.2196/jmir.1772] [Medline: 21821503]
42. Liu Y. Developing a scale to measure the interactivity of web sites. Journal of Advertising Research 2003;43:207-216.
43. Van Breukelen GJ. ANCOVA versus change from baseline: more power in randomized studies, more bias in nonrandomized studies [corrected]. J Clin Epidemiol 2006 Sep;59(9):920-925. [doi: 10.1016/j.jclinepi.2006.02.007] [Medline: 16895814]
44. Iacobucci D. Structural equations modeling: fit indices, sample size, and advanced topics. Journal of Consumer Psychology 2010;20:90-98. [doi: 10.1016/j.jcps.2009.09.003]
45. Kline RB. Principles and Practice of Structural Equation Modeling. New York, NY: Guilford Press; 2005.
46. Wertenbroch K, Vosgerau J, Bruyneel SD. Free will, temptation, and self-control: we must believe in free will, we have no choice. Journal of Consumer Psychology 2008;18:27-33. [doi: 10.1016/j.jcps.2007.10.006]
47. Lin J, Chan HC. Understanding the beliefs and intentions in search and purchase functions in an e-commerce website. IEEE Transactions on Engineering Management 2009;56:106-114. [doi: 10.1109/TEM.2008.922641]
48. Kim J, Fiore AM. Lee H-H. Influences of online store perception, shopping enjoyment, and shopping involvement on consumer patronage behavior towards an online retailer. Journal of Retailing and Consumer Services 2007;14:95-107. [doi: 10.1016/j.jretconser.2006.05.001]
49. Bart Y, Shankar V, Fareena S, Urban G. Are the drivers and roles of online trust the same for all web sites and consumers? A large-scale exploratory empirical study. Journal of Marketing 2005;69:133-152. [doi: 10.1509/jmkg.2005.69.4.133]
50. Flavián C, Guinalíu M, Gurrea R. The role played by perceived usability, satisfaction and consumer trust on website loyalty. Information & Management 2006;43:1-14. [doi: 10.1016/j.im.2005.01.002]
51. Orchard LJ, Fullwood C. Current perspectives on personality and Internet use. Social Science Computer Review 2009;28:155-169. [doi: 10.1177/0894439309335115]
52. Ross C, Orr ES, Sisic M, Arseneault JM, Simmering MG, Orr RR. Personality and motivations associated with Facebook use. Computers in Human Behavior 2009;25:578-586. [doi: 10.1016/j.chb.2008.12.024]
53. Crutzen R, Göritz AS. Social desirability and self-reported health risk behaviors in web-based research: three longitudinal studies. BMC Public Health 2010;10:720 [FREE Full text] [doi: 10.1186/1471-2458-10-720] [Medline: 21092267]
54. Crutzen R, Göritz AS. Does social desirability compromise self-reports of physical activity in web-based research? Int J Behav Nutr Phys Act 2011;8:31 [FREE Full text] [doi: 10.1186/1479-5868-8-31] [Medline: 21492435]
55. Mayer RE, Chandler P. When learning is just a click away: Does simple user interaction foster deeper understanding of multimedia messages? Journal of Educational Psychology 2001;93:390-397. [doi: 10.1037/0022-0663.93.2.390]

Abbreviations

ANCOVA: analyses of covariance
CFI: comparative fit index
HAV: hepatitis A virus
HBV: hepatitis B virus

XSL•FO
RenderX

HCV: hepatitis C virus
RMSEA: root mean square error of approximation
SEM: structural equation models
SRMR: standardized root mean square residual
TLI: Tucker-Lewis index

Edited by G Eysenbach; submitted 29.08.11; peer-reviewed by J Brown, L Donkin, E Montague, M Rogers; comments to author 25.09.11; revised version received 19.11.11; accepted 07.01.12; published 09.03.12.

Please cite as:
Crutzen R, Cyr D, de Vries NK
The Role of User Control in Adherence to and Knowledge Gained from a Website: Randomized Comparison Between a Tunneled Version and a Freedom-of-Choice Version
J Med Internet Res 2012;14(2):e45
URL: http://www.jmir.org/2012/2/e45/
doi:10.2196/jmir.1922
PMID:22532074

©Rik Crutzen, Dianne Cyr, Nanne K. de Vries. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 09.03.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Design of a Website on Nutrition and Physical Activity for Adolescents: Results From Formative Research

Debbe Thompson[1], PhD; Karen Weber Cullen[1], DrPH, RD; Carol Boushey[2], PhD, RD; Karen Konzelmann[3], MS, CHES

[1]USDA/ARS Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, Houston, TX, United States

[2]University of Hawaii Cancer Center, Epidemiology Program, University of Hawaii, Honolulu, HI, United States

[3]Organizational and Educational Consultant, Pearland, TX, United States

Corresponding Author:
Debbe Thompson, PhD
USDA/ARS Children's Nutrition Research Center
Department of Pediatrics
Baylor College of Medicine
1100 Bates Street
Houston, TX, 77030
United States
Phone: 1 713 798 7076
Fax: 1 713 798 7098
Email: dit@bcm.edu

Abstract

Background: Teens do not meet guidelines for healthy eating and physical activity. The Internet may be an effective method for delivering programs that help them adopt healthy behaviors.

Objective: To collect information to design content and structure for a teen-friendly website promoting healthy eating and physical activity behaviors.

Methods: Qualitative research, encompassing both focus group and interview techniques, were used to design the website. Participants were 12-17 year olds in Houston, Texas, and West Lafayette, Indiana.

Results: A total of 133 participants took part in 26 focus groups while 15 participated in one-on-one interviews to provide guidance for the development of teen-friendly content and structure for an online behavior change program promoting healthy eating and physical activity to 12-17 year olds. The youth made suggestions to overcome common barriers to healthy eating and physical activity. Their feedback was used to develop "Teen Choice: Food & Fitness," a 12-week online behavior change program, populated by 4 cartoon character role models.

Conclusions: It is critical that members of the target audience be included in formative research to develop behavior change programs that are relevant, appealing, and address their needs and interests.

(J Med Internet Res 2012;14(2):e59) doi:10.2196/jmir.1889

KEYWORDS

Internet; intervention; obesity prevention; food; physical activity

Introduction

Youth obesity has reached epidemic proportions [1] and adolescence appears to be a particularly critical intervention period [2,3]. Current obesity prevention interventions, such as those that are school-based, have generally not improved body composition outcomes [4] suggesting different approaches are needed to impact obesity risk.

To be effective, behavior change interventions must meet the expectations of today's technology-savvy users [5]. Online programs allow wide access to interventions, and the use of graphics and Web applications with interactivity allow the user to actively participate in programs that can promote healthy choices [6]. Reviews of the literature have identified that online interventions for adults have shown some success [7-12]. Youth online interventions have also been somewhat successful at improving diet [13-16] and physical activity [13,16,17]

XSL•FO
RenderX

behaviors, and promoting weight loss [18]. Critical components for success in these endeavors appears to be the active participation of youth in the development of such programs [6,19] and the use of theory and behavior change techniques to guide program development [20].

Although there has been concern regarding youth access to computers and the Internet among the general population, data reveal a somewhat different picture. Nationally representative surveys of media use reveal that home computer access among 8-18 year olds ranges from 89% to 94%, while 74% to 88% have home Internet access [21]. Approximately 55% of the adolescents surveyed reported searching for health information on the Internet [21], while approximately 63% of youth aged 12-17 years reported daily Internet use [22]. Further, the number of youth with high-speed Internet access at home has increased [21,23]. Therefore, online behavior change programs promoting healthy eating and physical activity behaviors have the potential to reach large numbers of youth in a familiar, convenient, and readily available manner. This paper presents the results of formative research that was conducted to inform the design of such a program for youth between ages 12 to 17 years.

Methods

Focus groups and one-on-one interviews were conducted to inform the content and structure of the online program, as well as to evaluate its components during development. The study was approved by the institutional review boards of Baylor College of Medicine in Houston, Texas, and Purdue University in West Lafayette, Indiana. Adolescents aged 12-17 years were recruited from youth centers and schools using standard recruitment techniques. Participants provided written parental consent and their own verbal assent prior to participation. Teens could participate in only one activity (ie, one focus group or one interview).

Focus Groups

Trained moderators and assistant moderators [24] conducted focus groups in community settings in Houston, Texas, and West Lafayette, Indiana. Focus groups were conducted in two different states to ensure the information obtained was not just relevant to teens in one area of the country. Focus group moderators followed a semi-structured script, and probes and prompts were used to expand and clarify responses. The moderator led the discussion and an assistant moderator recorded responses. Separate focus groups were held for nutrition and physical activity in order to develop content. Additional focus groups were held to adapt an existing healthy eating calculator to make it teen-friendly.

Healthy Eating and Physical Activity

The focus groups covered two general areas: (1) what youth thought should be included in an online program about healthy eating or physical activity and (2) suggestions for overcoming common barriers to healthy eating or physical activity. The information obtained on barriers and suggested solutions was used to create short role model video clips to be included in the online behavior change program under development.

To spark the discussion, separate lists of commonly reported barriers were created for healthy eating [25-41] and physical activity [42-58] (Table 1). As participants arrived for the focus group, they were given the list of diet or physical activity barriers (depending on the focus of the particular group) and were asked to check off those items on the list that were problems for them. The sheets were collected at the beginning of each focus group and the results were summarized on a large poster board. The 5-7 barriers that received the most votes were used to guide the discussion on ways to overcome each barrier. In addition, teen cartoon characters (ie, the role models who would appear in the program) and potential names for the online behavior change program were vetted by the focus group participants. After each focus group, the moderator and assistant moderator discussed the results (ie, debriefed) and generated a report that summarized the important findings from that group.

XSL•FO
RenderX

Table 1. Percentage of responses to commonly reported barriers to healthy eating [25-41] and obtaining physical activity [42-58] from adolescents attending initial focus groups.

Barriers	%
Barriers to healthy eating	
They eat too many snacks.	69
They like to eat foods from school vending machines or snack bar.	67
They drink a lot of sodas or sweetened beverages every day.	61
They skip breakfast.	54
They don't like most healthy foods, such as vegetables.	35
Their friends tease or make fun of them if they eat healthy foods.	35
Few or none of their friends eat healthy foods.	34
They eat at restaurants a lot (eg, several times a week).	31
Their friends do not eat healthy foods at restaurants.	29
They don't know how to prepare foods.	27
They think healthy foods cost too much.	23
Unhealthy foods taste better.	22
They don't like healthy foods in general.	11
It takes too much time to make healthy foods.	9
They do not have healthy foods at home.	5
Barriers to physical activity	
They would rather do other activities (eg, play video games, watch TV, or talk on the phone).	65
They have too much homework.	59
Their friends do not like or do physical activity with them.	59
They are too busy with afterschool activities or chores.	41
Bad weather (eg, rain, snow, or heat) is a problem.	39
They do not have enough time to be physically active.	31
They are not good at most physical activities.	27
They think physical activity is too hard.	21
They do not have physical activity equipment at home.	21
They don't have the money to pay for sports or physical activity costs (eg, clothing, equipment, or fees).	19
They do not have a safe place to be physically active.	14
They can't get to practices or places to be physically active.	14
No one reminds them to be physically active.	13
They think physical activity makes their body hurt.	12
They don't like to sweat.	11
They worry that other people will laugh or tease them when they do physical activity.	9
They think physical activity messes up hair and/or makeup.	4

Healthy Eating and Physical Activity Calculator

Additional focus groups were conducted to develop an online "calculator" that would be easy to use, in a format acceptable to this age group, and that provided information requested by the adolescents on what and how much to eat and how much physical activity they needed to do. An existing healthy eating calculator developed for adults was used to prompt discussion.

Program Development

Using information obtained from the focus groups, investigators created the online program components. Interviews were then conducted to review the materials prior to finalizing the program.

Interviews

Interviews (conducted in Houston only) followed a semi-structured script. Probes and prompts were used to expand

XSL•FO
RenderX

and clarify responses. Print versions of the teen cartoon characters (ie, online role models) and components of the behavior change program were used to guide the discussion. Two types of interviews were conducted: one set was to review role model scripts and teen characters; the second set of interviews was to review online behavior change program content and structure prior to finalizing the program. Participants for the first set of interviews were recruited from the same locations as the focus group participants using procedures described above. The second set of interviews was promoted only at the Children's Nutrition Research Center in Texas and interviews were conducted with children, relatives, and/or neighbors of faculty and staff.

Results

Focus Groups

In total, 18 initial focus groups—10 on healthy eating (n = 50 participants) and 8 on physical activity (n = 45 participants)—were conducted (Table 2). Participants stated that there should be an initial log-on page where each person could pick an avatar (ie, an online teen cartoon character to serve as a digital guide in the program) [59] and the log-on page should also provide ready access to all the different Web pages available in the behavior change program. Information on basic nutrition and physical activity concepts was also requested, as was information on what they should eat (ie, what foods were healthy) and how much physical activity they should get each day. They also liked the idea of goal setting and problem solving, as well as having a goal sheet that included a list of goals from which they could choose, a plan of action, and a self-monitoring form. Goal review should appear at subsequent log-ins. A blog was thought to be an important component, but only if entries were prescreened before posting. Teens who participated in the healthy eating focus groups also recommended including healthy recipes for themselves and their parents.

The top barriers to healthy eating and physical activity suggested by the groups are listed in Table 3. These barriers were used to create the role model stories. Online behavior change program components suggested by participants were consistent across focus group type (healthy eating or physical activity) and location (Texas or Indiana).

An additional 8 focus groups (n = 38) were conducted to develop a healthy eating and physical activity "calculator" to provide tailored information on nutritional needs and physical activity. Participants suggested a graphic "pie chart" figure that would provide both textual and visual information. They also suggested that users should be able to click on the various "wedges" of the pie to access additional information about that component. This design would give participants control over how much and what information they accessed.

Table 2. Characteristics of the content development focus group participants (N = 95 participants in 18 focus groups)

Characteristic	n (%)
Gender [a]	
Male	47 (50)
Female	47 (50)
Race/Ethnicity [b]	
African-American	10 (11)
Hispanic	36 (38)
Other	3 (3)
White	46 (48)

[a] Information about gender was unavailable for 1 participant.

[b] Participants were asked to respond to these racial/ethnic categories only.

XSL•FO
RenderX

Table 3. Top barriers reported in focus groups and the videos created to address each barrier.

Barriers		Video title
Healthy eating barriers		
1	Snacks	*Handle your Snack Attack*
		Nothing to Eat
2	School foods	*See What's Cookin' at School*
3	Soda/sweetened beverages	*Drop the Pop*
4	Breakfast skipping	*Energize your AM*
5	Friend influences	*Eat Healthy on the Go*
6	Restaurant eating	*Eat Healthy on the Go*
Physical activity barriers		
1	Like other activities better	*Choose to Move*
		Get Moving!
2	No time	*Juggle Time: Fit it all in*
		Fit Fitness in your Day
3	Friend influences	*Friends Make Fitness Fun!*
4	Weather	*No Excuses: Movin' at Home*

Interviews

Role Model Stories and Teen Characters

Using information from the focus groups that addressed common barriers to healthy eating and physical activity and how to overcome them (Table 3), 12 role model stories with 4 teen cartoon characters (ie, online role models) were identified. The scripts of the role model stories were written by a professional writer and reviewed by adolescents (n = 10) in individual interviews prior to finalizing them to ensure youth appeal. Interviews indicated that the youth liked the stories and the teen cartoon characters. An important change suggested during the interviews was that the teen cartoon characters store photos on their cell phones, laptops, or on social networking sites rather than in a photo album as portrayed in one of the role model stories.

Online Behavior Change Program Content

Using information from the focus groups and interviews, program components for the online program were developed. A final set of interviews (n = 5) was conducted to review program components prior to completion. During these one-on-one interviews, adolescents were shown the components and queried about their thoughts regarding relevance, appropriateness, and appeal. The interviews indicated no changes were needed to program content.

Final Online Behavior Change Program Structure and Content

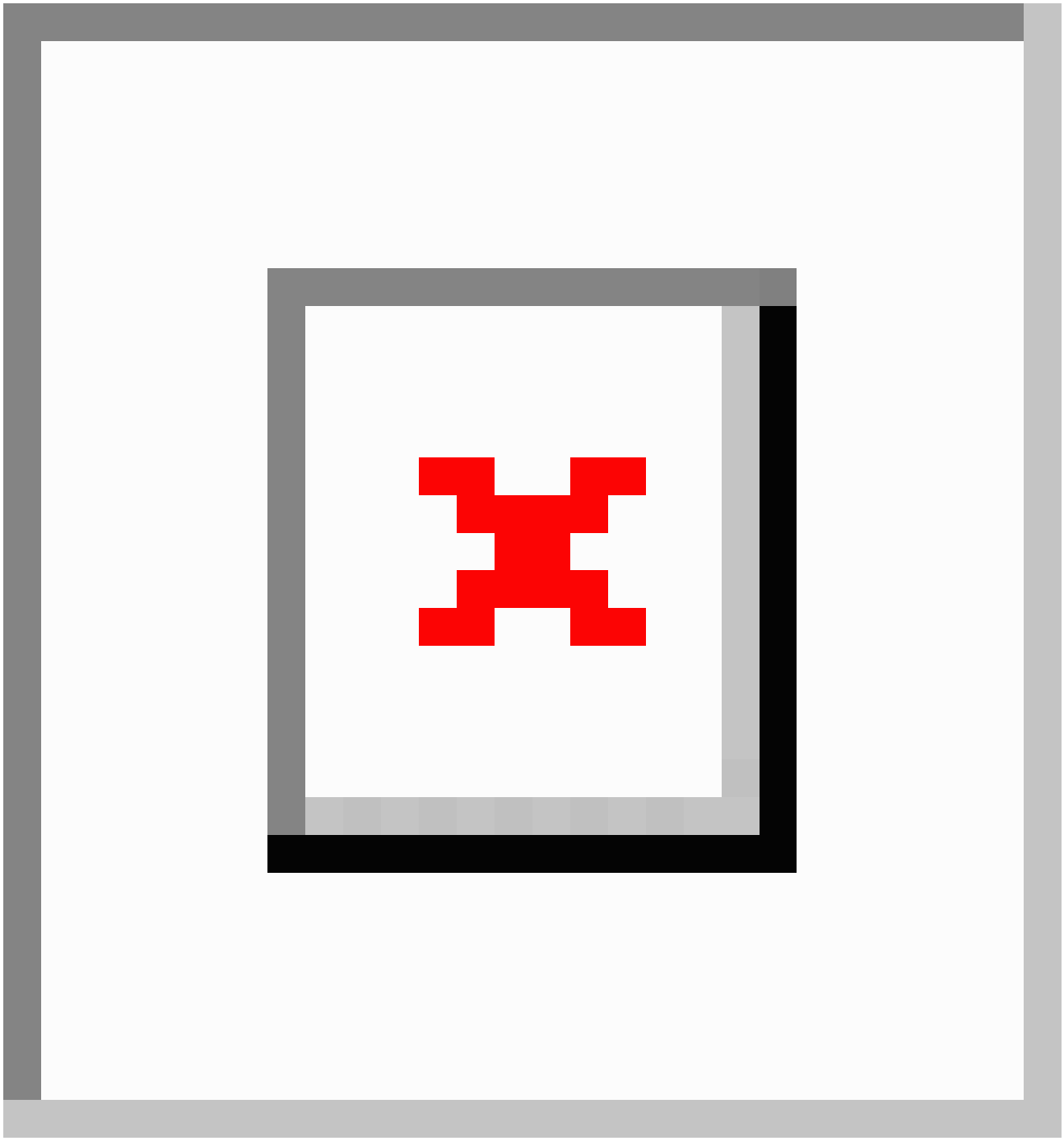
The name selected by participants for the 12-week online behavior change program was "Teen Choice: Food & Fitness." The online program contains an initial log-on page where teens enter their unique username and password to log on to the program website that is hosted on a secure server. Once on the website, they can view the 12 role model stories addressing barriers to healthy eating (n = 6) and physical activity (n = 6) (Figure 1) led by 4 teenage cartoon characters (ie, role models) (Figure 2). Figures 3 and 4 show screenshots of the recipes for teens and parents ("Teen Kitchen") and the nutrition and physical activity information sections ("Did You Know?") created in response to focus group discussions. Figure 5 shows the healthy eating calculator. In addition, teens can access a refereed blog, set goals, make plans to help them attain their goal, track their progress online, report goal attainment, and participate in problem-solving activities.

Control Program Content and Structure

For the randomized controlled trial to test the effectiveness of the online program at improving eating and physical activity behaviors, a control condition was needed. It was constructed by removing the role model stories and the goal setting, planning, self-monitoring, goal review, and problem-solving components from the treatment intervention (ie, the components that promote personal mastery and observational learning, two key components of Social Cognitive Theory [60]).

XSL•FO
RenderX

Figure 1. Screenshot of "Teen Video Clips" (short, animated role model stories) showing titles of topics addressed in the online behavior change program).



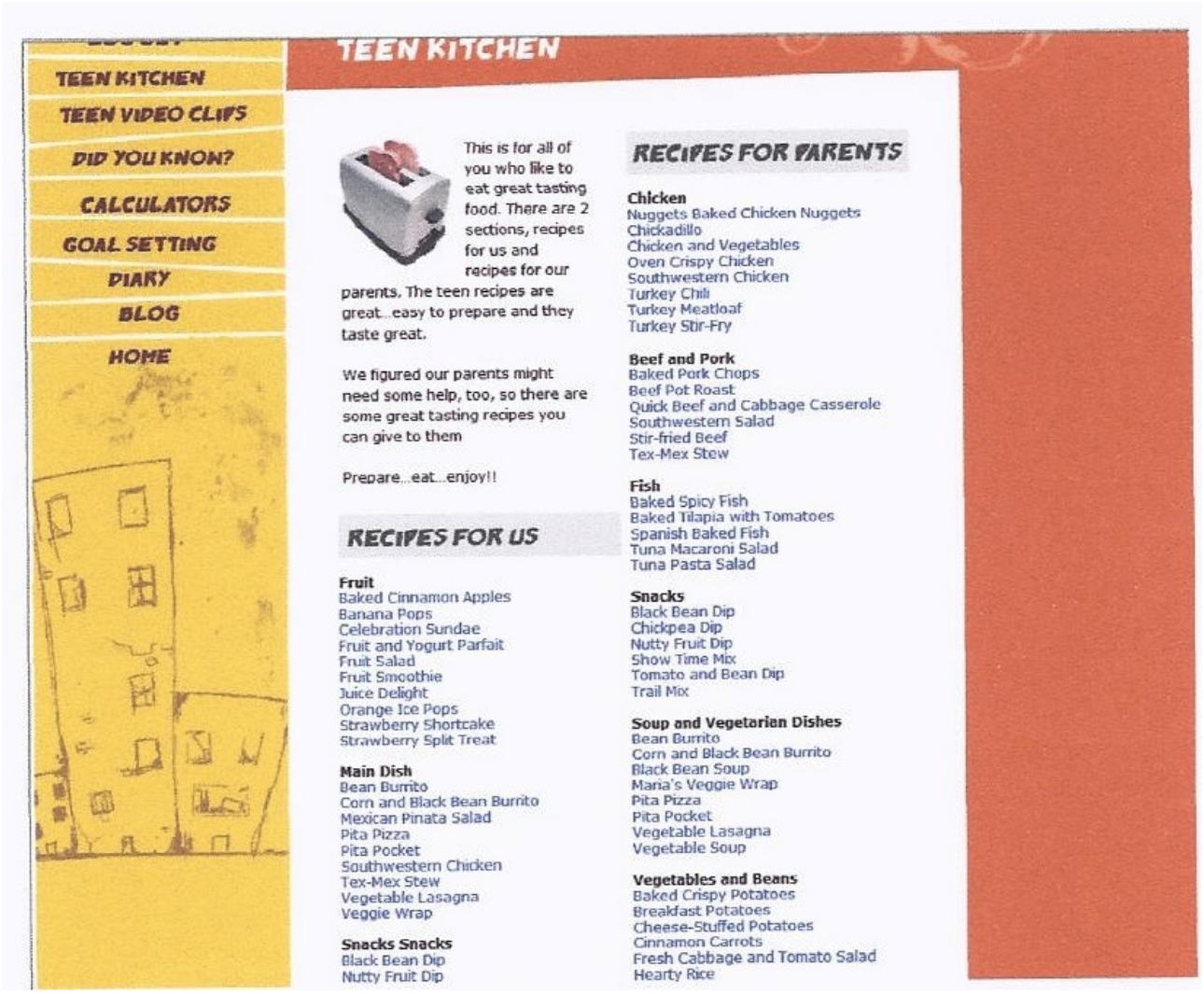
XSL•FO
RenderX

Figure 2. "Welcome" screenshot showing the online teen characters (ie, role models).



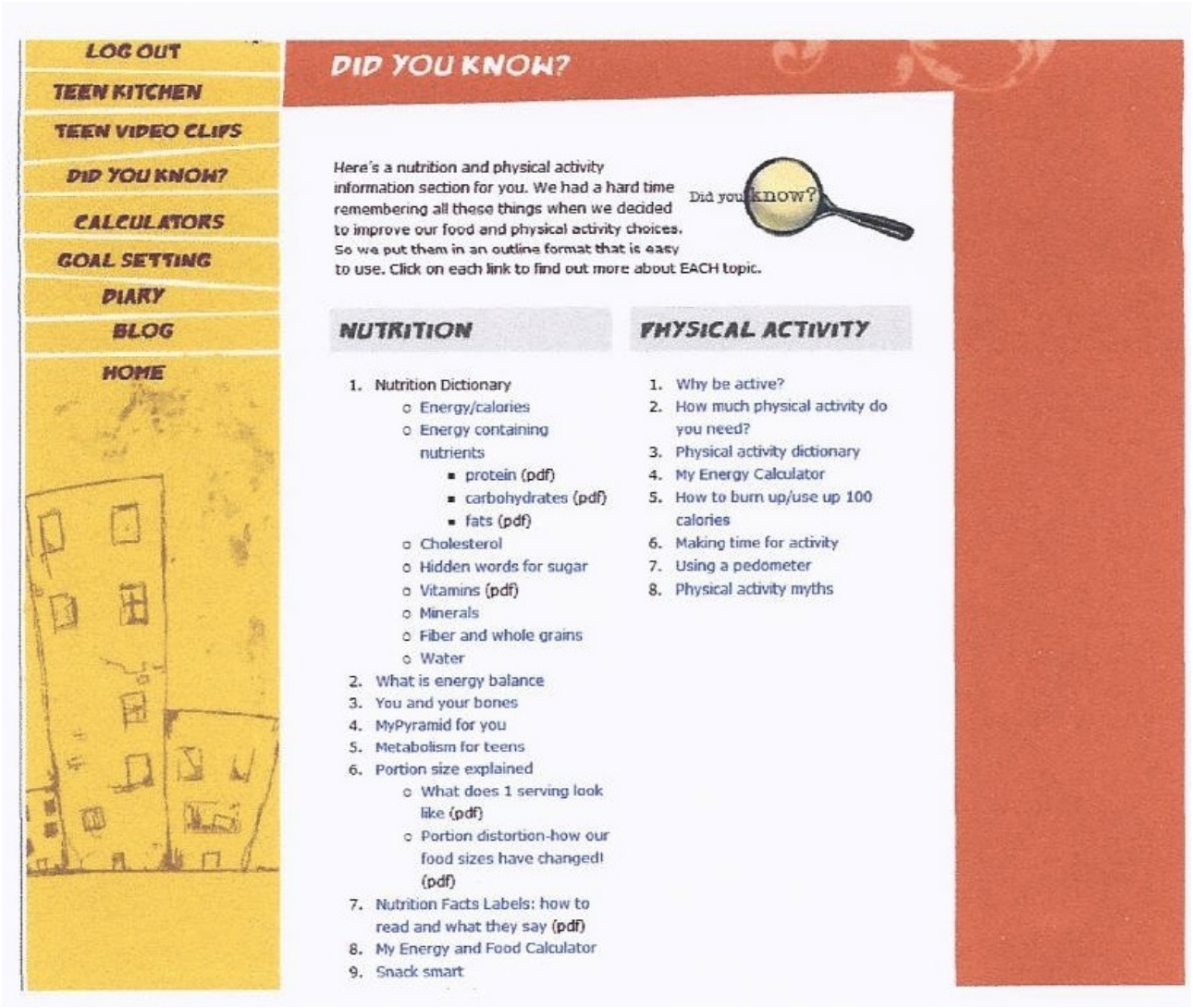
XSL•FO
RenderX

Figure 3. "Teen Kitchen" screenshot showing teen and parent recipes.



XSL•FO
RenderX

Figure 4. "Did You Know" screenshot showing topics.



XSL•FO
RenderX

Figure 5. "Healthy Eating Calculator" screenshot.



Discussion

Principal Results

This paper reports the results of formative research with adolescents to create an online program promoting healthy eating and physical activity that would appeal to this age group. Their recommendations were used to guide decisions about the online program content and structure. As such, it provides guidance on how to involve the target audience in the development of an online behavior change program.

Comparison With Prior Work

Internet and computer use are high among youth [21], thus offering a potential method for reaching them in a manner that is familiar, appealing, and readily available. The involvement of youth in the creation of online programs aimed at helping them reduce obesity risk, such as those that promote healthy diet and physical activity behaviors, is critical [61,62]. Although emerging evidence suggests online programs may be an effective method for modifying youth health behavior [13,14,16,17,63-66], few programs have been developed specifically for adolescents [14,16,17,65,66]. Thus, this paper offers a model for development of online programs for adolescents that demonstrates how to involve them in the design process.

Online programs provide an engaging venue for achieving behavior change through both personal mastery and observational learning. Personal mastery can be promoted in an online program through inclusion of self-regulatory activities, such as goal setting, planning, self-monitoring, and problem-solving activities; thus, it is important for these activities to be developmentally appropriate and utilize a format that appeals to the target audience [67]. Additionally, it is imperative that the content appeal to youth and reflect their reality. For example, the barriers to healthy eating and physical activity identified by youth reflect those specified in the literature [25-58]; however, it was critical to identify their top barriers and to create role model stories that reflected solutions perceived as realistic by teens. Formative research, such as that reported here, can provide important insights that are critical to achieving this goal.

Observational learning occurs by watching others (ie, role models) perform a particular behavior and receive rewards [60]. This process is facilitated when the role model is perceived to be both competent and similar to the observer [68,69]. In online behavior change programs, teen cartoon characters can function as role models [70]. Therefore, in programs attempting to capitalize on observational learning, engaging adolescents in the design of appealing and believable teen characters is essential to creating an effective program.

XSL•FO
RenderX

Attracting and maintaining attention is an important first step in observational learning because it initiates learning and behavior change processes [60]. Enhancing personal relevance [8,71] of the program components achieves this goal by alerting the participant that "this is for me." In the current program, formative research provided an opportunity to identify and understand real and perceived barriers adolescents encounter when attempting to make healthy diet and physical activity choices, as well as solutions that made sense to them. Incorporating these barriers and solutions in role model stories provided a venue for conveying this information to teens in an entertaining, personally relevant manner.

Next Steps

Recruitment for the randomized controlled trial to test the online program began in late 2009 and concluded in October, 2011. Data collection is currently underway.

Recommendations/Suggestions

Design of online programs promoting behavior change should be a collaborative effort between researchers and members of the target audience, such as teens. Suggestions for achieving this are:

1. A realistic timeline is essential. Allow ample time for recruitment, data collection, analysis, interpretation, and application.

2. Participants should represent the target population. This includes gender, socio-economic status, age, and other salient characteristics. If not, it is possible the data may be skewed and may not adequately represent the target group, thus reducing the potential effectiveness of the program. In this program, formative research was conducted in two states in order to ensure the results were not relevant to teens in only one part of the country.

3. Conduct enough focus groups or interviews to achieve theoretical saturation, or the point at which no new information emerges [24]. In the program described in this paper, both focus groups and interviews were conducted to ensure the topics were adequately covered.

4. Although scripts are important for consistency in data collection, they should be semi-structured, allowing ample room for participants to share thoughts and opinions. Discrepant information (ie, data different from those heard from others) may be especially useful. Scripts should contain open-ended, neutral, and non-leading questions. Probes, prompts, and follow-up questions should be generously used to expand and more fully understand responses. The scripts used to guide discussions in the current project were semi-structured, and probes and prompts were used to explore responses and elicit additional information as needed.

5. Member checks are important [72,73]. Member checks help ensure the data are being interpreted correctly. Although there are several ways to conduct member checks, one way that is particularly useful in the design of behavior change programs is to take the results of the analyses back to members of the target audience and ask if the data were correctly interpreted and/or applied. For example, in the current study we asked youth to review the role model stories.

Limitations

Limitations of this research include the use of qualitative research in only two locations, which limits generalizability of the findings. This research does not address desired frequency of user access, program components accessed, or time spent viewing or completing the various components. It also does not address the impact of the program on diet or physical activity behaviors. However, the outcome evaluation, which is currently underway, is collecting information to address these issues. Additional research is needed to understand triggers for participation (ie, why teens enroll in online behavior change programs), whether programs of this type meet their expectations, and long-term health effects in order to develop robust and effective online behavior change programs.

Conclusion

Successful programs that encourage adolescents to adopt healthy diet and physical activity behaviors are needed to reduce obesity risk. Online behavior change programs designed in conjunction with youth may provide an important venue for achieving desired changes in these behaviors. The efficacy of this approach with adolescents is currently being tested and will provide valuable insights that can be used to guide future intervention research.

Acknowledgments

This work is a publication of the United States Department of Agriculture, Agricultural Research Service (USDA/ARS) Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, Houston, Texas. This project was supported by the National Research Initiative of the United States Department of Agriculture Cooperative State Research, Education and Extension Service, grant number # 2007-55215-17998 (to Dr. Cullen). This project has also been funded in part by federal funds from the USDA/ARS under Cooperative Agreement No. 58-6250-0-008. The contents of this publication do not necessarily reflect the views or policies of the USDA and mention of trade names, commercial products, or organizations does not imply endorsement by the US Government.

The authors also would like to also acknowledge Archimage, Inc, Houston, Texas for their web design services.

Conflicts of Interest

None declared.

XSL•FO
RenderX

References

1. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007-2008. JAMA 2010 Jan 20;303(3):242-249. [doi: 10.1001/jama.2009.2012] [Medline: 20071470]
2. Must A, Jacques PF, Dallal GE, Bajema CJ, Dietz WH. Long-term morbidity and mortality of overweight adolescents. A follow-up of the Harvard Growth Study of 1922 to 1935. N Engl J Med 1992 Nov 5;327(19):1350-1355 [FREE Full text] [doi: 10.1056/NEJM199211053271904] [Medline: 1406836]
3. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. N Engl J Med 1997 Sep 25;337(13):869-873 [FREE Full text] [doi: 10.1056/NEJM199709253371301] [Medline: 9302300]
4. Thompson D, Baranowski T, Zakeri I, Jago R, Davis J, Cullen K. Chapter 8. Effectiveness of School-Based Environmental vs. Individual Approaches to Diet, Physical Activity, and Sedentary Behavior Change Among Youth. In: Flamenbaum RK, editor. Childhood obesity and health research. New York: Nova Science Publishers; 2006:154-174.
5. Ahern DK. Challenges and opportunities of eHealth research. Am J Prev Med 2007 May;32(5 Suppl):S75-S82. [doi: 10.1016/j.amepre.2007.01.016] [Medline: 17466822]
6. Mauriello LM, Sherman KJ, Driskell MM, Prochaska JM. Using interactive behavior change technology to intervene on physical activity and nutrition with adolescents. Adolesc Med State Art Rev 2007 Aug;18(2):383-99, xiii. [Medline: 18605653]
7. Wantland DJ, Portillo CJ, Holzemer WL, Slaughter R, McGhee EM. The effectiveness of Web-based vs. non-Web-based interventions: a meta-analysis of behavioral change outcomes. J Med Internet Res 2004 Nov 10;6(4):e40 [FREE Full text] [doi: 10.2196/jmir.6.4.e40] [Medline: 15631964]
8. Kroeze W, Werkman A, Brug J. A systematic review of randomized trials on the effectiveness of computer-tailored education on physical activity and dietary behaviors. Ann Behav Med 2006 Jun;31(3):205-223. [doi: 10.1207/s15324796abm3103_2] [Medline: 16700634]
9. Revere D, Dunbar PJ. Review of computer-generated outpatient health behavior interventions: clinical encounters "in absentia". J Am Med Inform Assoc 2001;8(1):62-79 [FREE Full text] [Medline: 11141513]
10. Neville LM, O'Hara B, Milat AJ. Computer-tailored physical activity behavior change interventions targeting adults: a systematic review. Int J Behav Nutr Phys Act 2009;6:30 [FREE Full text] [doi: 10.1186/1479-5868-6-30] [Medline: 19490649]
11. van den Berg MH, Schoones JW, Vliet Vlieland TP. Internet-based physical activity interventions: a systematic review of the literature. J Med Internet Res 2007;9(3):e26 [FREE Full text] [doi: 10.2196/jmir.9.3.e26] [Medline: 17942388]
12. Bennett GG, Glasgow RE. The delivery of public health interventions via the Internet: actualizing their potential. Annu Rev Public Health 2009 Apr 29;30:273-292. [doi: 10.1146/annurev.publhealth.031308.100235] [Medline: 19296777]
13. Thompson D, Baranowski T, Cullen K, Watson K, Liu Y, Canada A, et al. Food, fun, and fitness internet program for girls: pilot evaluation of an e-Health youth obesity prevention program examining predictors of obesity. Prev Med 2008 Nov;47(5):494-497. [doi: 10.1016/j.ypmed.2008.07.014] [Medline: 18718846]
14. Thompson D, Baranowski T, Baranowski J, Cullen K, Jago R, Watson K, et al. Boy Scout 5-a-Day Badge: outcome results of a troop and Internet intervention. Prev Med 2009 Dec;49(6):518-526. [doi: 10.1016/j.ypmed.2009.09.010] [Medline: 19765608]
15. Haerens L, Deforche B, Maes L, Brug J, Vandelanotte C, De Bourdeaudhuij I. A computer-tailored dietary fat intake intervention for adolescents: results of a randomized controlled trial. Ann Behav Med 2007;34(3):253-262. [doi: 10.1080/08836610701677246] [Medline: 18020935]
16. Patrick K, Calfas KJ, Norman GJ, Zabinski MF, Sallis JF, Rupp J, et al. Randomized controlled trial of a primary care and home-based intervention for physical activity and nutrition behaviors: PACE+ for adolescents. Arch Pediatr Adolesc Med 2006 Feb;160(2):128-136 [FREE Full text] [doi: 10.1001/archpedi.160.2.128] [Medline: 16461867]
17. Jago R, Baranowski T, Baranowski JC, Thompson D, Cullen KW, Watson K, et al. Fit for Life Boy Scout badge: outcome evaluation of a troop and Internet intervention. Prev Med 2006 Mar;42(3):181-187. [doi: 10.1016/j.ypmed.2005.12.010] [Medline: 16458955]
18. Williamson DA, Walden HM, White MA, York-Crowe E, Newton RL, Alfonso A, et al. Two-year internet-based randomized controlled trial for weight loss in African-American girls. Obesity (Silver Spring) 2006 Jul;14(7):1231-1243 [FREE Full text] [doi: 10.1038/oby.2006.140] [Medline: 16899804]
19. McPherson A, Macfarlane A. Health information for young people where and when they most want it: a case study of www.teenagehealthfreak.org. Adolesc Med State Art Rev 2007 Aug;18(2):407-14, xiv. [Medline: 18605655]
20. Webb TL, Joseph J, Yardley L, Michie S. Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. J Med Internet Res 2010;12(1):e4 [FREE Full text] [doi: 10.2196/jmir.1376] [Medline: 20164043]
21. Rideout V, Foehr U, Roberts D. Henry J. Kaiser Family Foundation. Menlo Park, Calif; 2010. Generation M2: Media in the Lives of 8- to 18- Year-Olds URL: http://www.kff.org/entmedia/mh012010pkg.cfm [accessed 2011-11-27] [WebCite Cache ID 63XUsUw6Q]

XSL•FO
RenderX

22. Lenhart A, Purcell K, Smith A, Zickuhr K. Social Media & Mobile Internet Use Among Teens and Young Adults. Washington, DC: Pew Internet & American Life Project; 2010 Feb. URL: http://pewresearch.org/pubs/1484/social-media-mobile-internet-use-teens-millennials-fewer-blog [accessed 2011-11-28] [WebCite Cache ID 63XV3iV4b]
23. Roberts D, Foehr U, Rideout V. Generation M: Media in the Lives of 8-18 Year-Olds. Menlo Park, Calif: Henry J. Kaiser Family Foundation; 2005. URL: http://www.kff.org/entmedia/entmedia030905pkg.cfm [accessed 2011-11-27] [WebCite Cache ID 63XV8yvEz]
24. Morgan D, Krueger R. The Focus Group Kit. Thousand Oaks, Calif.: SAGE Publications; 1998.
25. Zizza C, Siega-Riz AM, Popkin BM. Significant increase in young adults' snacking between 1977-1978 and 1994-1996 represents a cause for concern!. Prev Med 2001 Apr;32(4):303-310. [doi: 10.1006/pmed.2000.0817] [Medline: 11304090]
26. Piernas C, Popkin BM. Trends in snacking among U.S. children. Health Aff (Millwood) 2010;29(3):398-404. [doi: 10.1377/hlthaff.2009.0666] [Medline: 20194979]
27. Deshmukh-Taskar PR, Nicklas TA, O'Neil CE, Keast DR, Radcliffe JD, Cho S. The relationship of breakfast skipping and type of breakfast consumption with nutrient intake and weight status in children and adolescents: the National Health and Nutrition Examination Survey 1999-2006. J Am Diet Assoc 2010 Jun;110(6):869-878. [doi: 10.1016/j.jada.2010.03.023] [Medline: 20497776]
28. Briefel RR, Johnson CL. Secular trends in dietary intake in the United States. Annu Rev Nutr 2004;24:401-431. [doi: 10.1146/annurev.nutr.23.011702.073349] [Medline: 15189126]
29. Wang YC, Bleich SN, Gortmaker SL. Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among US children and adolescents, 1988-2004. Pediatrics 2008 Jun;121(6):e1604-e1614 [FREE Full text] [doi: 10.1542/peds.2007-2834] [Medline: 18519465]
30. Bowman SA, Gortmaker SL, Ebbeling CB, Pereira MA, Ludwig DS. Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. Pediatrics 2004 Jan;113(1 Pt 1):112-118 [FREE Full text] [Medline: 14702458]
31. Duerksen SC, Elder JP, Arredondo EM, Ayala GX, Slymen DJ, Campbell NR, et al. Family restaurant choices are associated with child and adult overweight status in Mexican-American families. J Am Diet Assoc 2007 May;107(5):849-853. [doi: 10.1016/j.jada.2007.02.012] [Medline: 17467384]
32. Taveras EM, Berkey CS, Rifas-Shiman SL, Ludwig DS, Rockett HR, Field AE, et al. Association of consumption of fried food away from home with body mass index and diet quality in older children and adolescents. Pediatrics 2005 Oct;116(4):e518-e524 [FREE Full text] [doi: 10.1542/peds.2004-2732] [Medline: 16199680]
33. Thompson OM, Ballew C, Resnicow K, Must A, Bandini LG, Cyr H, et al. Food purchased away from home as a predictor of change in BMI z-score among girls. Int J Obes Relat Metab Disord 2004 Feb;28(2):282-289. [doi: 10.1038/sj.ijo.0802538] [Medline: 14647177]
34. Larson NI, Perry CL, Story M, Neumark-Sztainer D. Food preparation by young adults is associated with better diet quality. J Am Diet Assoc 2006 Dec;106(12):2001-2007. [doi: 10.1016/j.jada.2006.09.008] [Medline: 17126631]
35. McKinley MC, Lowis C, Robson PJ, Wallace JM, Morrissey M, Moran A, et al. It's good to talk: children's views on food and nutrition. Eur J Clin Nutr 2005 Apr;59(4):542-551. [doi: 10.1038/sj.ejcn.1602113] [Medline: 15714214]
36. Evans AE, Wilson DK, Buck J, Torbett H, Williams J. Outcome expectations, barriers, and strategies for healthful eating: a perspective from adolescents from low-income families. Fam Community Health 2006;29(1):17-27. [Medline: 16340675]
37. Contento IR, Williams SS, Michela JL, Franklin AB. Understanding the food choice process of adolescents in the context of family and friends. J Adolesc Health 2006 May;38(5):575-582. [doi: 10.1016/j.jadohealth.2005.05.025] [Medline: 16635770]
38. Shepherd J, Harden A, Rees R, Brunton G, Garcia J, Oliver S, et al. Young people and healthy eating: a systematic review of research on barriers and facilitators. Health Educ Res 2006 Apr;21(2):239-257 [FREE Full text] [doi: 10.1093/her/cyh060] [Medline: 16251223]
39. Cullen KW, Baranowski T, Owens E, Marsh T, Rittenberry L, de Moor C. Availability, accessibility, and preferences for fruit, 100% fruit juice, and vegetables influence children's dietary behavior. Health Educ Behav 2003 Oct;30(5):615-626. [Medline: 14582601]
40. Cullen KW, Zakeri I. Fruits, vegetables, milk, and sweetened beverages consumption and access to à la carte/snack bar meals at school. Am J Public Health 2004 Mar;94(3):463-467. [Medline: 14998815]
41. Cullen KW, Watson K, Zakeri I. Improvements in middle school student dietary intake after implementation of the Texas Public School Nutrition Policy. Am J Public Health 2008 Jan;98(1):111-117. [doi: 10.2105/AJPH.2007.111765] [Medline: 18048778]
42. Kohl HW, Hobbs KE. Development of physical activity behaviors among children and adolescents. Pediatrics 1998 Mar;101(3 Pt 2):549-554. [Medline: 12224661]
43. Stucky-Ropp RC, DiLorenzo TM. Determinants of exercise in children. Prev Med 1993 Nov;22(6):880-889. [Medline: 8115345]
44. Gyurcsik NC, Spink KS, Bray SR, Chad K, Kwan M. An ecologically based examination of barriers to physical activity in students from grade seven through first-year university. J Adolesc Health 2006 Jun;38(6):704-711. [doi: 10.1016/j.jadohealth.2005.06.007] [Medline: 16730599]

XSL•FO
RenderX

45. Motl RW, Dishman RK, Ward DS, Saunders RP, Dowda M, Felton G, et al. Perceived physical environment and physical activity across one year among adolescent girls: self-efficacy as a possible mediator? J Adolesc Health 2005 Nov;37(5):403-408. [doi: 10.1016/j.jadohealth.2004.10.004] [Medline: 16227126]
46. Motl RW, Dishman RK, Saunders RP, Dowda M, Pate RR. Perceptions of physical and social environment variables and self-efficacy as correlates of self-reported physical activity among adolescent girls. J Pediatr Psychol 2007;32(1):6-12. [doi: 10.1093/jpepsy/jsl001] [Medline: 16707779]
47. Neumark-Sztainer D, Story M, Hannan PJ, Tharp T, Rex J. Factors associated with changes in physical activity: a cohort study of inactive adolescent girls. Arch Pediatr Adolesc Med 2003 Aug;157(8):803-810 [FREE Full text] [doi: 10.1001/archpedi.157.8.803] [Medline: 12912787]
48. Hohepa M, Schofield G, Kolt GS. Physical activity: what do high school students think? J Adolesc Health 2006 Sep;39(3):328-336. [doi: 10.1016/j.jadohealth.2005.12.024] [Medline: 16919793]
49. Lytle LA, Murray DM, Evenson KR, Moody J, Pratt CA, Metcalfe L, et al. Mediators affecting girls' levels of physical activity outside of school: findings from the trial of activity in adolescent girls. Ann Behav Med 2009 Oct;38(2):124-136. [doi: 10.1007/s12160-009-9127-2] [Medline: 20012810]
50. US Department of Health and Human Services. Physical Activity and Health: A Report of the Surgeon General. Atlanta, Georgia: US Department of Health and Human Services, Public Health Service, CDC, National Center for Chronic Disease Prevention and Health Promotion; 1996. URL: http://www.cdc.gov/NCCDPHP/SGR/index.htm [accessed 2012-04-08] [WebCite Cache ID 67DTZJV4g]
51. Sallis JF, Bauman A, Pratt M. Environmental and policy interventions to promote physical activity. Am J Prev Med 1998 Nov;15(4):379-397. [Medline: 9838979]
52. Tappe MK, Duda JL, Ehrnwald PM. Perceived barriers to exercise among adolescents. J Sch Health 1989 Apr;59(4):153-155. [Medline: 2716290]
53. Trost SG, Kerr LM, Ward DS, Pate RR. Physical activity and determinants of physical activity in obese and non-obese children. Int J Obes Relat Metab Disord 2001 Jun;25(6):822-829 [FREE Full text] [doi: 10.1038/sj.ijo.0801621] [Medline: 11439296]
54. Sallis JF, Berry CC, Broyles SL, McKenzie TL, Nader PR. Variability and tracking of physical activity over 2 yr in young children. Med Sci Sports Exerc 1995 Jul;27(7):1042-1049. [Medline: 7564971]
55. Popkin BM, Duffey K, Gordon-Larsen P. Environmental influences on food choice, physical activity and energy balance. Physiol Behav 2005 Dec 15;86(5):603-613. [doi: 10.1016/j.physbeh.2005.08.051] [Medline: 16246381]
56. Dishman RK, Dunn AL, Sallis JF, Vandenberg RJ, Pratt CA. Social-cognitive correlates of physical activity in a multi-ethnic cohort of middle-school girls: two-year prospective study. J Pediatr Psychol 2010 Mar;35(2):188-198. [doi: 10.1093/jpepsy/jsp042] [Medline: 19468040]
57. Taylor WC, Yancey AK, Leslie J, Murray NG, Cummings SS, Sharkey SA, et al. Physical activity among African American and Latino middle school girls: consistent beliefs, expectations, and experiences across two sites. Women Health 1999;30(2):67-82. [Medline: 10881759]
58. Grieser M, Vu MB, Bedimo-Rung AL, Neumark-Sztainer D, Moody J, Young DR, et al. Physical activity attitudes, preferences, and practices in African American, Hispanic, and Caucasian girls. Health Educ Behav 2006 Feb;33(1):40-51. [doi: 10.1177/1090198105282416] [Medline: 16397158]
59. Nowak K, Rauh C. The influence of the avatar on online perceptions of anthropomorphism, androgny, credibility, homophily, and attraction. Journal of Computer-Mediated Communication. 2005. (1) p. article 8 URL: http://jcmc.indiana.edu/vol11/issue1/nowak.html [WebCite Cache ID 67DTrjyDq]
60. Bandura A. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs, N.J.: Prentice-Hall; 1986.
61. Franck LS, Noble G. Here's an idea: ask the users! Young people's views on navigation, design and content of a health information website. J Child Health Care 2007 Dec;11(4):287-297. [doi: 10.1177/1367493507083941] [Medline: 18039731]
62. Ezendam NP, Oenema A, van de Looij-Jansen PM, Brug J. Design and evaluation protocol of. BMC Public Health 2007;7:324 [FREE Full text] [doi: 10.1186/1471-2458-7-324] [Medline: 17997834]
63. Baranowski T, Baranowski JC, Cullen KW, Thompson DI, Nicklas T, Zakeri IE, et al. The Fun, Food, and Fitness Project (FFFP): the Baylor GEMS pilot study. Ethn Dis 2003;13(1 Suppl 1):S30-S39. [Medline: 12713209]
64. Baranowski T, Baranowski J, Cullen KW, Marsh T, Islam N, Zakeri I, et al. Squire's Quest! Dietary outcome evaluation of a multimedia game. Am J Prev Med 2003 Jan;24(1):52-61. [Medline: 12554024]
65. Winett RRA, Winett S, Bajzek W, Rovniak L, Whiteley J. The Effects of the Eat4Life Internet-Based Health Behavior Program on the Nutrition and Activity Practices of High School Girls. Journal of Gender, Culture, and Health 1999;4(3):239-254. [doi: 10.1023/a:1023233416859]
66. Williamson DA, Martin PD, White MA, Newton R, Walden H, York-Crowe E, et al. Efficacy of an internet-based behavioral weight loss program for overweight adolescent African-American girls. Eat Weight Disord 2005 Sep;10(3):193-203. [Medline: 16277142]

XSL•FO
RenderX

67. Thompson D, Baranowski T, Buday R, Baranowski J, Thompson V, Jago R, et al. Serious Video Games for Health How Behavioral Science Guided the Development of a Serious Video Game. Simul Gaming 2010 Aug 1;41(4):587-606. [doi: 10.1177/1046878108328087] [Medline: 20711522]
68. Schunk D. Vicarious influences on self-efficacy for cognitive skill learning. Journal of Social and Clinical Psychology 1986;4(3):316-327. [doi: 10.1521/jscp.1986.4.3.316]
69. Schunk D. Peer models and children's behavioral change. Review of Educational Research 1987;57(2):149-174. [doi: 10.3102/00376543057002149]
70. Thompson D, Baranowski T, Buday R, Baranowski J, Juliano M, Frazior M, et al. In pursuit of change: youth response to intensive goal setting embedded in a serious video game. J Diabetes Sci Technol 2007 Nov;1(6):907-917 [FREE Full text] [Medline: 19885165]
71. Kreuter M, Farrell D, Olevitch L, Brennan L. Tailoring health messages: customizing communication with computer technology. Mahwah, N.J.: Lawrence Erlbaum Associates; 2000.
72. Ely M. Doing qualitative research: circles within circles. London: Falmer Press; 1991.
73. McMillan JH, Schumaker S. Chapter 11: Introduction to designing qualitative research. In: McGeehon P, editor. Research in education: a conceptual introduction (fourth edition). New York: Longman; 1997.

Edited by G Eysenbach; submitted 18.07.11; peer-reviewed by F Bassetti, A Booth, C Klein; comments to author 18.10.11; revised version received 25.01.12; accepted 14.02.12; published 26.04.12.

Please cite as:
Thompson D, Cullen KW, Boushey C, Konzelmann K
Design of a Website on Nutrition and Physical Activity for Adolescents: Results From Formative Research
J Med Internet Res 2012;14(2):e59
URL: http://www.jmir.org/2012/2/e59/
doi:10.2196/jmir.1889
PMID:22538427

©Debbe Thompson, Karen Weber Cullen, Carol Boushey, Karen Konzelmann. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 26.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Results from an Online Computer-Tailored Weight Management Intervention for Overweight Adults: Randomized Controlled Trial

Lenneke van Genugten[1], MSc; Pepijn van Empelen[2], PhD; Brigitte Boon[3], PhD; Gerard Borsboom[1], MSc; Tommy Visscher[4], PhD; Anke Oenema[5], PhD

[1]Department of Public Health, Erasmus MC, Univserity Medical Center, Rotterdam, Netherlands

[2]TNO Quality of Life, Leiden, Netherlands

[3]Trimbos Institute, Netherlands Institute of Mental Health and Addiction, Utrecht, Netherlands

[4]Research Centre for Overweight Prevention, Zwolle, Netherlands

[5]Department of Health Education and Health Promotion, Care And Public Health Research Institute (CAPHRI), Maastricht University, Maastricht, Netherlands

Corresponding Author:
Lenneke van Genugten, MSc
Department of Public Health
Erasmus MC
Univserity Medical Center
PO Box 2040
Rotterdam, 3000 CA
Netherlands
Phone: 31 107043721
Fax: 31 107038474
Email: l.vangenugten@erasmusmc.nl

Abstract

Background: Prevention of weight gain has been suggested as an important strategy in the prevention of obesity and people who are overweight are a specifically important group to target. Currently there is a lack of weight gain prevention interventions that can reach large numbers of people. Therefore, we developed an Internet-delivered, computer-tailored weight management intervention for overweight adults. The focus of the intervention was on making small (100 kcal per day), but sustained changes in dietary intake (DI) or physical activity (PA) behaviors in order to maintain current weight or achieve modest weight loss. Self-regulation theory was used as the basis of the intervention.

Objective: This study aims to evaluate the efficacy of the computer-tailored intervention in weight-related anthropometric measures (Body Mass Index, skin folds and waist circumference) and energy balance-related behaviors (physical activity; intake of fat, snacks and sweetened drinks) in a randomized controlled trial.

Methods: The tailored intervention (TI) was compared to a generic information website (GI). Participants were 539 overweight adults (mean age 47.8 years, mean Body Mass Index (BMI) 28.04, 30.9% male, 10.7% low educated) who where recruited among the general population and among employees from large companies by means of advertisements and flyers. Anthropometric measurements were measured by trained research assistants at baseline and 6-months post-intervention. DI and PA behaviors were assessed at baseline, 1-month and 6-month post-intervention, using self-reported questionnaires.

Results: Repeated measurement analyses showed that BMI remained stable over time and that there were no statistically significant differences between the study groups (BMI: TI=28.09, GI=27.61, *P*=.09). Similar results were found for waist circumference and skin fold thickness. Amount of physical activity increased and intake of fat, snacks and sweetened drinks decreased during the course of the study, but there were no differences between the study groups (eg, fat intake: TI=15.4, GI=15.9, *P*=.74). The first module of the tailored intervention was visited by almost all participants, but only 15% completed all four modules of the tailored intervention, while 46% completed the three modules of the general information intervention. The tailored intervention was considered more personally relevant (TI=3.20, GI=2.83, *P*=.001), containing more new information (TI=3.11, GI=2.73, *P*=.003) and having longer texts (TI=3.20, GI=3.07, *P*=.01), while there were no group differences on other process measures such as attractiveness and comprehensibility of the information (eg, attractive design: TI=3.22, GI=3.16, *P*=.58).

XSL•FO
RenderX

Conclusions: The online, computer-tailored weight management intervention resulted in changes in the desired direction, such as stabilization of weight and improvements in dietary intake, but the intervention was not more effective in preventing weight gain or modifying dietary and physical activity behaviors than generic information. A possible reason for the absence of intervention effects is sub-optimal use of the intervention and the self-regulation components. Further research is therefore needed to gain more insight into how the intervention and exposure to its contents can be improved.

Trial Registration: NTR1862; http://apps.who.int/trialsearch/trial.aspx?trialid=NTR1862

(J Med Internet Res 2012;14(2):e44) doi:10.2196/jmir.1901

KEYWORDS

Prevention; Overweight; Adults; Randomized Controlled Trial; Physical activity; Dietary intake; BMI

Introduction

Obesity (Body Mass Index: BMI > 30 kg/m^2) is a major public health concern, because of its high prevalence and association with several negative health outcomes [1-3], a lower quality of life [4,5], and increased health care costs [6]. Given the poor long-term results of weight loss attempts among obese people [7], prevention of weight gain has been postulated as an important strategy for fighting the obesity epidemic [8]. Prevention of weight gain is particularly important among people who are overweight (BMI 25-30 kg/m^2), since they are most at risk of becoming obese. Weight gain prevention (WGP) or modest weight loss does not require drastic dieting but can be achieved by making small, sustained changes in dietary intake or physical activity. In the Netherlands, the average annual weight gain was about 0.5 kg [9]. The global average 1 kg of annual weight gain that is seen in many populations is caused by excess energy intake of about 7000 kcal a year. In reverse, it is hypothesized that 1 kg of annual weight gain can be prevented in about 90% of the population by a daily decrease in dietary intake (DI) or increase in physical activity (PA) of about 100 kcal [10]. Currently, there are only a few effective interventions that focus on the prevention of obesity in overweight adults [11] that take the small changes approach and that can reach large numbers of people. Therefore, we developed a computer-tailored intervention aimed at preventing weight gain among overweight adults [12] and evaluated it for effects.

Behavior Change and Online Interventions

Evidence of the effectiveness of current obesity prevention interventions indicates that such interventions can be successful, but that findings are mixed. In the *Pound of Prevention Study*, a monthly newsletter (including practical guides for behavior change, recipes and locations for walking) and other activities such as weight control sessions were found to have favorable (but statistically non-significant) effects on behavior and weight [13]. Using 10 modules of usual care and email counseling [14] or individual and environmental intervention strategies [15], 2 Dutch worksite interventions were successful in changing behavior and/or preventing weight gain. In a review by Lemmens et al [16], 4 of 11 studies reported a positive effect on weight, of which 3 were aimed at modifying DI and PA; more intensive and sustained interventions, including monitoring of behavior, were more effective [16]. Kremers et al [17], in their meta-analysis on prevention of overweight and obesity, reported a small, but statistically significant average effect size (d=0.06) of weight management interventions, with studies aiming at weight management being more successful than studies aiming at behavior change for other reasons (eg, decrease risk for coronary event). However, most of these studies were not aimed at overweight adults [17].

One key factor in successful WGP is that changes in DI and PA need to be maintained for a long time, which requires self-regulation skills. Self-regulation [18,19] motivates and enables people to achieve self-set goals. The first step in self-regulation consists of setting a goal, in this case WGP. Second, one has to choose the means to achieve this goal. In the case of WGP this means deciding to make small changes in DI and/or PA. Third, a person needs to make a detailed plan for how to make the desired change and how to avoid difficulties that may occur when making the desired change. The step of planning is followed by actual goal pursuit, monitoring, and evaluation of progress toward goal achievement. Providing a platform for goal setting, planning, monitoring, and providing feedback on targeted behavior has been identified as pre-requisite for interventions that aim for change in dietary intake and physical activity [20]. Another prerequisite for WGP interventions is that large numbers of people need to be reached, with relative low costs per person, since about 35% of the adults in the Netherlands are overweight [21].

To be able to meet the criteria of an individualized approach and large reach, we chose to develop an online, computer-tailored intervention. Several reviews have shown that (online) computer-tailored interventions may have a positive effect on energy balance-related behaviors [22-25] compared with general information or no information. One review included 76 studies on eating a healthy diet and/or undertaking physical activity and found a statistically significant overall small effect size (g=0.17) for computer-tailored interventions [22]. Kroeze et al concluded in a review that there is consistent evidence that tailored interventions have a positive effect on dietary intake, especially on fat reduction, and probably on physical activity [23]. Of the 10 studies that were included in the review of Neville [25] and that were aimed at reduction of dietary fat intake, 5 found a positive effect of ‘second generation’ (delivered through interactive technology or desktop applications such as websites, email and CD-rom) tailored interventions. A review on physical activity showed that 10 of 16 studies found statistically significant positive effects on physical activity and weight reduction measures [24]. These reviews show that positive effects on weight, dietary and physical activity

XSL•FO
RenderX

behaviors can be achieved with computer-tailored interventions, but there is currently no evidence for the efficacy of a tailored intervention on prevention of weight gain among overweight adults.

Aims of the Study

The aim of this study was to establish the efficacy of an online, computer-tailored weight management intervention (GRIPP) on anthropometric outcome measures at 6-months post-intervention and on energy balance-related behaviors (intake of sugar-sweetened drinks, snacks and fat, and physical activity) at 1- and 6-months post-intervention compared to a generic information control group. The hypotheses were that anthropometric outcomes (BMI, waist circumference, and skin fold thickness) will be more favorable at 6-months post-intervention for the intervention group, because the average annual weight gain will occur in the control group and not in the intervention group, and that the intervention group will have lowered intake of sugar-sweetened drinks, snacks and high fat products, and engage in more PA at 1- and 6-months post-intervention, as compared with the control group.

In addition, we performed a process evaluation in order to contribute to a better understanding of the (non) effects of the intervention and to identification of areas for improvement for the intervention [26]. Therefore, measures of use and appreciation were included in the process evaluation.

Methods

Study Design

A 2-group randomized controlled trial was conducted in which the computer-tailored intervention (TI, n = 270) was compared with a generic information intervention (GI, n = 270) control group. Body height, weight, waist circumference, and skin fold thickness were measured at baseline and 6-month post-intervention and measurements of energy balance- related behavior were taken at baseline, 1-month post-intervention and 6-month post-intervention. After baseline assessment, participants were allocated to one of the two study groups (1:1) by means of sex-stratified computer block randomization (block size: 10). The study received a declaration of no objection from the Erasmus MC Medical Ethics Committee.

Participants

The participants were adults (18-65 years) who were overweight (self-reported BMI 25-30 m^2). Exclusion criteria were not having a sufficient command of the Dutch language, not having Internet access, being pregnant, following a diet prescribed by a physician or dietician, and having a history of depression or eating disorders.

A power calculation showed that 200 participants in each study group would be sufficient to detect 0.4 difference in BMI points between the intervention and control group (caused by weight gain of 0.3 kg in the control group and weight maintenance or slight weight reduction in the intervention group) with a power of 0.80 and a significance level of $P<.05$. To account for dropout between the measurements, 600 participants needed to be recruited for the study.

Participants were recruited between March and October 2009 from the general population in the Rotterdam (the second largest city in the Netherlands, with approximately 600,000 inhabitants) region through advertisements in local newspapers, flyers that were delivered door-to-door, in waiting rooms of GP's, and among the employees of 4 large companies, with the aim to reach a diverse population with respect to socioeconomic status. The recruitment materials contained information about the goal, process and incentives for the study. More detailed information was available on the study website. People who were interested in participating in the study were asked to fill out an online subscription form available on the study website that was used to assess whether they were eligible for participation in the study. Participants were included in the study if their BMI (calculated as weight/height^2), based on self-reported height and weight, was between 24 and 31 (this range was broader than the objective inclusion criteria of a BMI of 25-30, in order to prevent exclusion based on biased self-reported measures). If people did not meet the inclusion criteria, they could not subscribe for the study.

Procedures

After subscription, participants received a confirmation letter and information leaflet about the study. In addition, they received an email in which they were asked to fill out the baseline questionnaire online. Weight, height, waist circumference and skin folds were measured at the hospital site. Participants signed the consent form when they had their anthropometric measurements taken. When participants did not come to have their anthropometrics measured, the consent form was sent to their home address with a return-envelope. Participants preferably completed both measurements (anthropometrics and questionnaire) but were also randomized when they had completed only one measurement.

All randomized participants received a login name and a password by email, which gave them access to the allocated intervention program. Participants were asked to visit the websites at least three or four times during a 2-month period. They received email reminders to (re-) visit the intervention every 2 weeks. At 1 month and 6 months after the intervention period, participants were asked by email to fill out the online questionnaire again. Furthermore, after 6 months they were again invited to the hospital site for measurement of weight, waist circumference and skin fold thickness. Participants who did not respond to the email invitations for the anthropometric measurements or to complete the questionnaire received a phone call to motivate them to complete the questionnaire or to have their anthropometric measures taken. Gift vouchers were handed out as compensation for travel expenses and invested time. Participants who filled out the questionnaire 1-month post-intervention received a gift voucher of € 10. Participants who filled out the questionnaire and had their anthropometrics measured at 6-months post-intervention, received (another) gift voucher of € 10. Furthermore, because dropout at 1-month post-intervention was higher than the expected 10%, 10 extra gift vouchers of € 20 were raffled among the participants who completed all measures at 6-months post-intervention.

XSL•FO
RenderX

Outcomes/Measures

Anthropometric Measures

The body measurements were performed by trained research assistants following a measurement protocol. *Body height* was measured twice using a Seca mobile height rod with an accuracy of 0.1 cm. The mean of both measures was used for height. A calibrated electronic digital floor scale (Seca 888 clas III) was used to measure *body weight*, with an accuracy of 0.2 kg. The measures of height and weight were used to calculate *BMI* (weight [kg] / (height [m])^2). *Waist circumference* was measured twice with a flexible band (Seca 201) with a precision of 0.1 cm. When the difference between two measurements was larger than 1.0 cm, the waist circumference was measured twice again. Mean waist circumference was calculated based on the last two measurements. *Skin fold thickness* was measured at 4 sites (biceps, triceps, subscapular and supra-iliac) with the Harpenden Skinfold Caliper to assess body fat percentage [15,27]. Each site was measured 3 times and the mean was calculated for each site. A variable for total skin fold thickness in centimeters was composed by summing the means for the 4 sites in 1 measure. The same measures, except for height, were taken at baseline and 6-months post intervention.

Energy Balance-Related Behaviors

In this study, we examined the effects of the interventions on 1) fat intake, 2) snack intake, 3) intake of sweetened drinks (mean number of sweet and sweetened drinks per day), and 4) physical activity. *Fat intake*, expressed as 'fat score', was assessed using a food frequency questionnaire assessing the frequency and quantity of a variety of high density foods eaten in the past week. It was based on a validated questionnaire [28] and allows for calculating fat intake and intake from specific food groups. The questionnaire consisted of 74 questions and was organized according to meal pattern. Participants recorded their frequency of consumption and portion size for a selection of food items eaten during meals or between meals. Fat points were based on frequency and amount of intake of high fat products, with higher scores indicating higher fat intake. There were 23 products, in the following categories: dairy products (5), butter (1), gravy (1), sandwich fillings (3), meat and cheese for main dinner (2) and snacks (sweet, salty, hot and cold; 11 in total). There were a maximum number of points (2 to 5) for each product. In total, a maximum of 83 fat points could be obtained.

Furthermore, people were asked to answer questions about the mean number and amount of sweet and salty, and hot and cold snacks per week from 11 categories (eg, fried products, candy bars, etc). *High energy snack intake* was calculated as the mean number of high energy snacks per day by multiplying the frequency per week with the amount per frequency, divided by 7 (days a week). To assess intake of sweetened drinks, questions on frequency and amount for fruit juices, soft drinks and sweetened tea and coffee were asked. *Intake of sweetened drinks* was calculated in a similar way as intake of snacks.

Physical activity was assessed using a questionnaire based on 'The Short Questionnaire to Assess Health - Enhancing Physical Activity' (SQUASH), developed to assess habitual activity level [29]. In this 16-item questionnaire, participants were asked to indicate on how many days of the week they participated in specified activities, and how much time they engaged in the activity per occasion. For active transport, respondents were asked how often they cycled and walked for home to work transportation, and the duration. Similar questions were asked for walking and cycling during leisure time. Furthermore, participants were asked how many different sports they did on a weekly basis (with a maximum of 4). For each different sport, they were asked to choose the type of sport (eg, swimming, yoga, running) from a list, and to choose the weekly frequency, and the average duration per activity. For each category, the average number of minutes per week was calculated by multiplying the frequency with the duration. Then, this number was divided by 7 to calculate the mean number of minutes per day. Next, the number of minutes engaged in physical activity per day was calculated as the sum of all activities (active transportation, leisure time activities, and sports). The same questionnaires were used at baseline, 1-month and 6-month post-intervention to assess energy balance related behaviors.

Demographic Factors

Sex (male/female), date of birth, and educational level were assessed in the baseline questionnaire. To determine a*ge* we asked for date of birth. *Education* was assessed by asking the participants to indicate their highest completed education (8 answering options). A 3-category variable was subsequently made, indicating a low (completed no education, primary school, secondary school or lowest level of high school or lower vocational training), medium (intermediate or high level high school) or high (completed higher vocational training, college or university) level of *education*.

Process Measures

An *objective measure of exposure* to the intervention was obtained from the login data from the intervention registration, which keeps information from participants' use of the (tailored) information. One scale was made for use/exposure, indicating the number of modules actually used (0-4 for TI, 0-3 for GI). Self-reported measures of use and appreciation were included in the 1-month post-intervention questionnaire. If not stated otherwise, answer categories ranged from 'totally disagree' (1) to 'totally agree' (5).

Amount of information read was assessed by the question, "To what extent did you read the information in the program?" Answering categories ranged from 'none of it' (0) to 'all of it' (5). *Perceived length of the text* was assessed by the question, "What do you think of the lengths of the text in the program?" Answering categories ranged from 'much too short' (1) to 'much too long' (5). Perceived *personalization* was assessed with the statement, "The information in the program was relevant for me personally". *Novelty* of the information was assessed by, "The information in the program was new for me". *Usefulness* of the information was assessed with, "The information in the program was useful". *Attractiveness* was assessed by the question, "The design of the program is attractive". *Usefulness of the intervention* was assessed with the question, "the program is a good instrument to control my weight". Furthermore, participants were asked whether they would *recommend the*

XSL•FO
RenderX

intervention to others using the response options, 'no' (1), 'maybe', (2), or 'yes' (3). Participants were also asked to give an *overall grade* to the intervention on a scale from 1 to 10 (1 being very low, 10 being very high). These questions were included in the questionnaire for the intervention and the control group and are only reported for those who have actually used the interventions.

The Intervention

The objective of the computer-tailored intervention was to prevent weight gain in adults who are overweight by inducing small changes (100 kcal/day) in energy balance-related behaviors (DI and PA). It aimed at making a change in (one or more) behaviors that add most to the energy balance and that are associated with weight gain (frequency and duration of various physical activities and intake of fat (from several categories such as dairy, meat, cheese, sauce, snacks and sweetened drinks) [30]. The intervention was carefully developed based on theory and evidence using the Intervention Mapping approach [26]. The intervention goals, methods, and strategies were based on self-regulation theory [19], and other theories such as the Theory of Planned Behavior [31], Precaution Adoption Process Model [32] and implementation intentions [33]. The strategies were combined into a computer-tailored Internet-delivered intervention. Detailed information about the intervention development and content is described elsewhere [12].

The intervention consisted of 4 modules, each to be visited 1 week after the previous one and followed the steps of self-regulation. Completion of the entire program took about 90 minutes in total. The first module aimed at commitment to prevent weight gain by considering pros and cons of WGP, identifying and setting a goal for one relevant change in DI or PA and making a plan for change. Participants were made aware of current levels of DI and PA and possibilities for change by providing them with individualized feedback on their behavior. Then, people could make a choice for what to change (guided goal setting) and make a plan for where, when, and how to make that change (implementation plan). The second and third modules were focused around evaluation of progress toward behavior change, and provided feedback on past week performance. If necessary, it supported adaptation of action and coping plans (when attempts to change behavior were unsuccessful). The fourth module was aimed at promoting sustained self-regulation of body weight without use of the program. A tool to monitor and evaluate (changes in) body weight was provided, as well as a short guideline with sequences of actions for long term WGP, reflecting on the self-regulatory skills that had been practiced in the previous three modules, and provision of positive reinforcement to maintain behavior. At the end, the participants signed a personalized contract, which included their personal behavior goals, actions plans, weight status, etc. The tailored modules were embedded in a website that also contained recipes, a peer-to-peer forum and links to useful websites, and was accessible through the Internet.

The generic information for the control group was embedded in a website with similar content, and similar reminders were sent to the participants. The main components of this website were 3 modules with general information on weight gain prevention, which had a similar layout as the TI. The first module aimed at increasing the motivation for WGP. The second module aimed at choosing a behavior change by providing information about possible changes. The third module provided general information about a healthy diet and safe physical activity.

Statistical Analyses

Descriptive statistics were used to characterize both study groups at baseline. Logistic regression analyses were conducted to evaluate whether participant characteristics (BMI, sex, education, and age) and allocated intervention group were related to dropout (dropout, no = 0, yes = 1) during the study. Repeated measures analyses were performed, using a general linear mixed model with a random intercept, to study changes during the study period ('time') and differences in changes between the intervention groups ('group', GI = 0 vs TI = 1) for the main outcome measures. These measures were objectively measured BMI, skin fold thickness and waist circumference, and self-reported PA and DI (intake of fat, snacks and sweetened drinks) ('group*time' interaction). This procedure allows for inclusion of cases with missing data, without replacement of missing values, and therefore includes all randomized participants. The 'Type III Wald test' was used to test overall statistical significance of the effects. The significance level (*P*) was set at .05 and tests were two-sided. All analyses were performed using SPSS 17.

Results

Participant Characteristics

In total, 630 people completed the online registration, and 539 enrolled in the study by completing the baseline questionnaire and/or anthropometric measures (Figure 1). The mean age of the participants was 47.8 years (SD 9.4), 31% were male and 11% had a low level of education. The mean BMI was 28.04 (SD 1.94). No baseline differences in socio-demographic characteristics, behavior and anthropometrics were observed between the intervention groups at baseline ($P<.05$, t-tests) (Table 1).

XSL•FO
RenderX

Table 1. Participant characteristics at baseline.

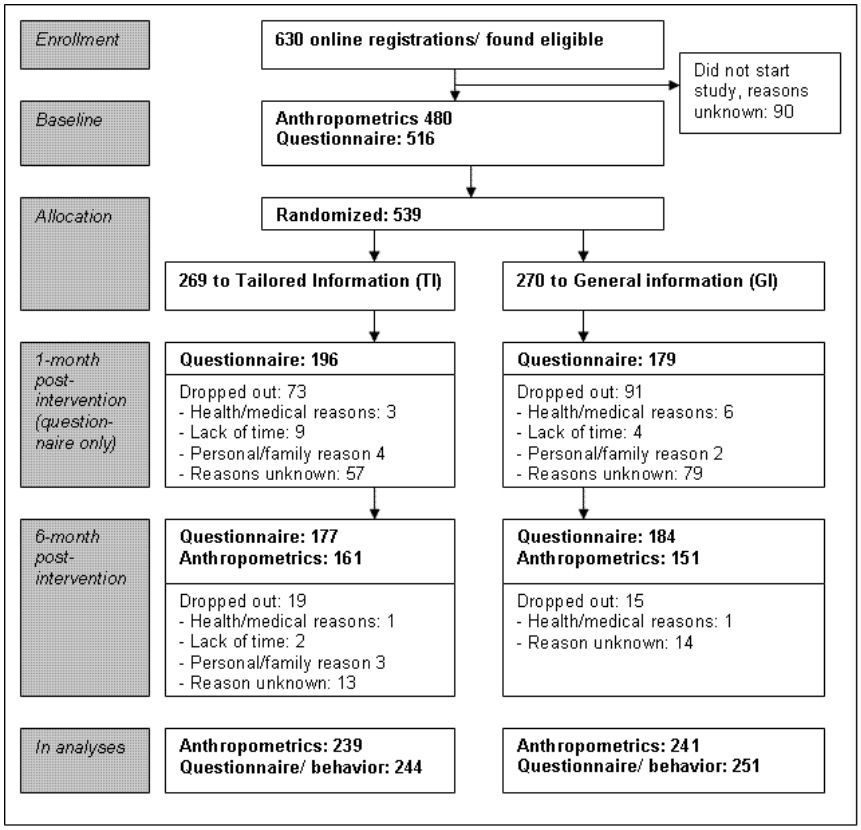
Group characteristics		Total (N = 539)	TI assigned group (n = 269)	GI assigned group (n = 270)
Age, mean (SD)		47.8 (9.4)	47.7 (9.2)	47.9 (9.7)
Male sex, % (n)		30.9 (164)	31.3 (84)	30.5 (80)
Education, % (n)				
	low	10.7 (49)	10.3 (24)	11.0 (25)
	medium	50.2 (231)	48.7 (113)	52.0 (118)
	high	39.1 (179)	40.9 (95)	37 (84)
Anthropometric measures [a]				
BMI	Mean kg/m^2 (SD)	28.04 (1.94)	28.17 (2.02)	27.91 (1.85)
	% Normal weight (<25) (n)	4.2 (20)	4.2 (10)	4.1 (10)
	% Overweight (25-30) (n)	78.5 (377)	75.3 (180)	81.7 (197)
	% Obese (>30) (n)	17.3 (83)	20.5 (49)	14.1 (34)
Waist circumference, mean centimeters (SD)		95.78 (8.79)	95.89 (9.05)	95.66 (8.55)
Skinfold thickness, mean centimeters (SD)		8.82 (1.97)	8.87 (1.92)	8.77 (2.0)
Self-reported behavior [b]				
Physical activity, mean minutes/day (SD)		67.12 (54.3)	63.1 (50.4)	69.6 (42.4)
Fat intake, mean points/week (SD)		17.14 (6.1)	17.0 (6.0)	17.3 (6.2)
Sweetened drinks, mean servings/day (SD)		0.95 (1.2)	0.96 (1.2)	0.93 (1.2)
Snacks, mean number/day (SD)		2.28 (1.9)	2.2 (2.0)	2.3 (1.9)

[a] N(total) = 480, n(TI group) = 239, n(GI group = 241)

[b] N(total) = 457, n(TI group) = 231, n(GI group = 226)

XSL•FO
RenderX

Figure 1. Participant flow for the GRIPP study.



Loss to Follow-up

At baseline, 480 participants had their anthropometrics measured and 313 people at 6-month post-intervention (dropout 34.8%). Younger people were more likely to dropout between the two moments of anthropometric measures (OR age = 0.97, 95% CI 0.95-0.99). A total of 375 participants filled out the 1-month post-intervention (dropout 31%) and 361 people the 6-month post-intervention questionnaire (dropout 33%). Dropout between baseline and 1-month post-intervention questionnaires was more likely among men (OR sex = 0.56, 95% CI 0.35-0.89). Dropout between baseline and 6-month post-intervention was more likely among younger participants (OR age=0.97, 95% CI 0.95-0.99). No other differences were observed among those who completed the study and those who were lost after the first or second measurement.

Intervention Effects

Repeated measures analyses showed that BMI did not change significantly over time (*P*=.09) (Table 2 and Table 3) and that there was no difference between the two groups (interaction effect group*time *P*=.09). Skin fold thickness increased significantly over time (*P*<.001) but there were no differences in change over time between the TI and GI group (interaction effect group*time *P*=.95). There was a statistically significant decrease in waist circumference over time (*P*<.001), but the change in time was not different between the study groups (interaction effect group*time *P*=.12).

Table 2. Crude means and difference of objectively measured anthropometric outcomes at baseline and 6-month post-intervention (N=480).

Outcome	Baseline mean (SD)		6-month post-intervention mean (SD)		Difference T0-T2	
	TI (n = 239)	GI (n = 241)	TI (n = 151)	GI (n = 161)	TI (n = 151)	GI (n = 161)
BMI, kg/m^2	28.17 (2.02)	27.91 (1.85)	28.09 (2.36)	27.61 (2.03)	-0.08	-0.30
WC[a], cm	95.89 (9.05)	95.66 (8.55)	94.41 (10.23)	93.20 (8.61)	-1.48	-2.46
SFT[a], cm	8.87 (1.92)	8.77 (2.0)	9.67 (2.14)	9.47 (2.14)	+0.80	+0.70

[a] WC = waist circumference, SFT = skin fold thickness

XSL•FO
RenderX

Table 3. Results of general linear mixed model analyses for objectively measured anthropometric outcome measures: Estimated marginal means and P values of time and group*time effects (N=480).

Outcome	Baseline estimated means		6-month post-intervention: estimated means		Type III tests *P* values	
	TI	GI	TI	GI	Time	Group*time
BMI, kg/m^2	28.19	27.89	29.19	27.65	.09	.09
WC[a], cm	95.87	95.66	94.62	93.48	<.001	.12
SFT[a], cm	8.87	8.77	9.55	9.66	<.001	.95

[a] WC = waist circumference, SFT = skin fold thickness

The time spent on physical activity decreased significantly in the total population (*P*=.002), but the change was not significantly different among the TI and GI (interaction effect group*time *P*=.44) (Table 4 and Table 5). Mean fat intake decreased statistically significantly between baseline measurement and post-intervention measurements (*P*<.001), but the decrease was similar in the two conditions (interaction effect group*time *P*=.74). Intake of sweetened drinks and snacks showed a similar pattern: intake decreased over time (sweetened drinks *P*<.001, snacks *P*<.001), but changes were not different between the intervention groups (interaction effect group*time: sweetened drinks *P*=.55, and snack intake *P*=.78).

Some of the behavioral outcomes measures (physical activity and intake of sweetened drinks and snacks) had a very skewed distribution. Log-transformation of these outcomes did not improve the fitted model and was not of influence on the time and intervention effects.

Table 4. Crude means and difference of specific self-reported behavior (DI and PA) at baseline, and 1- and 6-month post-intervention (N=495).

Outcome	Baseline mean (SD)		1-month post-intervention mean (SD)		6-month post-intervention mean (SD)		Mean difference T0-T1, T0-T2	
	TI (n = 231)	GI (n = 226)	TI (n = 196)	GI (n = 179)	TI (n = 177)	GI (n = 184)	TI	GI
Minutes PA/day	63.1 (50.4)	69.6 (42.4)	61.9 (56.5)	68.9 (51.8)	63.3 (53.6)	78.7 (60.7)	-1.2, +0.2	-0.7, +15.6
Fat intake/ week	17.0 (6.0)	17.3 (6.2)	15.3 (6.3)	15.7 (6.2)	15.4 (6.0)	15.9 (6.4)	-1.7, -1.6	-1.6, -1.4
Servings sweetened drinks/day	0.96 (1.2)	0.93 (1.2)	0.8 (1.3)	0.7 (1.2)	0.8 (1.1)	0.7 (1.0)	-0.16, 0.16	-0.23, -0.23
Snacks/ day	2.2 (2.0)	2.3 (1.9)	1.7 (1.6)	1.8 (1.6)	1.8 (1.4)	1.9 (1.5)	-0.5, -0.4	-0.5, -0.4

Table 5. Results of general linear mixed model analyses for specific self-reported behavior (DI and PA) at baseline, and 1- and 6-month post-intervention: Estimated marginal means and P values of time and group*time effects (N=495).

Outcome	Baseline estimated means		1-month post-intervention: estimated means		6-month post-intervention: estimated means		Type III tests *P* values	
	TI (n = 231)	GI (n = 226)	TI (n = 196)	GI (n = 179)	TI (n = 177)	GI (n = 184)	Time	Group*time
Minutes PA/day	63.06	69.58	61.94	68.90	63.25	78.71	<.001	.44
Fat intake/ week	17.94	16.94	15.47	15.89	15.23	15.99	<.001	.74
Servings sweetened drinks/day	0.96	0.94	0.82	0.74	0.81	0.67	<.001	.55
Snacks/ day	2.21	2.29	1.73	1.91	1.80	1.90	<.001	.78

Process Evaluation

The login data showed that more than 80% (n = 272) of the respondents used the first module of their allocated intervention (Figure 2). About 15% (n = 41) completed four modules of the TI intervention and 46% (n = 124) completed the three modules of the GI intervention.

T-tests (Table 6) showed that participants in the TI group reported to have read statistically significantly less of the presented information (TI 4.07 vs GI 4.5, *P*<.001) and were slightly less positive about the lengths of the texts (TI 3.20 vs GI 3.07, *P* = .01), compared to the TI group. The information in the TI group was experienced as more ‘new’ (TI 3.11 vs GI 2.73, *P*=.003) and individualized (TI 3.20 vs GI 2.83, *P*=.001),

XSL•FO
RenderX

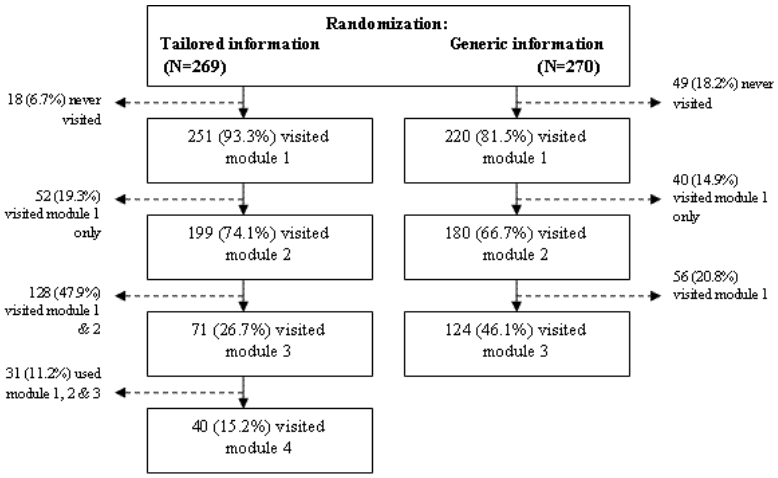
compared with the GI. No differences were found for the usefulness (TI 3.48 vs GI 3.44) and attractiveness (TI 3.22 vs GI 3.16) of the information, the usefulness of the program as a tool for WGP (TI 2.90 vs GI 2.75), recommending it to others (TI 2.14 vs GI 2.14), and the overall grade (TI 6.6 vs GI 6.6).

Table 6. Process measures; means (SD) of appreciation of general information intervention and tailored information intervention, self-reported at 1-month post intervention, and t tests for differences between these groups.

Self-reported process measures[a]	Scale	TI mean (SD) (n = 162)	GI mean (SD) (n = 154)	*P* values
Amount of information read	Nothing (1)-All (5)	4.07 (1.0)	4.5 (0.8)	<.001
Length of the texts	Much too short (1)-Much too long (5)	3.20 (0.5)	3.07 (0.4)	.01
Information meant for me personally	Not at all (1)-Very much (5)	3.20 (1.0)	2.83 (1.0)	.001
New information	Totally disagree (1)-Totally agree (5)	3.11 (1.1)	2.73 (1.1)	.003
Useful information	Totally disagree (1)-Totally agree (5)	3.48 (0.9)	3.44 (0.9)	.68
Attractive design	Totally disagree (1)-Totally agree (5)	3.22 (0.9)	3.16 (0.9)	.58
Good tool for WGP	Totally disagree (1)-Totally agree (5)	2.90 (1.1)	2.75 (1.0)	.20
Recommend to others	No (1)-Maybe (2)-Yes (3)	2.14 (0.7)	2.14 (0.8)	.93
Overall grade	Very low (0)-Very high (10)	6.6 (1.4)	6.6 (1.3)	.69

[a] Self-reported at 1-month post-intervention questionnaire, must have used at least the first module

Figure 2. Attrition flowchart: server registration of use of general information intervention and tailored information intervention.



Discussion

In the present study we evaluated the effects of a carefully developed multi-session computer-tailored weight management intervention for overweight adults that was based on self-regulation theory and contained a number of self-regulation strategies. The results of the study showed that weight remained stable over time and that waist circumference and dietary behaviors slightly improved over six months, but that these improvements were not different from those in the generic information control group. Thus, even though some of the effects of the intervention were in the desired direction, in the present study we could not demonstrate that the elaborate intervention was more effective in inducing weight gain prevention than more basic generic information about weight management.

Interpretation of the Results: Theory and Previous Evidence

Our intervention was solidly based on theory and evidence relevant for inducing weight maintenance and long-term changes

XSL•FO
RenderX

in dietary intake and physical activity, and used the promising method of computer tailoring as an educational technique. It therefore had, in theory, good prospects for effects. The technique of computer tailoring has successfully been applied in interventions aimed at dietary intake, physical activity and weight loss [22,34,35] but no meta-analytic results are known for prevention of weight gain.

Our tailored intervention had a number of characteristics that have been indentified as having a positive influence on intervention efficacy [22,35], such as including 4 modules (‘contact moments’), and at least six behavior change strategies. Thus, the intervention had, in theory, good prospects to be effective.

Furthermore, based on the limited evidence with respect to effectiveness of interventions aimed at the prevention of weight gain [17], the results of our study fit in the pattern of mixed effects that have been found. One study found positive effects of an online weight management intervention [36], but this intervention aimed at a restriction of calorie intake to 1200-1500 calories/day, while our study aimed at a reduction of 100 kcal/day. It may be argued that a change of 100 kcal/day is too small to prevent weight gain or induce modest weight loss, but there is compelling evidence that this approach can in fact result in weight maintenance and modest weight loss, including for people who are overweight [37-39]. Our results are, furthermore, comparable to a number of other studies where the intervention group showed small or no effects on weight, compared to their control group [13,40,41].

The results of our study compare unfavorably to the results from 2 previous intervention studies conducted in the Netherlands [14,15]. These studies found effects on waist circumference and skin fold thickness [15] or waist circumference and weight [14], but had employees of companies as their target population and were more extensive in that it included email counseling [14] and changes in the environment [15]. Despite the planned theory and evidence-based development, the number of contacts, and the dynamic tailoring, our tailored intervention did not appear to be more effective than general information. Possible explanations may be the integration of self-regulation theory in an online intervention, methodological issues, and limited exposure to the intervention.

Theoretical Basis

We used self-regulation theory as the main theoretical basis for the intervention. This theory is particularly suitable for management of chronic diseases, and behaviors and outcomes that need life long regulation, which is also the case for weight management. Self-regulation theory has been applied successfully in interventions aimed at weight-loss among young adults, asthma management, and diabetes [42-44]. Many successful interventions that were based on self-regulation have been intensive counselor-led interventions, in which participants are guided through all the important steps of self-regulation (monitoring, goal setting, action planning, evaluation, and adaptation). However, in the present study we had to apply the self-regulation principles and strategies in a computerized program that had to guide the participants through all the steps of self-regulation. Although feasible, incorporating principles from self-regulation theory and self-regulation strategies in an online self-management intervention may not translate into the same results as when implemented in a face-to-face counseling session. That is, there are fewer possibilities for instructions for use, a smaller variety of options, and use of the intervention components may be less optimal, both in quality and frequency of use. There is indeed evidence that, for example, implementation intentions have been of better quality when developed in the presence of a researcher who reviewed the plans, compared to plans that were developed without a counselor present [45]. Goals and plans that lack quality have previously been reported from unguided interventions [46,47].

Exposure to the Intervention

Even though multiple visits are associated with higher efficacy of (computer-tailored) interventions [48], it has also been well documented that attrition is high in online interventions with multiple sessions [49-51]. To improve the likelihood that participants would revisit the intervention, we incorporated some of the elements that had been indicated as potentially associated with more revisits in previous research [52] in the intervention. In follow-up visits participants could monitor progress, could access new elements of the intervention, could review recipes and tips on the website that were refreshed every 2 weeks and participants received email reminders to visit the website every 2 weeks. Nevertheless, logon rates decreased over time. As a consequence, large numbers of participants in the intervention group were not exposed to parts of the intervention in which important self-regulation strategies, such as monitoring, feedback, and coping planning were incorporated. Therefore, the ‘dynamic’ tailoring (eg, feedback on progress), which is one element of computer tailoring that can increase effect size [22,53], was not delivered to large numbers of participants. Similar (low) use of self-regulation components has been observed before among a study sample of overweight adults [54].

Possible reasons for dropout were the number and length of the tailored modules, and perhaps the ineffectiveness of the reminders. In order to increase use and effectiveness, we should improve these aspects, for example, by using other media such as short message service (SMS) as reminders [55]. Direct contact, in order to motivate people and to teach the steps of self-regulation and problem solving skills [48], may be useful to increase involvement. Furthermore, although the tailored intervention was appreciated a little bit more than the general information intervention, the overall appreciation was just sufficient. Improving the intervention on these aspects may have a positive influence on use and effect.

Methodological Considerations

Kremers et al [17] found in their review that interventions aimed at weight management have small effect sizes (mean effect size of 0.06). This means that studies need to be powered to detect such small effect sizes. Our study was sufficiently powered to detect a difference of 0.4 BMI points, based on the assumption that weight would remain stable or be slightly reduced in the intervention group, and that weight would show the usual annual increase of 0.6 kg among the control group. However, weight did not increase in the control group in the actual study, but

XSL•FO
RenderX

remained stable. Even though initially our sample size was sufficient for detecting the anticipated effect, retention of participants in the study was much lower than we had anticipated, thus reducing the actual power of the study. However, the size of the effect appears to be very small, indicating that lack of power was not the most important reason for not detecting an effect. Rather, the effect in the control group, whether it was caused by participation in the study, completion of the questionnaire, or the exposure to generic information, was larger than expected. The high dropout from the study is not unusual [56], but is a serious concern, and at this moment we do not know the reasons for this high dropout.

It is possible that we could have detected an effect had we compared the intervention with a no-intervention control group. There is evidence that the effect size of a computer-tailored intervention depends on the comparison condition: comparing a tailored intervention to a generic message (r = 0.058) results in smaller effect sizes than comparing it to a no-treatment group (r = 0.11) [35]. However, comparing the intervention to a no information control group can only provide insight into the effects of the intervention per se and cannot provide insight in the effectiveness of a specific technique, such as tailoring or self-regulation. In the present study we were interested in examining the effects in comparison to a control group that received 'usual care' in the form of generic information about weight management that can also be found on the website of the Dutch Nutrition Bureau. The technique of computer-tailoring and the incorporation of self-regulation strategies as incorporated and implemented in the present study appeared no more effective than the already available information on Dutch websites.

Another methodological issue that is worth discussing is the effect of offering respondents the option to choose their own behavioral change. Our second hypothesis concerned differences in dietary and physical activity behaviors. Changes in dietary and PA behaviors may precede or mediate changes in anthropometric outcome measures and are therefore relevant to study. Even though there was a time effect for some of these behaviors, there were no differences between the intervention and control group.

Lack of effects on the behavioral outcome measures was somewhat expected since participants could choose from 10 changes in DI and PA (eg, increase active transport with 20 minutes per day), and even more options within these subgroups (eg, cycling or walking), based on their current dietary and PA behavior. This results in small groups of people who chose for the same change to make, which makes it difficult to detect differences between the study groups in the dietary and PA sub-behaviors. Limited power for detection of differences in relevant underlying behaviors is one of the consequences of dynamic and personally adapted interventions.

Strengths and Limitations

Strengths of the study are its randomized controlled design and the use of objective measures of BMI, waist circumference and skin fold thickness. Limitations are the self-reported measures for physical activity and dietary intake, which may have resulted in less reliable outcomes. The baseline level of PA was high among all participants in the study, which may be due to over-reporting. If the participants also over-reported their PA level in the tailored intervention, this may have resulted in less room for improvement, limiting the potential intervention effect. Another limitation is that participants in the intervention and control condition were not exposed to an equal number of program sessions. However, we do not expect that this had a large effect on the study outcomes, since the tailored intervention (with more elaborate content) was not more effective than the generic information. Furthermore, we had a 6-month assessment as the longest follow-up. We cannot rule out that differences between the study groups would become more apparent after a longer follow-up period. Although dropout was high, it was similar in both conditions and mainly related to age, as in other studies [49-51]. However, due to the high dropout the results cannot be generalized to other populations than those who remained participating in the study.

Conclusion

The carefully developed online, computer-tailored weight management intervention for adults who are overweight resulted in stable weight, and changes in dietary intake in the desired direction, but the tailored intervention was not more effective than generic information. A possible reason for the absence of intervention effects is sub-optimal use of the intervention, and the self-regulation components. Further research is therefore needed to gain more insight into how the intervention and exposure to its contents can be improved.

Acknowledgments

This work was support by a grant from 'The Netherlands Organisation for Health Research and Development' (ZonMW) [6130.0025].

Authors' Contributions

AO had the original idea of for the study. LVG developed the intervention and conducted the evaluation study. AO and PVE supervised the intervention development and evaluation study. BB and TV provided feedback during intervention development, evaluation and writing the manuscript. GB supported the statistic analyses. LVG wrote the manuscript, supervised by AO and PVE. All authors have provided feedback on the manuscript.

XSL•FO
RenderX

Multimedia Appendix 1

CONSORT-EHEALTH checklist V1.6 [57].

[PDF File (Adobe PDF File), 1MB - jmir_v14i2e44_app1.pdf]

References

1. Formiguera X, Cantón A. Obesity: epidemiology and clinical aspects. Best Pract Res Clin Gastroenterol 2004 Dec;18(6):1125-1146. [doi: 10.1016/j.bpg.2004.06.030] [Medline: 15561643]
2. Stunkard AJ, Faith MS, Allison KC. Depression and obesity. Biol Psychiatry 2003 Aug 1;54(3):330-337. [Medline: 12893108]
3. Roberts RE, Deleger S, Strawbridge WJ, Kaplan GA. Prospective association between obesity and depression: evidence from the Alameda County Study. Int J Obes Relat Metab Disord 2003 Apr;27(4):514-521. [doi: 10.1038/sj.ijo.0802204] [Medline: 12664085]
4. Han TS, Tijhuis MA, Lean ME, Seidell JC. Quality of life in relation to overweight and body fat distribution. Am J Public Health 1998 Dec;88(12):1814-1820. [Medline: 9842379]
5. Burns CM, Tijhuis MA, Seidell JC. The relationship between quality of life and perceived body weight and dieting history in Dutch men and women. Int J Obes Relat Metab Disord 2001 Sep;25(9):1386-1392 [FREE Full text] [doi: 10.1038/sj.ijo.0801714] [Medline: 11571604]
6. Polder JJ, Takkern J, Meerding WJ, Kommer GJ, Stokx LJ. Kosten van Ziekten in Nederland - De zorgeuro ontrafeld Cost of illness in the Netherlands. Bilthoven: RIVM; 2002. URL: http://www.rivm.nl/bibliotheek/rapporten/270751005.pdf [accessed 2011-05-09] [WebCite Cache ID 5yY2cZlhB]
7. Jeffery RW, Drewnowski A, Epstein LH, Stunkard AJ, Wilson GT, Wing RR, et al. Long-term maintenance of weight loss: current status. Health Psychology 2000 Jan;19(1 Suppl):5-16. [Medline: 10709944]
8. WHO. The challenge of obesity in the WHO European Region and the strategies for response. Copenhagen: WHO; 2007. URL: http://www.euro.who.int/__data/assets/pdf_file/0010/74746/E90711.pdf [accessed 2011-05-09] [WebCite Cache ID 5yY2uvRfg]
9. Visscher TL, Kromhout D, Seidell JC. Long-term and recent time trends in the prevalence of obesity among Dutch men and women. Int J Obes Relat Metab Disord 2002 Sep;26(9):1218-1224 [FREE Full text] [doi: 10.1038/sj.ijo.0802016] [Medline: 12187399]
10. Hill JO, Wyatt HR, Reed GW, Peters JC. Obesity and the environment: where do we go from here? Science 2003 Feb 7;299(5608):853-855. [doi: 10.1126/science.1079857] [Medline: 12574618]
11. Lombard CB, Deeks AA, Teede HJ. A systematic review of interventions aimed at the prevention of weight gain in adults. Public Health Nutr 2009 Nov;12(11):2236-2246. [doi: 10.1017/S1368980009990577] [Medline: 19650959]
12. van Genugten L, van Empelen P, Flink I, Oenema A. Systematic development of a self-regulation weight-management intervention for overweight adults. BMC Public Health 2010;10:649 [FREE Full text] [doi: 10.1186/1471-2458-10-649] [Medline: 20979603]
13. Jeffery RW, French SA. Preventing weight gain in adults: the pound of prevention study. Am J Public Health 1999 May;89(5):747-751. [Medline: 10224988]
14. van Wier MF, Ariëns GA, Dekkers JC, Hendriksen IJ, Smid T, van Mechelen W. Phone and e-mail counselling are effective for weight management in an overweight working population: a randomized controlled trial. BMC Public Health 2009;9:6 [FREE Full text] [doi: 10.1186/1471-2458-9-6] [Medline: 19134171]
15. Kwak L, Kremers SP, Candel MJ, Visscher TL, Brug J, van Baak MA. Changes in skinfold thickness and waist circumference after 12 and 24 months resulting from the NHF-NRG In Balance-project. Int J Behav Nutr Phys Act 2010;7:26 [FREE Full text] [doi: 10.1186/1479-5868-7-26] [Medline: 20370934]
16. Lemmens VE, Oenema A, Klepp KI, Henriksen HB, Brug J. A systematic review of the evidence regarding efficacy of obesity prevention interventions among adults. Obes Rev 2008 Sep;9(5):446-455. [doi: 10.1111/j.1467-789X.2008.00468.x] [Medline: 18298429]
17. Kremers S, Reubsaet A, Martens M, Gerards S, Jonkers R, Candel M, et al. Systematic prevention of overweight and obesity in adults: a qualitative and quantitative literature analysis. Obes Rev 2010 May;11(5):371-379. [doi: 10.1111/j.1467-789X.2009.00598.x] [Medline: 19538441]
18. Austin JT, Vancouver JB. Goal Constructs in Psychology: Structure, Process, and Content. Psychological Bulletin 1996;120(3):338-375. [doi: 10.1037/0033-2909.120.3.338]
19. Maes S, Karoly P. Self-regulation assessment and intervention in physical health and illness: a review. Applied Psychology 2005;54:267-299. [doi: 10.1111/j.1464-0597.2005.00210.x]
20. Anderson-Bill ES, Winett RA, Wojcik JR. Social cognitive determinants of nutrition and physical activity among web-health users enrolling in an online intervention: the influence of social support, self-efficacy, outcome expectations, and self-regulation. J Med Internet Res 2011;13(1):e28 [FREE Full text] [doi: 10.2196/jmir.1551] [Medline: 21441100]
21. Bakel AM, Zantinge EM. Nationaal Kompas Volksgezondheid; Accessed 4 August. 2010. Hoeveel mensen hebben overgewicht of ondergewicht? (How many people are underweight or overweight?) URL: http://www.nationaalkompas.nl/

XSL•FO
RenderX

gezondheidsdeterminanten/persoonsgebonden/lichaamsgewicht/hoeveel-mensen-hebben-overgewicht-of-ondergewicht/ [accessed 2011-05-09] [WebCite Cache ID 5yY32BpOt]
22. Krebs P, Prochaska JO, Rossi JS. A meta-analysis of computer-tailored interventions for health behavior change. Prev Med 2010;51(3-4):214-221. [doi: 10.1016/j.ypmed.2010.06.004] [Medline: 20558196]
23. Kroeze W, Werkman A, Brug J. A systematic review of randomized trials on the effectiveness of computer-tailored education on physical activity and dietary behaviors. Ann Behav Med 2006 Jun;31(3):205-223. [doi: 10.1207/s15324796abm3103_2] [Medline: 16700634]
24. Neville LM, O'Hara B, Milat A. Computer-tailored physical activity behavior change interventions targeting adults: a systematic review. Int J Behav Nutr Phys Act 2009;6:30 [FREE Full text] [doi: 10.1186/1479-5868-6-30] [Medline: 19490649]
25. Neville LM, O'Hara B, Milat AJ. Computer-tailored dietary behaviour change interventions: a systematic review. Health Educ Res 2009 Aug;24(4):699-720 [FREE Full text] [doi: 10.1093/her/cyp006] [Medline: 19286893]
26. Parcel GS, Kok G, Gottlieb NH. Planning health promotion programs: an intervention mapping approach. San Francisco: Jossey-Bass; 2006.
27. Durnin JV, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. Br J Nutr 1974 Jul;32(1):77-97. [Medline: 4843734]
28. van Assema P, Brug J, Ronda G, Steenhuis I. The relative validity of a short Dutch questionnaire as a means to categorize adults and adolescents to total and saturated fat intake. J Hum Nutr Diet 2001 Oct;14(5):377-390. [Medline: 11906579]
29. Wendel-Vos GC, Schuit AJ, Saris WH, Kromhout D. Reproducibility and relative validity of the short questionnaire to assess health-enhancing physical activity. J Clin Epidemiol 2003 Dec;56(12):1163-1169. [Medline: 14680666]
30. Swinburn BA, Caterson I, Seidell JC, James WP. Diet, nutrition and the prevention of excess weight gain and obesity. Public Health Nutr 2004 Feb;7(1A):123-146. [Medline: 14972057]
31. Ajzen I. The theory of planned behavior. Organizational Behavior and Human Decision Processes 1991;50:179-211. [doi: 10.1016/0749-5978(91)90020-T]
32. Weinstein ND, Sandman PM. A model of the precaution adoption process: evidence from home radon testing. Health Psychol 1992;11(3):170-180. [Medline: 1618171]
33. Gollwitzer PM, Bargh JA. The volitional benefits of planning. In: The Psychology of Action: Linking Cognition and Motivation to Behavior. New York: The Guilford Press; 1996:287.
34. Enwald HP, Huotari ML. Preventing the obesity epidemic by second generation tailored health communication: an interdisciplinary review. J Med Internet Res 2010;12(2):e24 [FREE Full text] [doi: 10.2196/jmir.1409] [Medline: 20584698]
35. Noar SM, Benac CN, Harris MS. Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. Psychol Bull 2007 Jul;133(4):673-693. [doi: 10.1037/0033-2909.133.4.673] [Medline: 17592961]
36. Hunter CM, Peterson AL, Alvarez LM, Poston WC, Brundige AR, Haddock CK, et al. Weight management using the internet a randomized controlled trial. Am J Prev Med 2008 Feb;34(2):119-126. [doi: 10.1016/j.amepre.2007.09.026] [Medline: 18201641]
37. Hall KD, Sacks G, Chandramohan D, Chow CC, Wang YC, Gortmaker SL, et al. Quantification of the effect of energy imbalance on bodyweight. Lancet 2011 Aug 27;378(9793):826-837. [doi: 10.1016/S0140-6736(11)60812-X] [Medline: 21872751]
38. Hill JO. Can a small-changes approach help address the obesity epidemic? A report of the Joint Task Force of the American Society for Nutrition, Institute of Food Technologists, and International Food Information Council. Am J Clin Nutr 2009 Feb;89(2):477-484 [FREE Full text] [doi: 10.3945/ajcn.2008.26566] [Medline: 19088151]
39. Rodearmel SJ, Wyatt HR, Stroebele N, Smith SM, Ogden LG, Hill JO. Small changes in dietary sugar and physical activity as an approach to preventing excessive weight gain: the America on the Move family study. Pediatrics 2007 Oct;120(4):e869-e879 [FREE Full text] [doi: 10.1542/peds.2006-2927] [Medline: 17908743]
40. Booth AO, Nowson CA, Matters H. Evaluation of an interactive, Internet-based weight loss program: a pilot study. Health Educ Res 2008 Jun;23(3):371-381 [FREE Full text] [doi: 10.1093/her/cyn007] [Medline: 18349032]
41. Levine MD, Klem ML, Kalarchian MA, Wing RR, Weissfeld L, Qin L, et al. Weight gain prevention among women. Obesity (Silver Spring) 2007 May;15(5):1267-1277 [FREE Full text] [doi: 10.1038/oby.2007.148] [Medline: 17495203]
42. Gokee-LaRose J, Gorin A, Wing R. Behavioral self-regulation for weight loss in young adults: a randomized controlled trial. International Journal of Behavioral Nutrition and Physical Activity 2009;6(1):10. [doi: 10.1186/1479-5868-6-10]
43. Shegog R, Bartholomew LK, Parcel GS, Sockrider MM, Mâsse L, Abramson SL. Impact of a computer-assisted education program on factors related to asthma self-management behavior. J Am Med Inform Assoc 2001;8(1):49-61 [FREE Full text] [Medline: 11141512]
44. Thoolen BJ, de Ridder D, Bensing J, Gorter K, Rutten G. Beyond good intentions: The role of proactive coping in achieving sustained behavioural change in the context of diabetes management. Psychol Health 2009 Mar;24(3):237-254. [doi: 10.1080/08870440701864504] [Medline: 20204991]
45. Luszczynska A. An implementation intentions intervention, the use of a planning strategy, and physical activity after myocardial infarction. Soc Sci Med 2006 Feb;62(4):900-908. [doi: 10.1016/j.socscimed.2005.06.043] [Medline: 16095786]

XSL•FO
RenderX

46. de Vet E, Gebhardt WA, Sinnige J, Van Puffelen A, Van Lettow B, de Wit JBF. Implementation intentions for buying, carrying, discussing and using condoms: the role of the quality of plans. Health Education Research. 2011 Mar 16.
47. de Vet E, Oenema A, Brug J. More or better: Do the number and specificity of implementation intentions matter in increasing physical activity? Psychology of Sport and Exercise 2011;12(4):471-477. [doi: 10.1016/j.psychsport.2011.02.008]
48. Norman GJ, Zabinski MF, Adams MA, Rosenberg DE, Yaroch AL, Atienza AA. A review of eHealth interventions for physical activity and dietary behavior change. Am J Prev Med 2007 Oct;33(4):336-345. [doi: 10.1016/j.amepre.2007.05.007] [Medline: 17888860]
49. Brouwer W, Oenema A, Raat H, Crutzen R, de Nooijer J, de Vries NK, et al. Characteristics of visitors and revisitors to an Internet-delivered computer-tailored lifestyle intervention implemented for use by the general public. Health Educ Res 2010 Aug;25(4):585-595 [FREE Full text] [doi: 10.1093/her/cyp063] [Medline: 19897515]
50. Robroek SJ, Brouwer W, Lindeboom D, Oenema A, Burdorf A. Demographic, behavioral, and psychosocial correlates of using the website component of a worksite physical activity and healthy nutrition promotion program: a longitudinal study. J Med Internet Res 2010;12(3):e44 [FREE Full text] [doi: 10.2196/jmir.1402] [Medline: 20921001]
51. Verheijden MW, Jans MP, Hildebrandt VH, Hopman-Rock M. Rates and determinants of repeated participation in a web-based behavior change program for healthy body weight and healthy lifestyle. J Med Internet Res 2007;9(1):e1 [FREE Full text] [doi: 10.2196/jmir.9.1.e1] [Medline: 17478410]
52. Brouwer W, Oenema A, Crutzen R, de Nooijer J, de Vries NK, Brug J. An exploration of factors related to dissemination of and exposure to internet-delivered behavior change interventions aimed at adults: a Delphi study approach. J Med Internet Res 2008;10(2):e10 [FREE Full text] [doi: 10.2196/jmir.956] [Medline: 18417443]
53. Michie S, Abraham C, Whittington C, McAteer J, Gupta S. Effective techniques in healthy eating and physical activity interventions: a meta-regression. Health Psychol 2009 Nov;28(6):690-701. [doi: 10.1037/a0016136] [Medline: 19916637]
54. Binks M, van Mierlo T. Utilization patterns and user characteristics of an ad libitum Internet weight loss program. J Med Internet Res 2010;12(1):e9 [FREE Full text] [doi: 10.2196/jmir.1347] [Medline: 20350926]
55. Webb TL, Joseph J, Yardley L, Michie S. Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. J Med Internet Res 2010;12(1):e4 [FREE Full text] [doi: 10.2196/jmir.1376] [Medline: 20164043]
56. Groeneveld IF, Proper KI, van der Beek AJ, Hildebrandt VH, van Mechelen W. Factors associated with non-participation and drop-out in a lifestyle intervention for workers with an elevated risk of cardiovascular disease. Int J Behav Nutr Phys Act 2009;6:80 [FREE Full text] [doi: 10.1186/1479-5868-6-80] [Medline: 19951417]
57. Eysenbach G, CONSORT-EHEALTH Group. CONSORT-EHEALTH: improving and standardizing evaluation reports of Web-based and mobile health interventions. J Med Internet Res 2011;13(4):e126 [FREE Full text] [doi: 10.2196/jmir.1923] [Medline: 22209829]

Abbreviations

BMI: Body Mass Index
DI: Dietary intake
GI: Generic information intervention
PA: Physical activity
SFT: Skin fold thickness
SMS: Short message service
TI: Tailored intervention
WC: Waist circumference

Edited by G Eysenbach; submitted 03.08.11; peer-reviewed by C Vandelanotte; comments to author 19.10.11; revised version received 28.11.11; accepted 16.01.12; published 14.03.12.

Please cite as:
van Genugten L, van Empelen P, Boon B, Borsboom G, Visscher T, Oenema A
Results from an Online Computer-Tailored Weight Management Intervention for Overweight Adults: Randomized Controlled Trial
J Med Internet Res 2012;14(2):e44
URL: http://www.jmir.org/2012/2/e44/
doi:10.2196/jmir.1901
PMID:22417813

©Lenneke van Genugten, Pepijn van Empelen, Brigitte Boon, Gerard Borsboom, Tommy Visscher, Anke Oenema. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 14.03.2012. This is an open-access article distributed

XSL•FO
RenderX

under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Web-Based, Computer-Tailored, Pedometer-Based Physical Activity Advice: Development, Dissemination Through General Practice, Acceptability, and Preliminary Efficacy in a Randomized Controlled Trial

Katrien De Cocker[1], PhD; Heleen Spittaels[1], PhD; Greet Cardon[1], PhD; Ilse De Bourdeaudhuij[1], PhD; Corneel Vandelanotte[2], PhD

[1]Department of Movement and Sports Sciences, Ghent University, Ghent, Belgium

[2]Centre for Physical Activity Studies, Institute for Health and Social Science Research, Central Queensland University, Rockhampton, Australia

Corresponding Author:
Katrien De Cocker, PhD
Department of Movement and Sports Sciences
Ghent University
Watersportlaan 2
Ghent, B-9000
Belgium
Phone: 32 92646323
Fax: 32 92646484
Email: Katrien.DeCocker@ugent.be

Abstract

Background: Computer tailoring is a relatively innovative and promising physical activity intervention approach. However, few computer-tailored physical activity interventions in adults have provided feedback based on pedometer use.

Objectives: To (1) describe the development of a Web-based, pedometer-based, computer-tailored step advice intervention, (2) report on the dissemination of this tool through general practice, (3) report on its perceived acceptability, and (4) evaluate the preliminary efficacy of this tool in comparison with a standard intervention.

Methods: We recruited 92 participants through general practitioners and randomly assigned them to a standard condition (receiving a pedometer-only intervention, n = 47) and a tailored condition (receiving a pedometer plus newly developed, automated, computer-tailored step advice intervention, n = 45). Step counts, self-reported data obtained via telephone interview on physical activity, time spent sitting, and body mass index were assessed at baseline and postintervention. The present sample was mostly female (54/92, 59%), highly educated (59/92, 64%), employed (65/92, 71%), and in good health (62/92, 67%).

Results: Recruitment through general practitioners was poor (n = 107, initial response rate 107/1737, 6.2%); however, the majority of participants (50/69, 73%) believed it is useful that general practitioners help patients find ways to increase physical activity. In the tailored condition, 30/43 (70%) participants requested the computer-tailored step advice and the majority found it understandable (21/21, 100%), credible (17/18, 94%), relevant (15/18, 83%), not too long (13/18, 72%), instructive (13/18, 72%), and encouraging to increase steps (16/24, 67%). Daily step counts increased from baseline (mean 9237, SD 3749 steps/day) to postintervention (mean 11,876, SD 4574 steps/day) in the total sample (change of 2639, 95% confidence interval 105–5172; $F_1 = 5.0$, $P = .04$). No interaction or other time effects were found.

Conclusions : The majority of participants in the tailored condition accepted the step advice and indicated it was useful. However, in this selected sample of adults, the tailored condition did not show superior effects compared with the standard condition.

(J Med Internet Res 2012;14(2):e53) doi:10.2196/jmir.1959

KEYWORDS

Physical activity intervention; step counts; computer tailoring

XSL•FO
RenderX

Introduction

There is ample evidence of the positive effects of regular physical activity on physical and mental health [1]. International guidelines recommend at least 150 minutes/week of moderate to vigorous physical activity to prevent chronic diseases, such as cardiovascular diseases, type 2 diabetes mellitus, obesity, hypertension, and some cancers [2,3]. As most adults are not meeting this recommendation [4-6], several interventions to promote physical activity have been developed and implemented [7,8].

A relatively innovative and promising intervention approach in public health promotion is the use of computer tailoring via the Internet [9,10]. This technique mimics and automates the process of individual counseling, by giving participants immediate personally adapted feedback about their assessed behavior. After the completion of an online diagnostic questionnaire, the computer automatically translates this information, through a series of "if–then" statements, into individualized feedback [11]. This tailoring of messages is found to be a more effective technique to guide behavior change than is providing generic or standard advice [10]. However, several authors advocate more research on computer-tailored health programs [9,10].

The major advantage of computer tailoring through the Internet is the ability to reach many people in a variety of settings at any time and location, and at a relatively low cost. Research revealed that promoting physical activity via the Internet is feasible and appealing to adults [12,13]. Furthermore, the Internet now has more than one billion users worldwide [14] and, as such, has become a mainstream intervention-delivery channel. In Europe, 60% of the population uses the Internet daily [15].

Existing computer-tailored physical activity programs might, however, also have weaknesses. As the diagnostic assessment is mostly done by questionnaires [9], the self-reported data may have recall biases [16]. Consequently, using more objective outcome measures [11] might be a more appropriate way of assessing baseline physical activity levels in the process of providing computer-tailored feedback. The most commonly used, more objective way of assessing physical activity is measuring step counts through the use of step counters or pedometers [17]. Pedometers have become popular monitoring tools for physical activity in large free-living populations [17]. However, to our knowledge, few computer-tailored interventions in adults have provided feedback based on pedometer use [18,19]. Nevertheless, some potential benefits are associated with integrating pedometers in computer-tailored physical activity feedback. First, the accuracy of assessing the targeted behavior will increase, as it would be based on more objectively measured step counts. Second, the computer-tailored advice could specifically target step count increases through pedometer use and, as such, the pedometer would be used not only as an assessment instrument but also as an intervention tool. Due to the self-monitoring aspect of and the ongoing feedback provided by the pedometer, resulting in increased awareness and motivation, the device can be used as a behavior modification tool. In addition, goal setting, a behavioral change strategy used in many computer-tailored programs [9,10,20,21], can easily be facilitated through pedometer use [22]. Pedometer-based behavioral modification programs have already shown positive effects [23,24]; however, providing continuous face-to-face feedback is time consuming and expensive. Offering an additional online, computer-tailored tool in pedometer-based interventions might thus be beneficial.

Another weakness of online physical activity programs is reaching the targeted population. Recruiting individuals to visit website programs on health behavior change appears to be rather difficult. For example, Australian research conducted in a worksite sample showed that only 46% of participants who agreed to take part in a website-delivered physical activity intervention actually visited the website [25]. A computer-tailored program wherein computers and printers were installed in waiting rooms of general practices in Rhode Island also showed low rates (0%–12%) of use [26]. However, a Belgian study found that brief face-to-face contact when handing out flyers increased recruitment rates (46%) when compared with recruiting via flyers only (6%) [20]. As such, a possible promising dissemination channel of online physical activity interventions is the visit to primary health care [26], as general practitioners (GPs) have personal face-to-face contact with their patients but often lack the time or the skills to provide counseling on health behaviors themselves [27,28]. In addition, GPs are perceived as a highly credible source of influence concerning health aspects [29]. The objectives of the present paper were to (1) describe the development of an online pedometer-based, computer-tailored physical activity step advice intervention, (2) report on the dissemination of this tool through general practice, (3) report on its perceived acceptability among participants recruited through GPs, and (4) evaluate the preliminary efficacy of the new intervention in comparison with a standard pedometer-only intervention.

Methods

Development of the Pedometer-Based, Computer-Tailored Physical Activity Advice

The development of computer-tailored interventions requires (1) a data source, including the significant characteristics of the recipient derived from an individual diagnosis or assessment, (2) a message library that contains the intervention messages, (3) a set of decision rules that selects messages matched and tailored to the specific needs of the recipient, and (4) a channel that delivers the messages to the specific person, such as the Internet [30]. Based on previous computer-tailored interventions to increase physical activity in a Flemish population [31-34], a computer-tailored step advice intervention was developed. In this Web-based intervention, participants received personalized feedback on the amount of steps they take daily, and were provided with tips and suggestions on how they can take more steps if needed. The general approach, structure, and theoretical background of the new computer-tailored step advice intervention remained the same as in the previous developed computer-tailored interventions; however, the focus was changed from increasing physical activity to increasing steps. As such, the 10,000 steps concept [35,36] was integrated into the present

XSL•FO
RenderX

intervention. Multimedia Appendix 1 presents some examples of screenshots of the automated Web-based advice intervention.

Prior to visiting the computer-tailored website, participants' baseline step level had to be determined. Participants were instructed to wear a pedometer for 7 consecutive days without changing their usual lifestyle. To receive the computer-tailored step advice, participants had to log on to a website using a confidential username and password, and then complete a questionnaire (see Multimedia Appendix 1, Figure A and B). This questionnaire assessed participant's demographics, baseline step level, and the psychosocial correlates of achieving 10,000 steps/day. As soon as participants had completed all the questions, tailored feedback was provided on the computer screen.

The tailored feedback was created from a database of messages that match any possible combination of answers and is based on the theory of planned behavior [37] and the transtheoretical model [38]. The theory of planned behavior was considered by giving feedback about participants' intentions, attitudes, self-efficacy, social support, knowledge, benefits, and barriers related to physical activity. We considered the stages of change in two ways. First, the content differed between stages. Precontemplators mainly received general information about the 10,000 steps concept and about its health benefits. To avoid resistance, the need for behavior change was not dictated, but only vaguely suggested. Contemplators received the same information, although not so extensively, and it was mentioned that they might benefit from taking more steps. In the preparation stage, the emphasis was on increasing steps, combined with specific step and health information. In the action stage, the emphasis was on keeping up the steps and preventing relapse. In the maintenance stage, feedback was reduced to saying that they were doing well and that they should carry on. Second, the way in which the participants were approached also differed between stages. Information for precontemplators was presented in an impersonal way (eg, people could...), again avoiding resistance. Contemplators were approached in a personal way (eg, you could...), but not in the decisive way that was used for preparators (eg, you should...) or the supportive way used for people in the action or maintenance phase (eg, you do...).

The feedback was organized so that participants first received a general introduction (see Multimedia Appendix 1, Figure C), followed by normative feedback, which relates participants' step level to the goal of 10,000 steps/day. Based on baseline step levels, a schedule was provided on how they could reach the goal of 10,000 steps/day over time (participants could choose to increase their current steps by 500 or 1000 per week [39]; see Multimedia Appendix 1, Figure D). Progress feedback (positive or negative evolution) was provided when participants requested advice for a second time or more; it compared the previous step level with the current level. Next, participants received tips on how to increase steps (if needed) during work, household chores, gardening, leisure time, and transport (see Multimedia Appendix 1, Figure E). This further included information on what a walking buddy is, how step guidelines compare with overall physical activity guidelines, how to correctly use a pedometer, what benefits originate from 10,000 steps/day, how to deal with barriers associated with stepping more, how to overcome low self-efficacy to take more steps, and how the local environment can provide opportunities to walk. Altogether the feedback, which can be printed, could amount to as much as 5 or 6 pages of advice. Table 1 provides some examples of the introduction to the tips and suggestions part of the advice intervention for the various stages of change.

Table 1. Examples of introductions to the tips and suggestions of the advice intervention for the various stages of change.

Stage of change	Example of introduction to the tips and suggestions section of the pedometer-based, computer-tailored advice
Precontemplation	It seems that you are not reaching the goal of 10,000 steps a day. That's a pity because being active has several health advantages, in both the short and the long term. People can experience these benefits when they are being physically active on a regular basis. The following tips could help people who want to be more active...
Contemplation	It seems that you are not reaching the goal of 10,000 steps a day, but are planning to become more active at some point in the future. That's good because being active has several health advantages, in both the short and the long term. You could experience these benefits when you are being physically active on a regular basis. When you decide the time has come to take more steps, the following tips and suggestions will certainly be helpful...
Preparation	You are intending to take more steps than you are taking now, and you want to reach this goal within 1 month. This is a good idea, as you are currently not reaching the goal of 10,000 steps a day which is needed to achieve health benefits. The following tips should help you to realize your good intentions...
Action	Because you are already reaching the 10,000 steps goal, it doesn't seem necessary to overload you with tips to take even more steps. After all, you are doing well! Still, we want to give you some tips, which may be helpful in times when it is hard to keep up your high level of physical activity...
Maintenance	Because your step level is high and you have been able to maintain this for quite a while, it seems unnecessary to give you tips to step more. They would probably not be very helpful. However, we want to emphasize that you are among the few Flemish people who are very active, and that's really good! Carry on being this active!

Pretesting Procedures of the Computer-Tailored Step Advice

Through contacts with GPs' organizations, we found a convenience sample of 38 GPs willing to take part in this pretest study to evaluate the dissemination and test the acceptability of the computer-tailored step advice. We recruited participants through GPs, who were asked to personally hand out invitation letters to the 50 first counseling patients eligible for the study. Exclusion criteria were (1) being physically unable to engage in physical activity, (2) already being highly active or

XSL•FO
RenderX

participating in sport activities, and (3) not being Dutch speaking. The letter briefly explained the purpose of the project, namely promoting physical activity in the general population through pedometer use and providing computer-tailored feedback; invited the patient to take part in the study; and presented the inclusion criteria: (1) being aged 18–65 years, (2) having Internet access at home or at work, and (3) having a personal email address. To participate, they were required to email us their full name, address, telephone number, date of birth, and name of GP.

On receiving this information from the participants, we sent them an envelope containing a pedometer, a step log for 7 days, information on how to use these instruments, and a stamped, self-addressed envelope for return mailing after 3 months. Participants were first asked to wear the pedometer for 7 consecutive days and to complete the step log in order to assess their baseline step level; they were asked not to increase their step or activity levels from what they would usually do in this period. Afterward, they had to email the step log to us. After receiving the step log, we contacted the participants by telephone to complete the baseline assessment.

After this interview, we randomly assigned participants to (1) the pedometer intervention only (standard condition) or (2) the pedometer intervention supplemented with computer-tailored step advice (tailored condition). Participants in both conditions were mailed generic paper booklets with information on how to increase their steps [35,36]. Participants in the tailored condition also received a login and password to enter the website that provided the computer-tailored step advice. Every month, we checked whether participants had requested the computer-tailored step advice. If they did, we emailed them an invitation to access the computer-tailored step advice for a second or third time to receive feedback on their progress. If they did not, a reminder was emailed to reinvite participants to request the computer-tailored step advice for the first time. At 3 months, we asked participants to report a second step count registration of 7 consecutive days and to participate in a second telephone interview.

Participants completed informed consent forms, and the study protocols were approved by the Ethics Committee of the Ghent University, Belgium. The study was conducted between January and August 2010.

Measures

Pedometer

We used the Yamax Digiwalker SW-200 (Yamax, Tokyo, Japan) in this study, as it is known to be a valid, accurate, and reliable instrument for counting steps in adults [40].

Step Log

Participants were requested to record the date, the daily steps taken, and the type and duration of nonambulatory activities (eg, biking and swimming) in an activity log. Following established guidelines [41], we added 150 steps to the daily total for every minute of reported biking or swimming.

Demographics

During a telephone interview at baseline and postintervention, we asked participants their gender, age, height, and weight. The interviewers also obtained information on participants' perceived health (very good, good, moderate, poor, or very poor), education (primary education, vocational secondary education,; technical secondary education, general secondary education, and college or university), employment status (yes or no), computer and Internet use (daily, weekly, monthly, a couple of times a year, or never), and Internet access at home or at work (yes or no). Furthermore, participants were asked who gave them the invitation letter (GP or other; in the case of answering other, participants were asked to specify). Finally, we assessed their intention to participate in physical activity by asking whether participants planned to increase their steps (yes, within 1 month; yes, within 6 months; or no intention).

International Physical Activity Questionnaire

To assess physical activity and time spent sitting, we used the long interview form of the International Physical Activity Questionnaire (IPAQ) at baseline and postintervention. Physical activity in a usual week in four different domains was measured: at work, during transport, at home, and during leisure time. The IPAQ has been shown to be a valid and reliable instrument at the population level in Europe [42] and in Flanders, Belgium [43].

Feasibility Telephone Interview

At postintervention, we assessed the feasibility of disseminating the intervention through GPs. We asked all participants about the usefulness of GPs emphasizing the importance of sufficient physical activity, helping to find ways to increase steps, and providing pedometers to their patients, using 5-point Likert scales (ranging from totally not useful to very useful).

Acceptability Telephone Interview

At postintervention, we asked participants in the tailored condition about the understandability, logic, practical use, and length of the questionnaire prior to receiving the advice. Four questions assessed what participants did with the advice (read it, discussed it with others, saved it, or reread it later). The interviewer also asked what the advice indicated about the step level of participants (insufficient, just enough, or sufficient) and whether participants were aware of this. Further, participants were asked about the relevance, credibility, understandability, and length of the advice; whether the advice helped them to gain insight into their physical activity pattern; and whether the advice was an encouragement to increase steps. If participants requested the advice more than once, they were asked about the usefulness of receiving the advice twice or more.

Data Analyses

We analyzed all data using SPSS 17.0 for Windows (IBM Corporation, Somers, NY, USA). The level of statistical significance was set at .05. Participant characteristics were described using descriptive statistics. Self-reported physical activity was expressed in minutes/day for total time spent walking and total physical activity, and in hours/day for sitting time (based on guidelines at www.ipaq.ki.se). Walking and total

XSL•FO
RenderX

physical activity scores were log transformed to obtain normal distributions. However, for clarity, the numbers in the tables are the means and standard deviations of the nontransformed data. Average daily step counts were calculated, and values over 20,000 steps/day were truncated as 20,000 to limit unrealistically high averages and to ensure normal distributions [44]. All participants provided at least 5 days of pedometer registration.

We compared participant characteristics at baseline between the two conditions using independent-samples *t* tests (quantitative variables) and chi-square tests (qualitative variables). The same tests were used to compare baseline characteristics between participants who dropped out and those who did not. Descriptive statistics (numbers, percentages) were used to report on the feasibility of disseminating the intervention through GPs and to test the acceptability of the computer-tailored step advice. Participants who requested the computer-tailored step advice and those who did not were compared using independent-samples *t* tests (quantitative variables) and chi-square tests (qualitative variables).

The time and intervention effects on body mass index (BMI), self-reported and pedometer-based physical activity, and sitting time were examined using repeated measures analyses of variance with condition as the between-participants factor and time as the within-participants factor. We conducted these analyses using both a retained-sample analysis (only participants who completed postintervention assessments) and an intent-to-treat analysis (assuming baseline values at postintervention for dropout participants). As we found no differences between these two types of analyses, we report only the results of the retained-sample analysis.

Results

Study Sample

Most of the sample were female (54/92, 59%), were highly educated (59/92, 64%), were employed (65/92, 71%), were in good health (62/92, 67%), used the computer (75/91, 82%) and the Internet (69/92, 75%) daily, and did not reach 10,000 steps/day (65/87, 75%) at baseline. Table 2 presents characteristics of the participants in both conditions. No significant differences were found between the two conditions at baseline for the demographic variables, use (and access) of PC and Internet, intention to change physical activity, self-reported and pedometer-based physical activity, and time spent sitting (see Table 2).

XSL•FO
RenderX

Table 2. Participant characteristics at baseline.

Characteristic	Tailored condition (n = 45)	Standard condition (n = 47)	Group comparison	*P* value
Demographic variable				
Age (years), mean (SD)	46.6 (10.9)	47.7 (11.4)	$t_{90} = 0.5$	.63
Male, n (%)	17/45 (38%)	21/47 (45%)	$\chi^2_1 = 0.5$	.50
BMI[a] (kg/m^2), mean (SD)	25.8 (4.3)	26.3 (4.6)	$t_{76} = 0.5$	.64
Higher education, n (%)	30/45 (67%)	29/47 (62%)	$\chi^2_1 = 0.2$	.62
Employed, n (%)	35/45 (78%)	30/47 (64%)	$\chi^2_1 = 2.2$	.14
Good to very good health, n (%)	26/45 (58%)	36/47 (77%)	$\chi^2_1 = 3.7$	.06
Computer/Internet use and Internet access, n (%)				
Daily computer use	36/45 (80%)	39/46 (85%)	$\chi^2_1 = 0.4$	.55
Daily Internet use	30/45 (67%)	39/47 (83%)	$\chi^2_1 = 3.3$	.07
Internet access at home	44/45 (98%)	46/46 (100%)	$\chi^2_1 = 1.0$	.31
Internet access at work	28/35 (80%)	22/30 (73%)	$\chi^2_1 = 3.4$	.19
Intention to change physical activity, n (%)			$\chi^2_2 = 2.3$	.31
Within 1 month	23/43 (54%)	19/42 (45%)		
Within 6 months	11/43 (26%)	8/42 (19%)		
No intention	9/43 (21%)	15/42 (36%)		
Self-reported physical activity (minutes/day), mean (SD)				
Walking	33.2 (60.3)	44.9 (57.4)	$t_{50} = 0.8$	.43
Total physical activity	142.7 (123.8)	163.6 (120.8)	$t_{65} = 1.7$	.10
Pedometer-based physical activity (steps/day), mean (SD)	8609 (3370)	8933 (3367)	$t_{85} = 0.4$	.66
Sitting time (hours/day), mean (SD)	7.0 (3.1)	7.0 (3.4)	$t_{87} = 0.0$	.97

[a] Body mass index.

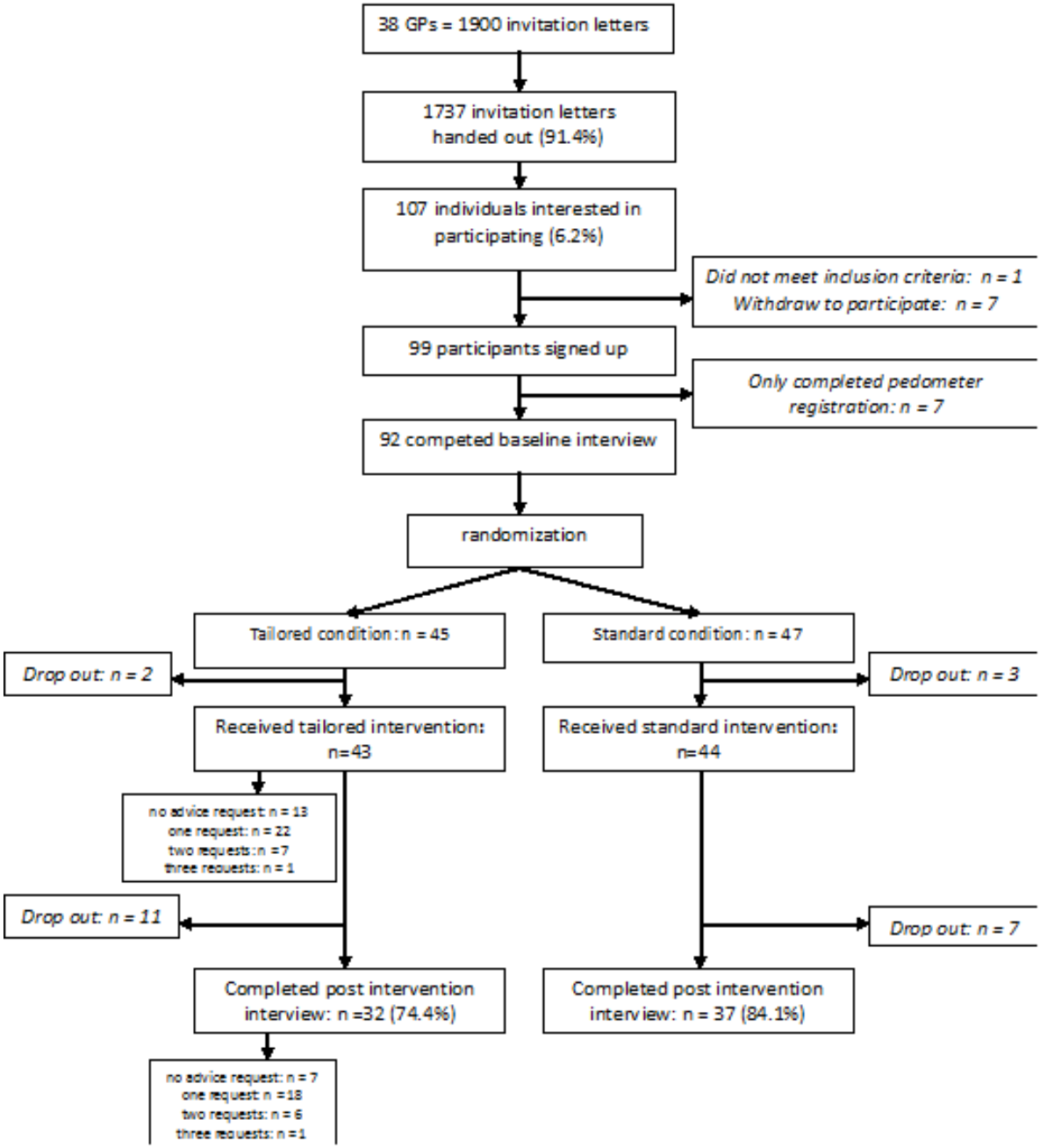
In total, 23 participants dropped out: 7 had health problems, 3 lacked the time, and 1 went abroad. The other 12 dropout participants could not be reached at postintervention, so the reason for dropout is unknown. Dropout analyses revealed no significant differences between those who dropped out (n = 13 in the tailored condition; n = 10 in the standard condition) and those who did not (data not shown).

Feasibility of Dissemination Through GPs

From the 1900 available invitation letters (50 per GP, 38 GPs), 1737 letters were handed out to patients. A total of 107 individuals expressed an interest in participating (response rate 6.2%); however, 1 participant did not meet the inclusion criteria and 7 eventually withdrew for family- or work-related reasons, leaving 99 participants at baseline (see Figure 1). The baseline interview (completed by 92 participants) showed that 89 participants had received the invitation letter from their GP, 1 person found it in the waiting room, 1 received it from his wife, and 1 received it from a parent. At postintervention (interview completed by 69 participants), the majority believed that it is useful to very useful that GPs emphasize the importance of sufficient physical activity (61/69, 88%), that it is useful to very useful for GPs to offer pedometers to their patients (61/69, 88%), and that it is useful to very useful for GPs to help patients find ways to increase physical activity (50/69, 73%).

XSL•FO
RenderX

Figure 1. Flow of participants through the study. GP = general practitioner.



Acceptability of Web-Based, Computer-Tailored Step Advice

Figure 1 shows that 30% (n = 13) of participants in the tailored condition did not request the computer-tailored step advice, while the other 70% (n = 30) did request the advice at least once: 22 requested it once (51%), 7 twice (16%), and 1 three times (2%). Characteristics of these individuals are presented in Table 3. At baseline, those who requested the advice took fewer steps (P = .03) and used their computer less on a daily basis (P = .04) than those who did not request the advice (see Table 3). No other characteristics differed significantly between those who requested the advice and those who did not.

Of the 43 participants who received the tailored intervention, 32 completed the postintervention telephone interview (74%). Of this group, 7 did not request the computer-tailored step advice (22%), 18 requested it once (56%), 6 twice (19%) and 1 person three times (3%). The most frequently mentioned reason for not requesting the advice was lack of time; 1 person had computer problems; and 1 believed that he didn't need the advice. Of those who did request the advice, all found the questions prior to receiving the advice understandable (21/21, 100%), and most had no problems answering them (24/25, 96%), found the questions logically built up (19/20, 95%), and didn't find the questionnaire too long (14/19, 74%).

After receiving the advice, almost everyone read it (20/21, 95%) and the majority saved it (12/20, 60%). Fewer participants discussed it with others (8/19, 42%), printed it (8/21, 38%), or reread it later (7/20, 35%). Of those who could remember the feedback on their step level, almost half (9/19, 47%) got the advice that they were insufficiently active. The majority (13/19, 68%) had expected the feedback they got. Of those requesting

XSL•FO
RenderX

the advice more than once (n = 7), all found it useful to be able to receive the advice several times.

Everyone found the advice understandable (100%), and the majority found the advice credible (17/18, 94%), relevant (15/18, 83%), and not too long (13/18, 72%). The majority also reported that the advice helped them to gain insight into their physical activity pattern (13/18, 72%), and two-thirds found that the advice encouraged them to increase their number of steps (16/24, 67%).

Table 3. Baseline characteristics of the participants in the tailored condition who requested the computer-tailored step advice at least once and those who did not request the computer-tailored step advice.

Characteristic	At least one request (n = 30)	No request (n = 13)	Group comparison	*P* value
Demographic variable				
Age (years), mean (SD)	47.2 (11.2)	43.5 (9.9)	$t_{26} = 1.0$	.31
Male, n (%)	11/30 (37%)	4/13 (31%)	$\chi^2_1 = 0.1$	.76
BMI[a] (kg/m^2), mean (SD)	26.1 (4.7)	24.4 (2.7)	$t_{20} = 1.0$	.32
Higher education, n (%)	19/30 (63%)	9/13 (69%)	$\chi^2_1 = 0.1$	.71
Employed, n (%)	25/30 (83%)	10/13 (77%)	$\chi^2_1 = 0.2$	.62
Good to very good health, n (%)	16/30 (53%)	9/13 (69%)	$\chi^2_1 = 0.9$	.33
Intention to change physical activity, n (%)			$\chi^2_2 = 2.2$	.34
Within 1 month	13/29 (45%)	9/13 (69%)		
Within 6 months	9/29 (31%)	2/13 (15%)		
No intention	7/29 (24%)	2/13 (15%)		
Computer/Internet use and Internet access, n (%)				
Daily computer use	22/30 (73%)	13/13 (100%)	$\chi^2_1 = 4.3$	.04[b]
Daily Internet use	18/30 (60%)	11/13 (85%)	$\chi^2_1 = 2.5$	.11
Internet access at home	30/30 (100%)	12/13 (92%)	$\chi^2_1 = 2.4$	.12
Internet access at work	19/25 (76%)	9/10 (90%)	$\chi^2_1 = 1.0$	.61
Self-reported physical activity (minutes/day), mean (SD)				
Walking	30.1 (43.4)	41.0 (66.2)	$t_{14} = 0.0$	.99
Total physical activity	142.7 (128.0)	153.9 (124.9)	$t_{40} = 1.1$	.28
Pedometer-based physical activity (steps/day), mean (SD)	7690 (2416)	10,730 (4319)	$t_{15} = 2.4$	.03[b]
Sitting time (hours/day), mean (SD)	7.0 (3.2)	7.3 (2.9)	$t_{26} = 0.3$	.77

[a] Body mass index.

[b] $.01 < P < .05$.

Preliminary Efficacy

Table 4 presents the intervention and time effects on self-reported and pedometer-based physical activity, BMI, and sitting time. Daily step counts increased significantly from baseline (mean 9237, SD 3749) to postintervention (mean 11,876, SD 4574) in both conditions (change of 2639, 95% confidence interval 105–5172; $P = .04$); no other significant time or intervention effects were found (see Table 4). In the tailored condition only, no intervention or time effects were found for those who did request the advice and those who did not (data not shown).

XSL•FO
RenderX

Table 4. Effects on body mass index, physical activity, and time spent sitting in both conditions.

Variable/condition	n	Baseline	Postintervention	Change (95% CI[a])	F_1 (time × condition)	*P* value	F_1 (time)	*P* value
Body mass index (kg/m^2), mean (SD)					0.7	.40	3.5	.07
Tailored condition	27	26.3 (4.7)	26.0 (4.5)	–0.3 (–0.6 to 0.0)				
Standard condition	33	26.2 (4.6)	26.0 (4.6)	–0.2 (–0.5 to 0.3)				
Self-reported physical activity (minutes/day), mean (SD)								
Walking					0.1	.82	0.1	.71
Tailored condition	21	17.8 (21.8)	26.4 (34.6)	8.6 (–6.6 to 23.9)				
Standard condition	22	46.2 (59.7)	38.9 (44.8)	–7.3 (–40.8 to 26.1)				
Total physical activity					2.0	.16	0.5	.47
Tailored condition	32	131.0 (121.1)	142.0 (108.9)	11.0 (–25.5 to 47.5)				
Standard condition	36	165.9 (125.7)	138.2 (98.5)	–27.8 (–72.5 to 16.9)				
Pedometer-based physical activity (steps/day), mean (SD)					1.1	.31	5.0	.04[b]
Tailored condition	10	9162 (2542)	10,668 (3826)	1505 (–1850 to 4861)				
Standard condition	10	9549 (4903)	13,690 (4743)	4141 (462 to 8744)				
Sitting time (hours/day)					0.0	.85	2.4	.12
Tailored condition	28	7.1 (3.0)	6.6 (3.1)	–0.5 (–1.5 to 0.4)				
Standard condition	35	7.1 (3.6)	6.4 (3.2)	–0.7 (–1.9 to 0.5)				

[a] Confidence interval.

[b] $P < .05$

Discussion

We developed a new pedometer-based, computer-tailored step advice intervention and examined the feasibility of disseminating this tool through general practice, and its acceptability and preliminary efficacy in adults. Overall, participants accepted the computer-tailored step advice well. Results are comparable with the previous computer-tailored advice intervention [33] on which this pedometer-based, computer-tailored advice intervention was based. Nearly the same number of participants (95% here vs 96%–100% in the original study) read the advice, while even more participants in the present study (94% vs 57%–66%) rated the advice as credible. This might be because we invited participants via GPs, who are perceived as a well-established authority on health issues [29], or because we based the advice on objectively measured step counts. On the other hand, fewer participants discussed the advice with others (42%) and printed it (38%), compared with the previous study (59%–64% and 55%–75%, respectively) [33]. In the Australian study of Leslie et al, only 10% of participants printed out any information from the website physical activity program [25].

Despite this positive evaluation of the computer-tailored step advice, the tool did not result in significant effects on behavior or BMI, compared with participants who did not receive the advice. The evidence on this matter is inconsistent: while some physical activity programs did find good outcomes [34,45], others did not [46,47]. None of these studies, however, were pedometer based. We found only one study [48] that used a personal activity monitor, a uniaxial accelerometer, in combination with tailored physical activity advice through the Internet in the general population (adolescents aged 12–18 years and young adults aged 25–35 years). In the adolescent group, findings suggested promising intervention effects on moderate-intensity physical activity among girls and sedentary time among boys [49]. The intervention in the young working population appeared to be easily applicable to real-life settings, but it was ineffective in improving physical activity behavior or its determinants in healthy office workers [19]. The efficacy of the personal activity monitor study in office workers seems comparable with the present findings; however, in the study of Slootmaker et al only 39% of the users found the advice appealing, while in the present intervention this was evaluated more positively [19].

The fact that the standard condition in the present study was not a true nonintervention may partially explain the lack of interaction effects. Participants in our standard condition used a pedometer and received standard 10,000 steps intervention materials, two strategies that have been shown to be effective in increasing physical activity in adults [36]. A lack of statistical power likely also affected the current outcomes. A priori power analysis indicated that 23 individuals in each intervention condition (total n = 46) would have to participate to achieve sufficient power. This was the case for most self-reported data, but unfortunately only 20 did actually provide objective step count data on both baseline and postintervention measurements. It should also be noted that, even though the majority of the sample did not reach 10,000 steps/day at baseline, most individuals (68%) were already somewhat active (at least 7500 steps/day), which could also explain the lack of effects.

XSL•FO
RenderX

The initial response rate to the invitation letter spread by GPs was very poor. Only 6% signed up for the project after receiving an invitation letter from their GP; we did, however, expect that more participants would respond, as previous research showed that face-to-face contact significantly increased recruitment for an online tailored intervention (46%) compared with recruitment via a flyer only (6%) [20]. A possible explanation for the low recruitment rate might be that some GPs simply put the invitation letters in their waiting room or did not provide any explanation about the study when handing out the invitation letters to their patients. Apart from 1 participant indicating having found the leaflet in a GP's waiting room, no further details are available on how GPs delivered the invitation letters. Australian research showed that the response rate for a website physical activity program can be as high as 79% when recruiting via telephone [25]. Consequently, in future studies, personal (face-to-face or telephone) contact should be explicitly demanded when recruiting for Web-based interventions. Despite low initial response rates via general practice, most participants believed that GPs promoting physical activity was useful.

The number of participants actually visiting the website and requesting the computer-tailored step advice was reasonably high (nearly 70%) when compared with other studies. Mailing participants a personal login and password seems an effective strategy to invite them to visit the website. Figures were lower in previous Belgian [34] and Australian [25] research, showing that only 53.1% and 46%, respectively, visited the website. It is interesting to note that participants already meeting the 10,000 steps guideline were less likely to request the computer-tailored step advice; this might be due to the 7-day baseline pedometer measurement, suggesting to those participants that there was no real need to visit a website to help them increase their steps. Those who did not request the advice indicated lack of time as the main reason for not doing so. Therefore, in the future, strategies should be developed to encourage those participants to overcome this barrier. Current and future technology might reduce this problem, as Internet access, also due to mobile devices, continues to increase and is now available at several public places such as Wi-Fi hot spots.

Some limitations need to be mentioned. First, as mentioned above, the small sample, which was mainly female, highly educated, employed, and in good health, is the main weakness of the present study. As such, the generalizability of the present findings is limited. Second, the lack of information on how GPs spread the invitation letters confines our understanding of the low initial response rate. In addition, we do not know what the dissemination strategy of the GPs was: did they hand out the invitation letters to their first 50 patients or only to those who were most in need of a physical activity intervention? We also do not know how motivating GPs were during recruitment. The fact that we collected no data on the recruitment process from GPs is a limitation in terms of understanding the poor retention rates. A final weakness is the use of self-reports, which may be subject to recall [16] and social desirability [50] biases. However, we used more objective, pedometer-based step counts to assess physical activity, which is a strong point of the study. The major strength here is the innovative approach of developing pedometer-based and computer-tailored physical activity step advice, which was never used before in an adult population. However, to truly test the impact of this newly developed intervention tool, the present preliminary results need to be confirmed in a larger, sufficiently powered trial applying more successful recruitment methods (eg, telephone contact or online advertising after personally handing out an invitation letter) and in other specific (patient) populations (eg, patients with type 2 diabetes or with cardiovascular disease).

Existing interventions promoting step count increases could benefit from an additional computer-tailored component. For example, community-based interventions guided by socioecological models of health behavior, such as 10,000 Steps Rockhampton, Canada on the Move, and 10,000 Steps Ghent, focus primarily on social systems, policy, and organizations [51]. Individual approaches are less commonly realized [52]. By adding or integrating a computer-tailored component to the community-based interventions, this shortcoming could be overcome, which might increase the effectiveness of these types of programs. In addition, this new tool could be valuable as a stand-alone intervention or as a part of a more comprehensive program in specific groups, such as older people, or patients with type 2 diabetes or other chronic illnesses, after being evaluated in these populations.

To conclude, we describe the development of a new pedometer-based, computer-tailored step advice intervention, which was disseminated through GPs. Despite the poor results of the recruitment method, participants evaluated the dissemination through general practice positively and found it useful for GPs to promote physical activity. A substantial number of participants requested the computer-tailored step advice and rated the acceptability of the tool very well. However, the tailored condition showed no superior effects on self-reported and pedometer-based physical activity, BMI, or time spent sitting, compared with the standard condition. More research is needed to enhance our knowledge of the best dissemination channel and the effectiveness of this tool in larger trials.

Acknowledgments

K De Cocker was supported by the Research Foundation Flanders (FWO) (postdoctoral research fellowship: FWO11/PDO/097). C Vandelanotte was supported by National Health and Medical Research Council of Australia (#519778) and National Heart Foundation of Australia (#PH 07B 3303) postdoctoral research fellowships.

Conflicts of Interest

The authors are the developers of the intervention. No other conflicts have been declared.

XSL•FO
RenderX

Multimedia Appendix 1

Examples of screenshots of the web-based computer-tailored and pedometer-based physical activity advice.

[PPTX File, 850KB - jmir_v14i2e53_app1.pptx]

Multimedia Appendix 2

CONSORT-EHealth V1.6 Checklist [53].

[PDF File (Adobe PDF File), 583KB - jmir_v14i2e53_app2.pdf]

References

1. Powell KE, Paluch AE, Blair SN. Physical activity for health: What kind? How much? How intense? On top of what? Annu Rev Public Health 2011 Apr 21;32:349-365. [doi: 10.1146/annurev-publhealth-031210-101151] [Medline: 21128761]
2. Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc 2007 Aug;39(8):1423-1434. [doi: 10.1249/mss.0b013e3180616b27] [Medline: 17762377]
3. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, American College of Sports Medicine. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc 2011 Jul;43(7):1334-1359. [doi: 10.1249/MSS.0b013e318213fefb] [Medline: 21694556]
4. Carlson SA, Fulton JE, Schoenborn CA, Loustalot F. Trend and prevalence estimates based on the 2008 Physical Activity Guidelines for Americans. Am J Prev Med 2010 Oct;39(4):305-313. [doi: 10.1016/j.amepre.2010.06.006] [Medline: 20837280]
5. Vandelanotte C, Duncan MJ, Caperchione C, Hanley C, Mummery WK. Physical activity trends in Queensland (2002 to 2008): are women becoming more active than men? Aust N Z J Public Health 2010 Jun;34(3):248-254. [doi: 10.1111/j.1753-6405.2010.00521.x] [Medline: 20618264]
6. Hansen BH, Kolle E, Dyrstad SM, Holme I, Anderssen SA. Accelerometer-determined physical activity in adults and older people. Med Sci Sports Exerc 2012 Feb;44(2):266-272. [doi: 10.1249/MSS.0b013e31822cb354] [Medline: 21796052]
7. Hillsdon M, Foster C, Thorogood M. Interventions for promoting physical activity. Cochrane Database Syst Rev 2005 Jan(1):CD003180. [doi: 10.1002/14651858.CD003180.pub2] [Medline: 15674903]
8. Kahn EB, Ramsey LT, Brownson RC, Heath GW, Howze EH, Powell KE, et al. The effectiveness of interventions to increase physical activity. A systematic review. Am J Prev Med 2002 May;22(4 Suppl):73-107. [Medline: 11985936]
9. Kroeze W, Werkman A, Brug J. A systematic review of randomized trials on the effectiveness of computer-tailored education on physical activity and dietary behaviors. Ann Behav Med 2006 Jun;31(3):205-223. [doi: 10.1207/s15324796abm3103_2] [Medline: 16700634]
10. Lustria ML, Cortese J, Noar SM, Glueckauf RL. Computer-tailored health interventions delivered over the Web: review and analysis of key components. Patient Educ Couns 2009 Feb;74(2):156-173. [doi: 10.1016/j.pec.2008.08.023] [Medline: 18947966]
11. Brug J, Oenema A, Campbell M. Past, present, and future of computer-tailored nutrition education. Am J Clin Nutr 2003 Apr;77(4 Suppl):1028S-1034S [FREE Full text] [Medline: 12663313]
12. Marshall AL, Eakin EG, Leslie ER, Owen N. Exploring the feasibility and acceptability of using internet technology to promote physical activity within a defined community. Health Promot J Austr 2005 Apr;16(1):82-84. [Medline: 16389938]
13. Vandelanotte C, Spathonis KM, Eakin EG, Owen N. Website-delivered physical activity interventions a review of the literature. Am J Prev Med 2007 Jul;33(1):54-64. [doi: 10.1016/j.amepre.2007.02.041] [Medline: 17572313]
14. Internet World Stats. 2011 Oct 1. Internet Users in the World: Distribution by World Regions 2011 URL: http://www.internetworldstats.com/stats.htm [accessed 2011-10-04] [WebCite Cache ID 62BEu1N2Q]
15. Internet World Stats. 2012 Mar 12. Internet Users in Europe: December 31, 2011 URL: http://www.internetworldstats.com/stats4.htm [accessed 2012-03-26] [WebCite Cache ID 66SGGaZGX]
16. Sallis JF, Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. Res Q Exerc Sport 2000 Jun;71(2 Suppl):S1-14. [Medline: 10925819]
17. Tudor-Locke C. President's Council on Physical Fitness and Sports, series 3, number 17. 2002 Jun. Taking Steps Toward Increased Physical Activity: Using Pedometers to Measure and Motivate URL: http://www.presidentschallenge.org/informed/digest/docs/200206digest.pdf [accessed 2012-03-26] [WebCite Cache ID 66S9pBHJr]
18. Hurling R, Catt M, Boni MD, Fairley BW, Hurst T, Murray P, et al. Using internet and mobile phone technology to deliver an automated physical activity program: randomized controlled trial. J Med Internet Res 2007;9(2):e7 [FREE Full text] [doi: 10.2196/jmir.9.2.e7] [Medline: 17478409]
19. Slootmaker SM, Chinapaw MJ, Schuit AJ, Seidell JC, Van Mechelen W. Feasibility and effectiveness of online physical activity advice based on a personal activity monitor: randomized controlled trial. J Med Internet Res 2009;11(3):e27 [FREE Full text] [doi: 10.2196/jmir.1139] [Medline: 19674956]

XSL•FO
RenderX

20. Spittaels H, De Bourdeaudhuij I. Implementation of an online tailored physical activity intervention for adults in Belgium. Health Promot Int 2006 Dec;21(4):311-319 [FREE Full text] [doi: 10.1093/heapro/dal030] [Medline: 16963783]
21. van Stralen MM, Kok G, de Vries H, Mudde AN, Bolman C, Lechner L. The Active plus protocol: systematic development of two theory- and evidence-based tailored physical activity interventions for the over-fifties. BMC Public Health 2008;8:399 [FREE Full text] [doi: 10.1186/1471-2458-8-399] [Medline: 19055806]
22. Tudor-Locke CE, Myers AM, Rodger NW. Development of a theory-based daily activity intervention for individuals with type 2 diabetes. Diabetes Educ 2001;27(1):85-93. [Medline: 11912619]
23. Raedeke TD, Focht BC, King JS. The impact of a student-led pedometer intervention incorporating cognitive-behavioral strategies on step count and self-efficacy. Res Q Exerc Sport 2010 Mar;81(1):87-96. [Medline: 20387402]
24. De Greef KP, Deforche BI, Ruige JB, Bouckaert JJ, Tudor-Locke CE, Kaufman JM, et al. The effects of a pedometer-based behavioral modification program with telephone support on physical activity and sedentary behavior in type 2 diabetes patients. Patient Educ Couns 2011 Aug;84(2):275-279. [doi: 10.1016/j.pec.2010.07.010] [Medline: 20732776]
25. Leslie E, Marshall AL, Owen N, Bauman A. Engagement and retention of participants in a physical activity website. Prev Med 2005 Jan;40(1):54-59. [doi: 10.1016/j.ypmed.2004.05.002] [Medline: 15530581]
26. Sciamanna CN, Marcus BH, Goldstein MG, Lawrence K, Swartz S, Bock B, et al. Feasibility of incorporating computer-tailored health behaviour communications in primary care settings. Inform Prim Care 2004;12(1):40-48. [Medline: 15140352]
27. Kushner RF. Barriers to providing nutrition counseling by physicians: a survey of primary care practitioners. Prev Med 1995 Nov;24(6):546-552. [doi: 10.1006/pmed.1995.1087] [Medline: 8610076]
28. Walsh JM, Swangard DM, Davis T, McPhee SJ. Exercise counseling by primary care physicians in the era of managed care. Am J Prev Med 1999 May;16(4):307-313. [Medline: 10493287]
29. Graham RC, Dugdill L, Cable NT. Health professionals' perspectives in exercise referral: implications for the referral process. Ergonomics 2005;48(11-14):1411-1422. [doi: 10.1080/00140130500101064] [Medline: 16338709]
30. de Vries H, Brug J. Computer-tailored interventions motivating people to adopt health promoting behaviours: introduction to a new approach. Patient Educ Couns 1999 Feb;36(2):99-105. [Medline: 10223015]
31. Vandelanotte C, De Bourdeaudhuij I. Acceptability and feasibility of a computer-tailored physical activity intervention using stages of change: project FAITH. Health Educ Res 2003 Jun;18(3):304-317 [FREE Full text] [Medline: 12828232]
32. Vandelanotte C, De Bourdeaudhuij I, Sallis JF, Spittaels H, Brug J. Efficacy of sequential or simultaneous interactive computer-tailored interventions for increasing physical activity and decreasing fat intake. Ann Behav Med 2005 Apr;29(2):138-146. [doi: 10.1207/s15324796abm2902_8] [Medline: 15823787]
33. Spittaels H, De Bourdeaudhuij I, Brug J, Vandelanotte C. Effectiveness of an online computer-tailored physical activity intervention in a real-life setting. Health Educ Res 2007 Jun;22(3):385-396 [FREE Full text] [doi: 10.1093/her/cyl096] [Medline: 16971674]
34. Spittaels H, De Bourdeaudhuij I, Vandelanotte C. Evaluation of a website-delivered computer-tailored intervention for increasing physical activity in the general population. Prev Med 2007 Mar;44(3):209-217. [doi: 10.1016/j.ypmed.2006.11.010] [Medline: 17197015]
35. De Cocker KA, De Bourdeaudhuij IM, Brown WJ, Cardon GM. Effects of “10,000 Steps Ghent”: a whole-community intervention. Am J Prev Med 2007 Dec;33(6):455-463. [doi: 10.1016/j.amepre.2007.07.037] [Medline: 18022061]
36. De Cocker KA, De Bourdeaudhuij IM, Cardon GM. The effect of pedometer use in combination with cognitive and behavioral support materials to promote physical activity. Patient Educ Couns 2008 Feb;70(2):209-214. [doi: 10.1016/j.pec.2007.10.008] [Medline: 18036764]
37. Ajzen I. From intentions to actions: a theory of planned behavior. In: Kuhl J, Beckman J, editors. Action Control: From Cognition to Behavior. Berlin: Springer-Verlag; 1985.
38. Prochaska JO, DiClemente CC, Norcross JC. In search of how people change. Applications to addictive behaviors. Am Psychol 1992 Sep;47(9):1102-1114. [Medline: 1329589]
39. Dalle Grave R, Calugi S, Centis E, El Ghoch M, Marchesini G. Cognitive-behavioral strategies to increase the adherence to exercise in the management of obesity. J Obes 2011;2011:348293 [FREE Full text] [doi: 10.1155/2011/348293] [Medline: 21052533]
40. Crouter SE, Schneider PL, Karabulut M, Bassett DR. Validity of 10 electronic pedometers for measuring steps, distance, and energy cost. Med Sci Sports Exerc 2003 Aug;35(8):1455-1460. [doi: 10.1249/01.MSS.0000078932.61440.A2] [Medline: 12900704]
41. Miller R, Brown W, Tudor-Locke C. But what about swimming and cycling? How to “count” for non-ambulatory activity when using pedometers to assess physical activity. J Phys Act Health 2006;3(3):257-266.
42. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003 Aug;35(8):1381-1395. [doi: 10.1249/01.MSS.0000078924.61453.FB] [Medline: 12900694]
43. Vandelanotte C, De Bourdeaudhuij I, Sallis JF, Philippaerts RM, Sjöström M. Reliability and validity of a computerized and Dutch version of the International Physical Activity Questionnaire (IPAQ). J Phys Act Health 2005;2(1):63-75.

XSL•FO
RenderX

44. Tudor-Locke C, Ham SA, Macera CA, Ainsworth BE, Kirtland KA, Reis JP, et al. Descriptive epidemiology of pedometer-determined physical activity. Med Sci Sports Exerc 2004 Sep;36(9):1567-1573. [Medline: 15354039]
45. Napolitano MA, Fotheringham M, Tate D, Sciamanna C, Leslie E, Owen N, et al. Evaluation of an internet-based physical activity intervention: a preliminary investigation. Ann Behav Med 2003;25(2):92-99. [Medline: 12704010]
46. McKay HG, King D, Eakin EG, Seeley JR, Glasgow RE. The diabetes network internet-based physical activity intervention: a randomized pilot study. Diabetes Care 2001 Aug;24(8):1328-1334. [Medline: 11473065]
47. Marshall AL, Leslie ER, Bauman AE, Marcus BH, Owen N. Print versus website physical activity programs: a randomized trial. Am J Prev Med 2003 Aug;25(2):88-94. [Medline: 12880874]
48. Slootmaker SM, Chin A Paw MJ, Schuit AJ, Seidell JC, van Mechelen W. Promoting physical activity using an activity monitor and a tailored web-based advice: design of a randomized controlled trial [ISRCTN93896459]. BMC Public Health 2005;5:134 [FREE Full text] [doi: 10.1186/1471-2458-5-134] [Medline: 16356182]
49. Slootmaker SM, Chinapaw MJ, Seidell JC, van Mechelen W, Schuit AJ. Accelerometers and Internet for physical activity promotion in youth? Feasibility and effectiveness of a minimal intervention [ISRCTN93896459]. Prev Med 2010 Jul;51(1):31-36. [doi: 10.1016/j.ypmed.2010.03.015] [Medline: 20380847]
50. Adams SA, Matthews CE, Ebbeling CB, Moore CG, Cunningham JE, Fulton J, et al. The effect of social desirability and social approval on self-reports of physical activity. Am J Epidemiol 2005 Feb 15;161(4):389-398 [FREE Full text] [doi: 10.1093/aje/kwi054] [Medline: 15692083]
51. Mummery WK, Brown WJ. Whole of community physical activity interventions: easier said than done. Br J Sports Med 2009 Jan;43(1):39-43. [doi: 10.1136/bjsm.2008.053629] [Medline: 18981043]
52. Van Acker R, De Bourdeaudhuij I, De Cocker K, Klesges LM, Cardon G. The impact of disseminating the whole-community project '10,000 Steps': a RE-AIM analysis. BMC Public Health 2011;11:3 [FREE Full text] [doi: 10.1186/1471-2458-11-3] [Medline: 21205290]
53. Eysenbach G, CONSORT-EHEALTH Group. CONSORT-EHEALTH: improving and standardizing evaluation reports of Web-based and mobile health interventions. J Med Internet Res 2011;13(4):e126 [FREE Full text] [doi: 10.2196/jmir.1923] [Medline: 22209829]

Abbreviations

BMI: body mass index
GP: general practitioner
IPAQ: International Physical Activity Questionnaire

Edited by G Eysenbach; submitted 05.10.11; peer-reviewed by M Neve; comments to author 15.01.12; revised version received 26.01.12; accepted 31.01.12; published 24.04.12.

Please cite as:
De Cocker K, Spittaels H, Cardon G, De Bourdeaudhuij I, Vandelanotte C
Web-Based, Computer-Tailored, Pedometer-Based Physical Activity Advice: Development, Dissemination Through General Practice, Acceptability, and Preliminary Efficacy in a Randomized Controlled Trial
J Med Internet Res 2012;14(2):e53
URL: http://www.jmir.org/2012/2/e53/
doi:10.2196/jmir.1959
PMID:22532102

©Katrien De Cocker, Heleen Spittaels, Greet Cardon, Ilse De Bourdeaudhuij, Corneel Vandelanotte. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 24.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

A 12-Week Commercial Web-Based Weight-Loss Program for Overweight and Obese Adults: Randomized Controlled Trial Comparing Basic Versus Enhanced Features

Clare E Collins[1,2], BSC, Dip Nutr&Diet, Dip Clin Epi, PhD; Philip J Morgan[2,3], BEd (HPE) (Hons1), PhD; Penelope Jones[4], BND; Kate Fletcher[1], B HumN (merit), BND (Hons); Julia Martin[1], BND; Elroy J Aguiar[2,5], BBiomedSci(Hons); Ashlee Lucas[5], BBiomedSci(Hons), G Cert Clin Epi; Melinda J Neve[1,2], BND (Hons), PhD; Robin Callister[2,5], BPharm, MSc, PhD

[1]Nutrition and Dietetics, School of Health Sciences, Faculty of Health, The University of Newcastle, Callaghan, NSW, Australia

[2]Priority Research Centre in Physical Activity and Nutrition, The University of Newcastle, Callaghan, NSW, Australia

[3]School of Education, Faculty of Education & Arts, The University of Newcastle, Callaghan, NSW, Australia

[4]SP Health Co. Pty Ltd, North Sydney, Australia

[5]School of Biomedical Sciences and Pharmacy, Faculty of Health, The University of Newcastle, Callaghan, NSW, Australia

Corresponding Author:
Clare E Collins, BSC, Dip Nutr&Diet, Dip Clin Epi, PhD
Nutrition and Dietetics
School of Health Sciences, Faculty of Health
The University of Newcastle
HA 12 Hunter Building
University Drive
Callaghan, NSW, 2308
Australia
Phone: 61 2 49215646
Fax: 61 2 49217053
Email: clare.collins@newcastle.edu.au

Abstract

Background: The development and use of Web-based programs for weight loss is increasing rapidly, yet they have rarely been evaluated using randomized controlled trials (RCTs). Interestingly, most people who attempt weight loss use commercially available programs, yet it is very uncommon for commercial programs to be evaluated independently or rigorously.

Objective: To compare the efficacy of a standard commercial Web-based weight-loss program (basic) versus an enhanced version of this Web program that provided additional personalized e-feedback and contact from the provider (enhanced) versus a wait-list control group (control) on weight outcomes in overweight and obese adults.

Methods: This purely Web-based trial using a closed online user group was an assessor-blinded RCT with participants randomly allocated to the basic or enhanced 12-week Web-based program, based on social cognitive theory, or the control, with body mass index (BMI) as the primary outcome.

Results: We enrolled 309 adults (129/309, 41.8% male, BMI mean 32.3, SD 4 kg/m^2) with 84.1% (260/309) retention at 12 weeks. Intention-to-treat analysis showed that both intervention groups reduced their BMI compared with the controls (basic: –0.72, SD 1.1 kg/m^2, enhanced: –1.0, SD 1.4, control: 0.15, SD 0.82; $P < .001$) and lost significant weight (basic: –2.1, SD 3.3 kg, enhanced: –3.0, SD 4.1, control: 0.4, SD 2.3; $P < .001$) with changes in waist circumference (basic: –2.0, SD 3.5 cm, enhanced: –3.2, SD 4.7, control: 0.5, SD 3.0; $P < .001$) and waist-to-height ratio (basic: –0.01, SD 0.02, enhanced: –0.02, SD 0.03, control: 0.0, SD 0.02; $P < .001$), but no differences were observed between the basic and enhanced groups. The addition of personalized e-feedback and contact provided limited additional benefits compared with the basic program.

Conclusions: A commercial Web-based weight-loss program can be efficacious across a range of weight-related outcomes and lifestyle behaviors and achieve clinically important weight loss. Although the provision of additional personalized feedback did not facilitate greater weight loss after 12 weeks, the impact of superior participant retention on longer-term outcomes requires

XSL•FO
RenderX

further study. Further research is required to determine the optimal mix of program features that lead to the biggest treatment impact over time.

Trial Registration: Australian New Zealand Clinical Trials Registry (ANZCTR): 12610000197033; http://www.anzctr.org.au/trial_view.aspx?id=335159 (Archived by WebCite at http://www.webcitation.org/66Wq0Yb7U)

(J Med Internet Res 2012;14(2):e57) doi:10.2196/jmir.1980

KEYWORDS

Intervention; weight loss; Web-based intervention; randomized controlled trial; reducing diet; eHealth

Introduction

The prevalence of overweight and obesity among adults is increasing worldwide [1]. Therefore, effective treatment programs with a large reach are required. Web-based weight-loss programs have emerged in response to the exponential growth in Internet access, as well as increasing use of the Internet as part of daily life and improved accessibility. In the United States, 66% of households have access to broadband Internet [2], while 72% of Australian households have access to the Internet [3]. Furthermore, many adults (61% in the United States) use the Internet to access information about health, nutrition, physical activity, and weight loss [4]. The multimedia capabilities of the Internet allow up-to-date, interactive, and individualized lifestyle programs to be provided, which endeavor to emulate traditional face-to-face consultations [5]. These programs also overcome several barriers of attending face-to-face consultations, such as poor accessibility [6], lack of anonymity [7], and participant burden associated with attendance.

However, Web-based weight-loss programs are an underevaluated treatment medium. A recent systematic review and meta-analysis examined the efficacy of 12 randomized controlled trials (RCTs) of Web-based weight-loss programs [8]. The results suggest that, in general, participants in these programs achieve similar weight-loss outcomes to control or minimal intervention groups. In addition, it has been suggested that Web-based programs with enhanced features (eg, tailored information and counseling) achieve greater weight loss than those that focus on information alone, although these studies are highly heterogeneous [8]. Further studies are required, as it has not yet been possible to establish the overall efficacy of Web-based interventions or the superiority of those with more enhanced features, due to the heterogeneity of study designs and therefore the small number of comparable studies.

Of the small number of Web-based programs that have been evaluated using an RCT, remarkably few are available to the public. Commercial Web-based weight-loss programs are likely to be the most accessible to consumers [9] but have rarely been independently evaluated [10]. Of the two RCTs of eDiets, a commercial Web-based weight-loss program in the United States, one found that after 12 months those using eDiets lost significantly less weight than those following a self-help manual (–1.1% vs –4.0%) [11], while the second compared eDiets with a structured behavioral Web-based program [12] and found the behavioral program achieved significantly greater weight loss after 12 months (–2.8% vs –5.5%). Overall, limited evidence exists for the efficacy of commercial Web-based programs as a viable obesity treatment option. Therefore, examining the efficacy of commercially available Web-based weight-loss programs on weight-related outcomes is warranted to increase the treatment options for people seeking to engage in commercial treatment programs, especially those who have limited options in their region.

The primary aim of this study was to determine whether there was a significant difference in body mass index (BMI) posttreatment among participants randomly assigned to a standard (basic) 12-week commercial Web-based weight-loss program versus a version of this program with additional online features and personalized e-feedback and reminder calls (enhanced) versus a wait-list control (control). We hypothesized that the reduction in BMI would be greater in the basic and enhanced groups than in the control group, with the BMI reduction greater in the enhanced than in the basic group.

Methods

The present study was an assessor-blinded RCT with a 12-week follow-up. The methods have been published in detail [13]. Briefly, overweight and obese adults were recruited offline and enrolled by research assistants at the University of Newcastle from October to December 2009 from the Hunter community in New South Wales, Australia. Eligibility criteria were age 18 to 60 years, BMI 25 to 40 kg/m^2, not participating in other weight-loss programs, passing a health screen [14], being available for in-person assessments, and having access to a computer with email and Internet services, although neither computer nor eHealth literacy was assessed. Exclusion criteria were pregnancy or trying to conceive, major medical problems, orthopedic problems, recent weight loss of ≥4.5 kg, and medications affecting or affected by weight loss. Trial sample size calculations have been previously published [13].

Stratification and Randomization

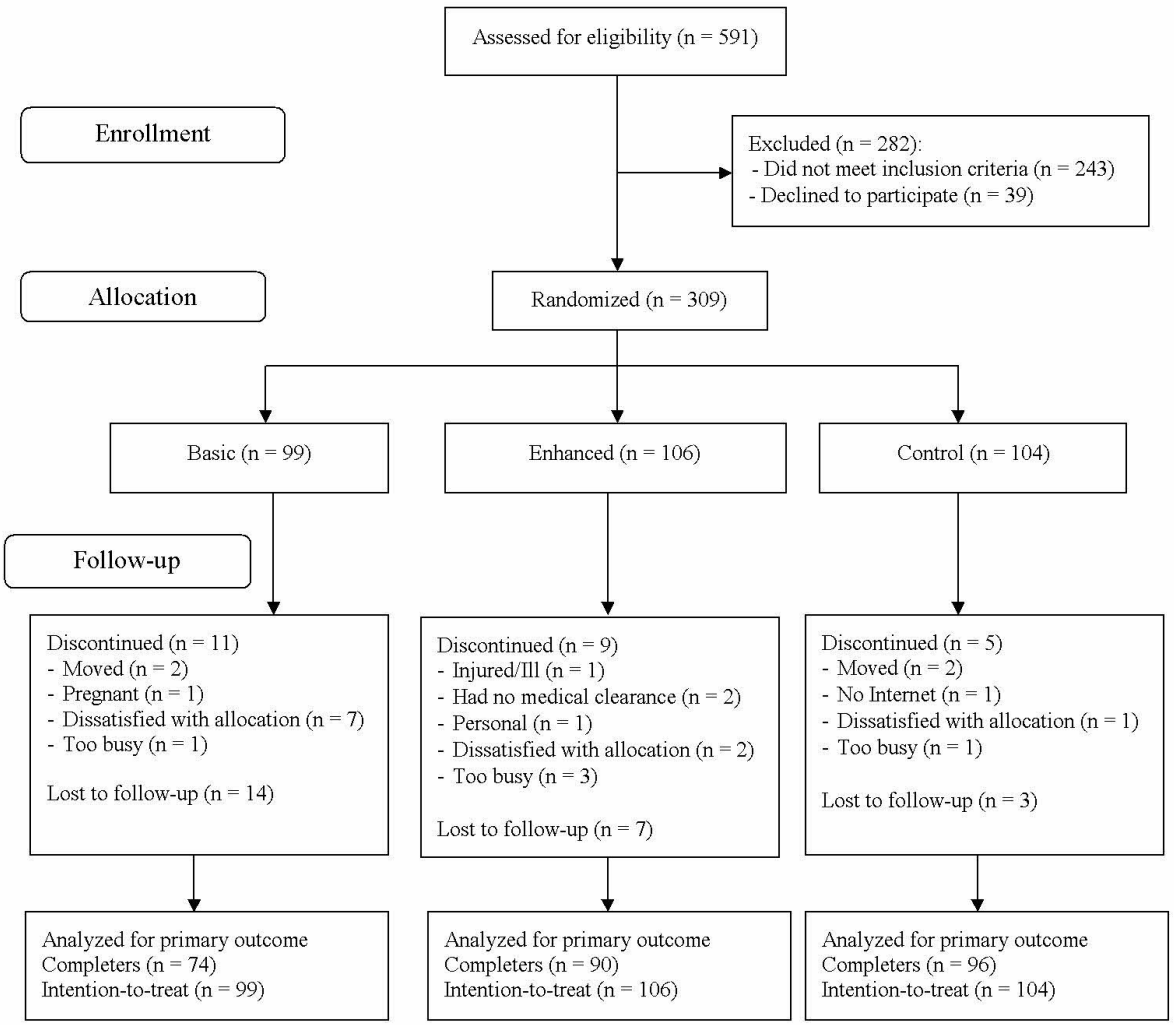
Once written consent was obtained and baseline assessments completed, participants were stratified by sex and BMI category (25 to <30; ≥30 to <35 or ≥35 to 40 kg/m^2). They were randomly allocated to one of the three groups between October and December 2009 (Figure 1) using a stratified randomized block design with variable blocks length (either 3 or 6) generated by the statistician. A researcher not involved in data collection distributed sequentially numbered sealed envelopes with allocation details and a login code. Participants were given an instruction sheet and the Web address and asked to set up their own login. We also gave them a toll-free number to call if they experienced any difficulties in logging in. No training on program use was provided to participants in order to mirror the

XSL•FO
RenderX

program engagement that commercial users would experience and to increase external validity. The groups were (1) control: a wait-list control group who were not provided with access to the weight-loss program website and were asked to refrain from participating in other weight-loss programs for 12 weeks, (2) basic: who were provided with free access to the basic (standard) Web-based program that was commercially available at that time and did not change, and (3) enhanced: who were provided with free access to an enhanced version of the Web-based program that was provided in a closed test environment. Both basic and enhanced group participants were advised to use the online diary a minimum of 4 times per week to record their dietary intake and physical activity, and to enter a weekly weight. Participants were blinded to allocation for the basic and enhanced groups, but not to the control. Research assistants were blinded to allocation for all groups. At each time point all were reminded to not discuss group allocation at assessments.

XSL•FO
RenderX

Figure 1. Flow of participants through the three groups (control, basic, enhanced) of a web-based weight-loss randomized controlled trial.



XSL•FO
RenderX

Web-Based Weight-Loss Programs

The Web-based program was underpinned by social cognitive theory [15] and targeted key mediators of behavior change, including self-efficacy, goal setting, and self-monitoring of weight, body measurements, exercise, and diet; outcome expectations (knowledge-based Web components); modeling (interactive website features and demonstrations); and social support (forums, blogs, feedback, email, and telephone contact). The interventions were Web based and delivered for 12 weeks, with new program content provided weekly by SP Health Co Pty Ltd, a commercial Web-based weight-loss program provider in Australia, under the name The Biggest Loser Club. Participation was in a quasi-anonymous manner. The reach [16], retention [17], and weight loss achieved by real-world participants [18] in the basic program have been previously evaluated.

The basic program had the following features: individualized daily calorie targets to facilitate 0.5–1 kg of weight loss per week; goal-setting options; Web-based food and exercise diary; weekly calorie-controlled, low-fat menu plans and grocery list; weekly physical activity plan based on exercise preferences; weekly educational tips and challenges; Web-based community forums; daily and weekly calculations of energy balance and nutrition summary compared with recommended nutrient targets; weekly email newsletters with alerts to new relevant content; self-monitoring of weight, and waist and hip girths; graphical display of changes in body measurement data and body (BMI) silhouette; and automated weekly reminders to enter weight. The enhanced program included access to the Web-based program described above plus (1) personalized, system-generated enrollment reports that suggested appropriate weight-loss goals and key behavior changes required for success, (2) weekly automated, system-generated, personalized e-feedback for key elements of diet and physical activity based on diary entries, usage patterns for website features, and level of success with weight loss, and (3) an escalating reminder schedule to use the diary, visit the program site, and enter a weekly weight, which was as an initial reminder email, then a short message service text message if they did not respond, then a courtesy reminder phone call if a weekly weight was still not entered.

Participants accessed the website using their usual Internet connection, at any time of the day or night that suited them.

Outcome Measures

Participant assessments were conducted at baseline and 12 weeks in the Human Performance Laboratory at the University of Newcastle, Callaghan campus [13]. Assessors of the main outcome measures, including those performing anthropometric and blood pressure measurements and blood collection, were blinded to participant group allocation at baseline and 12 weeks. We asked participants not to inform assessors of their group allocation.

The primary outcome, BMI, was calculated as weight (in kilograms) divided by height (in meters) squared. Height was measured to 0.1 cm using the stretch stature method on a Harpenden portable stadiometer (Holtain Limited, Croswell, Crymych, Pembrokeshire, UK). Weight was measured in light clothing, without shoes, on a digital scale to 0.01 kg (CH-150kp; A&D Mercury Pty Ltd, Adelaide, Australia).

Waist circumference was measured to 0.1 cm using a nonextensible steel tape (KDSF10-02; KDS Corporation, Osaka, Japan) at two points: (1) level with the umbilicus, and (2) at the narrowest point between the lower costal border and the umbilicus. Systolic and diastolic blood pressure and heart rate were measured using an automated blood pressure monitor (NISSEI/DS-105E digital electronic blood pressure monitor; Nihon Seimitsu Sokki Co Ltd, Gunma, Japan) under standardized conditions.

Blood samples were collected after an overnight fast and analyzed for lipids (total cholesterol, low-density lipoprotein and high-density lipoprotein cholesterol, and triglycerides), glucose, and insulin using standard automated techniques at a single National Association of Testing Authorities-accredited pathology service.

Dietary intake was assessed using the Australian Child and Adolescent Eating Survey, a 135-item semiquantitative food frequency questionnaire used previously in Australian youth [19] and currently being validated in adults. We asked participants to self-report frequency of consumption over the previous 6 months using the paper-based tool at baseline and over the previous 12 weeks at the follow-up assessment. Frequency options ranged from never up to ≥4 times per day. Completed food frequency questionnaires were scanned and nutrient intakes computed using FoodWorks (version 3.02.581; Xyris Software, Highgate Hill, Australia) using the Australian AusNut 1999 database (All Foods) revision 14 and AusFoods (Brands) revision 5 (Food Standards Australia New Zealand, Canberra, Australia) to generate individual mean daily nutrient intakes. We used the paper-based Three-Factor Eating Questionnaire-R18 (TFEQ-R18) to measure cognitive restraint, uncontrolled eating, and emotional eating [20]. Quality of life was assessed using the paper-based SF-36, version 2.0 (QualityMetric Incorporated, Lincoln, RI, USA), a multipurpose, generic, short-form health survey consisting of an 8-scale profile of functional health and well-being scores and psychometrically based physical and mental health summary measures [21].

We used the International Physical Activity Questionnaire (short form) paper-based questionnaire to estimate total metabolic equivalents (METs) in minutes/week [22]. Pedometers were used to objectively measure steps per day for 7 consecutive days (Yamax Digi-Walker SW-700; Yamasa Tokei Keiki Co Ltd, Tokyo, Japan). The step counts were adjusted for additional physical activity self-reported by participants when the pedometers were not worn (eg, contact sports and swimming) or problematic (eg, cycling). We added 1000 steps for every 10 minutes of moderate activity and 2000 steps for every 10 minutes of vigorous activity.

Ethics

The procedures followed were in accordance with the ethics standards of the University of Newcastle Human Ethics Research Committee. We obtained written informed consent from all participants. Institutional affiliations were displayed

XSL•FO
RenderX

on paper-based information and consent forms, but not on the Web-based program materials.

Statistical Analysis

Analysis of covariance was used to test for differences in weight loss between groups at 3 months after adjusting for baseline values. Analysis was on an intention-to-treat basis with participants who did not use the application included in the analysis, while baseline observation carried forward was used those lost to follow-up. The model was fitted using linear regression with BMI at 12weeks as the outcome variable, treatment group as the predictor variable of interest, and BMI at baseline included as a covariate. We based statistical significance of the primary efficacy analysis on Hochberg multiple testing procedures with the familywise error rate held at 2.5% because there will be an additional analysis at 18 months. All secondary hypothesis tests were performed using a 2-sided 5% significance level.

Results

Baseline Characteristics

Of the 591 people assessed for eligibility, 309 (129 men) were randomly allocated into the trial (Figure 1). Baseline characteristics did not differ between groups for any variable, other than general health scale (Table 1). Most of the participants were overweight (108, 35.0%) or in obese category 1 (122, 39.5%), most (280, 90.6%) were Australian born, and few (33, 11%) had ever smoked.

XSL•FO
RenderX

Table 1. Baseline characteristics of participants in a 12-week Web-based weight-loss (WL) program by intervention group.

Characteristic	Treatment group				*P* value[a]
	Control (n = 104)	Basic WL (n = 99)	Enhanced WL (n = 106)	Total (N = 309)	
Sex, n(%)					
Men	44 (42%)	41 (41%)	44 (42%)	129 (42%)	.99
Women	60 (58%)	58 (59%)	62 (58%)	180 (58%)	
BMI group strata (kg/m ^{2}), n (%)					
25 to <30	36 (35%)	34 (34%)	38 (36%)	108 (35.0%)	.99
30 to <35	42 (40%)	39 (39%)	41 (39%)	122 (39.5%)	
35 to <40	26 (25%)	26 (26%)	27 (25%)	79 (26%)	
Current or previous smoker, n (%)					
Never smoker	93 (91%)	85 (87%)	95 (90%)	273 (89%)	.59
Current/former smoker	9 (9%)	13 (13%)	11 (10%)	33 (11%)	
Highest level of education, n (%)					
School	27 (26%)	32 (32%)	31 (29%)	90 (29%)	.78
Trade/diploma	37 (36%)	31 (31%)	43 (41%)	111 (36%)	
University degree	26 (25%)	23 (23%)	19 (18%)	68 (22%)	
Higher university degree	13 (13%)	13 (13%)	13 (12%)	39 (13%)	
Weekly household income (A $), n (%)					
<$700	10 (10%)	9 (10%)	6 (6%)	25 (8.6%)	.72
$700 to <$1000	6 (6%)	3 (3%)	7 (7%)	16 (6%)	
$1000 to <$1400	12 (12%)	15 (16%)	9 (9%)	36 (12%)	
$1500 or more	68 (69%)	62 (67%)	75 (75%)	205 (70%)	
Don’t know/no answer	3 (3%)	4 (4%)	3 (3%)	10 (3%)	
Country of birth, n (%)					
Australia	92 (89%)	90 (91%)	98 (92%)	280 (90.6%)	.73
Other	11 (11%)	9 (9%)	8 (8%)	28 (9%)	
Age (years), mean (SD)	41.7 (9.4)	42.0 (10.9)	42.2 (10.2)	42.0 (102)	.94
Physical measurements, mean (SD)					
Height (cm)	1.7 (0.1)	1.7 (0.1)	1.7 (0.1)	1.7 (0.1)	.65
Weight (kg)	93.6 (13.9)	94.9 (15.4)	93.4 (14.6)	94.0 (14.6)	.75
Body mass index (kg/m^2)	32.2 (3.9)	32.3 (3.6)	32.3 (4.3)	32.3 (4.0)	.98
Waist circumference (umbilicus) (cm)	107.2 (10.4)	106.9 (9.8)	106.6 (12.5)	106.9 (10.9)	.92
Waist circumference (narrowest) (cm)	98.2 (11.4)	98.6 (11.5)	97.7 (11.7)	98.2 (11.5)	.86
Waist (umbilicus) to height ratio	0.63 (0.07)	0.63 (0.06)	0.63 (0.08)	0.63 (0.07)	.91
Waist (narrowest) to height ratio	0.58 (0.06)	0.58 (0.06)	0.57 (0.06)	0.58 (0.06)	.98
Physiological measurements, mean (SD)					
Systolic blood pressure (mmHg)	122 (16)	121 (13)	121 (11)	122 (13)	.81
Diastolic blood pressure (mmHg)	79 (10)	80 (11)	79 (10)	79 (10)	.75
Pulse rate (beats/minute)	70 (10)	68 (9)	68 (10)	69 (10)	.55
Blood tests, mean (SD)					
Total serum cholesterol (mmol/L)	5.1 (0.8)	5.2 (1.0)	5.0 (1.1)	5.1 (1.0)	.64

XSL•FO
RenderX

Characteristic	Treatment group				*P* value[a]
	Control (n = 104)	Basic WL (n = 99)	Enhanced WL (n = 106)	Total (N = 309)	
LDL[b] cholesterol (mmol/L)	3.0 (0.6)	3.1 (0.8)	3.0 (0.9)	3.0 (0.8)	.38
HDL[c] cholesterol (mmol/L)	1.3 (0.3)	1.3 (0.3)	1.3 (0.3)	1.3 (0.3)	.85
Triglycerides (mmol/L)	1.8 (1.9)	1.6 (0.8)	1.8 (1.2)	1.7 (1.4)	.54
LDL to HDL ratio	2.40 (0.79)	2.54 (0.80)	2.38 (0.79)	2.44 (0.79)	.35
Glucose (mmol/L)	5.0 (1.4)	4.8 (0.6)	4.8 (0.6)	4.8 (0.9)	.20
Insulin (mIU/L)	10.5 (7.5)	11.8 (13.1)	11.2 (13.1)	11.1 (11.5)	.73
SF-36 scores, mean (SD)					
Physical functioning	85.4 (15.2)	86.1 (14.2)	82.5 (19.8)	84.6 (16.7)	.27
Role physical	87.1 (19.9)	88.8 (16.8)	86.3 (19.5)	87.4 (18.8)	.63
Bodily pain	60.9 (28.4)	61.4 (27.3)	61.2 (29.8)	61.2 (28.4)	.99
General health	63.9 (18.5)	69.8 (16.8)	72.8 (18.8)	68.7 (18.5)	.004
Vitality	78.1 (70.6)	69.3 (14.8)	81.4 (45.3)	76.8 (51.4)	.32
Social functioning	81.4 (23.8)	84.5 (20.6)	85.0 (21.7)	83.5 (22.2)	.51
Role emotional	86.5 (17.4)	89.9 (21.7)	89.4 (15.9)	88.5 (18.2)	.41
Mental health	74.0 (17.3)	78.9 (16.5)	79.2 (14.8)	77.2 (16.4)	.06
Physical activity, mean (SD)					
Total (MET[d] minutes/week)	2724 (2732)	3024 (3029)	2846 (3127)	2863 (2964)	.80
Step count/day	7971 (3511)	8664 (3773)	8680 (3752)	8427 (3677)	.34
Three-Factor Eating Questionnaire-R18 scores, mean (SD)					
Cognitive restraint scale	13.0 (3.0)	13.3 (2.9)	13.1 (2.8)	13.2 (2.9)	.70
Uncontrolled eating scale	20.9 (5.1)	20.9 (4.7)	20.8 (4.8)	20.9 (4.8)	.97
Emotional eating scale	7.7 (2.5)	7.6 (2.2)	7.8 (2.6)	7.7 (2.4)	.86
Total energy intake (kJ/day), mean (SD)	10,311 (3229)	9958 (3223)	10,250 (3257)	10,175 (3229)	.71

[a] *P* values are from analysis of variance for continuous measures and from a chi-square test for categorical measures.

[b] Low-density lipoprotein.

[c] High-density lipoprotein.

[d] Metabolic equivalent.

Retention at 12 Weeks

The percentage of participants who attended the 12-week follow-up assessment was significantly different between treatment groups (*P* = .003). Participants randomly assigned to the basic group (74/99, 75%) were less likely (*P* = .001) to attend the 12-week visit than those in the control group (96/104, 92%), with the percentage attending from the enhanced group (90/106, 85%) not significantly different from either the control (*P* = .09) or basic condition (*P* = .07) (Figure 1).

Changes in Weight, BMI, and Waist Circumference

Participants in the basic and enhanced groups lost significant amounts of weight whether expressed as BMI or kilograms lost (Table 2, Table 3), with the increase in weight in controls not statistically significant. Consequently, those randomly assigned to the basic and enhanced groups had statistically significant reductions in the primary outcome, BMI (kg/m^2), compared with those in the control group. Waist circumferences decreased significantly more in the basic and enhanced groups than in the control group, and waist circumference measured at the narrowest point decreased significantly more in the enhanced group than in the basic group (Table 2, Table 3). Waist-to-height ratios decreased in the basic and enhanced groups compared with the control group.

Secondary Outcomes

After 12 weeks we observed a statistically significant improvement in total serum cholesterol and systolic and diastolic blood pressures in those randomly assigned to the enhanced condition compared with control, with a nonsignificant benefit in those in the basic condition. There were no differences between groups in changes in any of the other plasma variables, including triglycerides, glucose, and insulin. There was a trend toward a greater reduction in pulse rate in the enhanced compared with control group (*P* = .06). There was no significant

XSL•FO
RenderX

change in total physical activity METs (minutes/week), with the average step count per day decreasing in the controls but increasing in the basic and enhanced groups, and a significantly greater increase in enhanced relative to control (P = .005). While all groups decreased their energy intake (kJ/day), those in the enhanced group decreased theirs more than those in the control group (P = .03). There was no change in most of the subscales of the SF-36 quality-of-life questionnaire, with the exception of the general health scale, which improved more in the enhanced than in the control group (P = .03). Within the TFEQ-R18, the scales of cognitive constraint and uncontrolled eating also improved. Both basic and enhanced participants increased eating restraint and reduced uncontrolled eating compared with controls (P < .001).

Table 2. Mean (SD) change in variables from baseline to 12 weeks in each treatment group.

Variable	Total n	Treatment group		
		Control	Basic	Enhanced
Weight (kg)	309	0.36 (2.33)	–2.14 (3.32)	–2.98 (4.05)
Percentage weight loss (%)	309	0.44 (2.44)	–2.29 (3.51)	–3.26 (4.31)
Body mass index (kg/m^2)	309	0.15 (0.82)	–0.72 (1.07)	–0.98 (1.38)
Waist circumference at umbilicus (cm)	309	0.26 (3.10)	–2.63 (3.99)	–3.18 (5.00)
Waist circumference at narrowest point (cm)	309	0.46 (3.02)	–1.96 (3.47)	–3.17 (4.69)
Waist to height ratio at umbilicus	309	0.00 (0.02)	–0.02 (0.02)	–0.02 (0.03)
Waist to height ratio at narrowest point	309	0.00 (0.02)	–0.01 (0.02)	–0.02 (0.03)
Systolic blood pressure (mmHg)	308	–1.09 (10.90)	–3.56 (9.35)	–4.95 (10.08)
Diastolic blood pressure (mmHg)	308	–0.35 (7.04)	–2.09 (7.74)	–3.02 (8.57)
Pulse rate (beats/minute)	306	–0.86 (6.54)	–0.99 (6.47)	–2.52 (6.28)
Total serum cholesterol (mmol/L)	309	0.08 (0.55)	–0.05 (0.51)	–0.17 (0.56)
LDL[a] cholesterol (mmol/L)	271	0.09 (0.49)	0.03 (0.40)	–0.05 (0.43)
HDL[b] cholesterol (mmol/L)	309	–0.00 (0.13)	0.01 (0.15)	–0.01 (0.16)
Triglycerides (mmol/L)	309	–0.22 (1.50)	–0.17 (0.58)	–0.23 (0.67)
LDL to HDL ratio	271	0.06 (0.40)	0.00 (0.36)	–0.03 (0.34)
Glucose (mmol/L)	307	–0.45 (0.91)	–0.35 (0.53)	–0.33 (0.55)
Insulin (mIU/L)	309	–0.76 (5.11)	–1.53 (12.76)	–1.55 (6.04)
Physical functioning (SF-36)	301	0.45 (14.27)	1.79 (22.64)	4.86 (17.22)
Role physical (SF-36)	301	1.92 (21.74)	2.04 (21.74)	3.07 (16.39)
Bodily pain (SF-36)	300	–2.08 (27.65)	0.20 (25.40)	0.85 (34.34)
General health (SF-36)	303	3.02 (11.90)	3.72 (12.17)	6.75 (12.42)
Vitality (SF-36)	297	14.11 (68.04)	2.36 (22.48)	12.91 (59.23)
Social functioning (SF-36)	298	1.36 (24.42)	0.26 (14.47)	4.48 (21.77)
Role emotional (SF-36)	303	1.32 (20.51)	2.47 (13.55)	3.07 (16.48)
Mental health (SF-36)	299	2.28 (15.66)	2.55 (15.68)	4.86 (13.26)
Total physical activity MET[c] (minutes/week)	274	341.8 (3116)	151.4 (1946)	491.6 (2601)
Average step count per day	263	–61 (2480)	153 (2095)	867 (2947)
Cognitive restraint scale (TFEQ-R18)[d]	296	0.28 (2.50)	1.16 (2.48)	1.78 (3.34)
Uncontrolled eating scale (TFEQ-R18)	302	0.05 (3.03)	–1.58 (3.53)	–1.81 (3.74)
Emotional eating score (TFEQ-R18)	304	–0.32 (1.37)	–0.47 (1.38)	–0.63 (1.64)
Total energy intake (kJ/day)	304	–734 (2129)	–1003 (2498)	–1465 (2470)

[a] Low-density lipoprotein.

[b] High-density lipoprotein.

[c] Metabolic equivalent.

[d] Three-Factor Eating Questionnaire-R18.

XSL•FO
RenderX

Table 3. Absolute and least square mean (LSM) differences between groups at 12 weeks (intention-to-treat population).

Variable	Total n	Treatment group LSM (95% CI[a])						Group effect (*P* value)
		Basic vs control		Enhanced vs control		Enhanced vs basic		
		Difference	95% CI	Difference	95% CI	Difference	95% CI	
Weight (kg)	309	2.48	1.38 to 3.58	3.34	2.26 to 4.42	0.86	–0.23 to 1.95	<.001
Percentage weight loss (%)	309	2.73	1.57 to 3.89	3.70	2.55 to 4.84	0.97	–0.19 to 2.12	<.001
Body mass index (kg/m^2)	309	0.87	0.51 to 1.24	1.13	0.77 to 1.50	0.26	–0.11 to 0.63	<.001
Waist circumference at umbilicus (cm)	309	2.90	1.54 to 4.26	3.45	2.11 to 4.79	0.55	–0.81 to 1.91	<.001
Waist circumference at narrowest point (cm)	309	2.40	1.16 to 3.64	3.65	2.43 to 4.87	1.25	0.02 to 2.49	<.001
Waist to height ratio at umbilicus	309	0.02	0.01 to 0.03	0.02	0.01 to 0.03	0.00	–0.01 to 0.01	<.001
Waist to height ratio at narrowest point	309	0.01	0.01 to 0.02	0.02	0.01 to 0.03	0.01	–0.00 to 0.01	<.001
Systolic blood pressure (mmHg)	308	2.82	–0.17 to 5.81	4.24	1.31 to 7.17	1.42	–1.55 to 4.39	.003
Diastolic blood pressure (mmHg)	308	1.41	–0.96 to 3.78	2.54	0.22 to 4.87	1.13	–1.23 to 3.49	.04
Pulse rate (beats/minute)	306	0.31	–1.77 to 2.39	1.92	–0.12 to 3.95	1.60	–0.47 to 3.67	.06
Total serum cholesterol (mmol/L)	309	0.11	–0.06 to 0.28	0.25	0.08 to 0.42	0.14	–0.03 to 0.31	.003
LDL[b] cholesterol (mmol/L)	271	0.04	–0.11 to 0.20	0.14	–0.01 to 0.29	0.10	–0.06 to 0.25	.09
HDL[c] cholesterol (mmol/L)	309	0.01	–0.04 to 0.05	0.01	–0.03 to 0.06	0.02	–0.03 to 0.07	.59
Triglycerides (mmol/L)	309	0.07	–0.15 to 0.28	0.03	–0.18 to 0.25	0.03	–0.18 to 0.25	.78
LDL to HDL ratio	271	0.05	–0.08 to 0.18	0.09	–0.03 to 0.22	0.05	–0.08 to 0.17	.23
Glucose (mmol/L)	307	0.00	–0.17 to 0.17	0.03	–0.14 to 0.20	0.03	–0.14 to 0.21	.86
Insulin (mIU/L)	309	0.21	–2.07 to 2.50	0.46	–1.78 to 2.71	0.25	–2.02 to 2.53	.89
Physical functioning (SF-36)	301	1.78	–3.51 to 7.06	2.65	–2.54 to 7.83	0.87	–4.37 to 6.11	.47
Role physical (SF-36)	301	0.72	–4.83 to 6.26	0.05	–5.38 to 5.48	0.77	–4.72 to 6.26	.94
Bodily pain (SF-36)	300	2.91	–5.63 to 11.45	2.69	–5.66 to 11.04	0.22	–8.22 to 8.66	.67
General health (SF-36)	303	1.25	–2.63 to 5.13	4.24	0.45 to 8.04	2.99	–0.84 to 6.82	.03
Vitality (SF-36)	297	10.38	–5.56 to 26.32	1.12	–14.5 to 16.71	9.26	–6.49 to 25.01	.24

XSL•FO
RenderX

Variable	Total n	Treatment group LSM (95% CI[a])						Group effect (*P* value)
		Basic vs control		Enhanced vs control		Enhanced vs basic		
		Difference	95% CI	Difference	95% CI	Difference	95% CI	
Social functioning (SF-36)	298	0.15	–6.07 to 6.36	2.05	–4.02 to 8.13	1.90	–4.26 to 8.07	.68
Role emotional (SF-36)	303	2.74	–2.02 to 7.51	1.37	–3.29 to 6.02	1.38	–3.34 to 6.10	.40
Mental health (SF-36)	299	1.02	–3.56 to 5.60	2.30	–2.18 to 6.78	1.28	–3.25 to 5.82	.48
Total physical activity MET[d] (minutes/week)	274	96.51	–776 to 969.4	190.3	–661 to 1042	286.8	–568 to 1141	.72
Average step count per day	263	436	–485 to 1357	1225	339.3 to 2111	789	–130 to 1707	.005
Cognitive restraint scale (TFEQ-R18)[e]	296	1.05	0.16 to 1.93	1.57	0.72 to 2.43	0.52	–0.36 to 1.40	<.001
Uncontrolled eating scale (TFEQ-R18)	302	1.65	0.55 to 2.76	1.89	0.82 to 2.96	0.23	–0.86 to 1.33	<.001
Emotional eating score (TFEQ-R18)	304	0.18	–0.30 to 0.65	0.30	–0.16 to 0.77	0.13	–0.35 to 0.60	.30
Total energy intake (kJ/day)	304	397	–291 to 1084	782	100 to 1463	385	–304 to 1074	.03

[a] Confidence interval.

[b] Low-density lipoprotein.

[c] High-density lipoprotein.

[d] Metabolic equivalent.

[e] Three-Factor Eating Questionnaire-R18.

There were significant between-group differences in the proportions of participants who lost 5 to <10% (control: 3%, basic: 18%, enhanced: 17%) or ≥10% of their baseline weight (control: 0%, basic: 18%, enhanced: 28%), or gained weight (control: 53%, basic: 22%, enhanced: 17%) (all $P < .001$).

Discussion

The primary aim of this study was to determine whether using a commercial Web-based weight-loss program, with or without enhanced online features including personalized e-feedback and reminder calls, would lead to a greater reduction in BMI compared with each other or with a wait-list control group. This study demonstrated that participation in either version of the 12-week commercial Web-based weight-loss program (standard or enhanced with feedback) resulted in statistically significant and clinically important objectively measured weight loss. Many desirable improvements in secondary risk markers for chronic disease were achieved, irrespective of the program version used. This suggests that the fundamental elements of the Web-based program were the drivers of the behavior change. However, the enhanced program version achieved a greater retention rate, which in the longer term is critical for maximizing program reach and opportunity to facilitate maintenance of lost weight. There were advantages for those in the enhanced program group related to the extent of improvements in several secondary outcomes compared with the controls, including decreases in waist circumference, plasma total cholesterol, blood pressure, energy intake, and steps per day. Overall, both program versions provided important reductions in several risk factors for cardiovascular disease, as well as improvements in domains of quality of life and eating behavior.

In the only previous RCT of a commercial Web-based weight-loss program [11,12], the commercial Web-based program was found to be less effective than a self-help manual [11] and a more structured Web-based behavioral weight-loss program [12]. The eDiets commercial Web-based program had some similar program features to The Biggest Loser Club program, such as weekly self-monitoring of weight, meal and exercise plans, educational materials, and social support via a discussion board. Although eDiets also offered alternative sources of social support such as Web-based meetings and chat rooms, it did not provide a tool for participants to monitor and receive feedback on their dietary intake and physical activity, nor were participants reminded to use the program, which differs from the program in the current study. Therefore, we hypothesized that the mean weight losses for the basic and enhanced versions after 12 weeks in this study would be greater than those from the 2004 RCT using eDiets (–0.9% after 16

XSL•FO
RenderX

weeks) [11]. Interestingly, the 12-week weight loss in the current study is similar to the results of a more recent RCT using eDiets, which reported a mean weight loss of –3.6% after 6 months [12], which may indicate that developments in online capabilities facilitate program effectiveness.

This is the first RCT to examine the efficacy of a commercial program that specifically sought to include enhanced features (provision of additional personalized e-feedback, reminders, and phone calls) compared with the basic commercial program version without these features. We have shown that participants using the enhanced program did not lose significantly more weight after 12 weeks than did those in the basic program. This finding is not consistent with previous RCTs comparing basic versus enhanced versions of Web-based programs, as these have typically demonstrated greater weight loss in the enhanced study arm [12,23-27]. However, the basic programs in these previous studies had fewer program features and typically did not include all of the key components of Web-based interventions reported to be essential, such as being based on a theoretical framework, providing diet and physical activity feedback to participants, and having interactive features [28,29]. For example, Rothert et al's basic Web-based program provided information only [27], while the enhanced features in other studies commonly used more human interventions, such as individualized human e-feedback generated by a therapist [24-26] or Web-based chat sessions conducted by a trained therapist [12]. The lack of difference between the basic and enhanced program in the current study, along with the magnitude of the weight lost after 12 weeks, suggests that either format of the program can produce clinically important initial weight loss. However, it also suggests that the enhanced program may require a greater number or intensity of enhanced features to be more effective than the basic version, or that the enhanced features provided are not necessary for many participants.

Although no significant difference in weight loss between basic and enhanced groups was observed, the enhanced group achieved significantly greater improvements in waist circumference than the basic group. They also demonstrated greater improvements in blood pressure, plasma total cholesterol, steps per day, measures of general health, and reduction in total daily energy intake than the control group, whereas the basic group did not. This suggests that the enhanced program offers additional benefit to participants in terms of risk factor reduction and in achieving behavior change that may assist with long-term maintenance of lost weight. Furthermore, the basic group were more likely to drop out of the study (25%) than the enhanced group (15%). The impact of this should not be overlooked because weight-loss success is associated with greater adherence to the prescribed treatment plan, and retention within treatment is the primary component of program adherence. Further follow-up of these participants will determine whether greater initial improvements in indicators of health status, quality of life, dietary intake, and physical activity, as well as higher initial retention, affect weight-loss outcomes in the long term and whether improvements are sustained over time. This will be important in evaluating the long-term efficacy of the basic program compared with the enhanced program.

This is one of the first RCTs of a Web-based weight-loss program to comprehensively assess secondary outcomes and to capture the potential of the program to have significant health benefits, irrespective of the weight loss achieved. To our knowledge, no other RCT evaluating Web-based weight-loss studies have assessed changes in lipids or insulin levels, and only one has evaluated changes in glucose levels [26]. The current study also demonstrated significantly greater reductions in blood pressure (systolic and diastolic) among the enhanced program users. Only two other RCTs evaluating Web-based weight-loss programs have assessed changes in blood pressure [30-32], with one of these finding greater reductions in systolic blood pressure among male participants only. Also, these improvements were demonstrated after 12 months [31], but not after 3 or 6 months [32]. Therefore, this is the first Web-based weight-loss RCT to demonstrate significant improvements in plasma total cholesterol and blood pressure after 12 weeks via participation in a Web-based weight-loss program that provides comprehensive personalized feedback and reminders to engage with the program.

Only a few Web-based weight-loss RCTs have reported changes in dietary intake and physical activity, and assessed difference in change across study arms [23-26,32-35]. To date, no study has demonstrated significant differences in dietary intake or physical activity change among participants of Web-based weight-loss programs compared with control groups, other treatment formats (eg, face-to-face), or enhanced Web-based programs. The current study found significantly greater reductions in mean total daily energy intake and increases in steps per day in the enhanced program users, which suggests that additional personalized feedback and reminders to use the program had positive influences on food and physical activity behaviors. However, further detailed investigation is needed to examine how participants change their food and physical activity behaviors in response to Web-based intervention. Further, no previous Web-based weight-loss studies have measured components of appetite and hunger using the TFEQ-R18. We have demonstrated improvements in both intervention groups compared with a control group in the domains of cognitive restraint and uncontrolled eating, but no significant improvements in emotional eating scores. Previous research has highlighted the association between appropriate eating patterns, such as higher dietary restraint and less emotional eating, and long-term weight-loss maintenance [36], and therefore this is an area where the current program could be refined. Longer-term follow-up of participants will demonstrate whether these initial improvements in eating patterns can be sustained or improved, and whether this affects weight-loss maintenance.

One other Web-based weight-loss study has measured quality of life. McConnon and colleagues found significant improvements in quality of life in Internet and usual-care groups with no significant difference between groups [33]. Therefore, the finding in the current study of significant improvements in quality of life, namely the general health domain of the SF-36, after 12 weeks' participation in the enhanced version of the program is important.

XSL•FO
RenderX

A limitation of the current study is that all participants did receive human contact when they attended the clinical research center for clinical assessments. However, they were assessed by blinded assessors. Further, we gave them no advice on how to log in or engage with the program, other than giving them their login details. This was to simulate real-world engagement and use of the program, making the results generalizable to the overweight population of adults using commercial weight-loss programs. Due to the inclusion of a control group, the study also did not consider the potential differential impact of the Web-based programs as a result of participants' varying levels of website usage. Study strengths include the use of a control group compared with two versions of the Web-based program, as well as the robust study design and the use of predominantly objective measures.

The results of this study demonstrate that Web-based weight loss can be efficacious across a range of weight-related outcomes and lifestyle behaviors, and that commercial providers can deliver effective Web-based programs targeting this important public health issue. Further study is needed to examine longer-term outcomes and whether Web-based programs with enhanced program features, including provision of personalized feedback, can retain people in the long term and lead to a greater treatment impact over time.

Acknowledgments

We would like to thank the study participants and research assistants (Rebecca Collins, Trevor Cripps, James Dower, Sharenjit Gill, Jenna Hannan, Skye Huxley, Hannah Mackay, Bryana Melnick, Justin Nicol, Hannah Lucas, Tom Mitchell, Huiru Teoh, Janine Wright, and Mei Yap) who helped with data collection; Louana Moller, Lynn Clarke, and Narelle Eddington from Hunter Area Pathology Service; Scott Penn, Anna Crook, Julian Barton, Sandra Mitchell, and Laura Welsford from SP Health Pty Ltd; and Patrick McElduff for assistance with the statistical analysis.

This trial was funded by an Australian Research Council Linkage Project grant (2009–2012) (LP0990414, G0189752), with SP Health as the Industry Partner Organization (G0189753). CEC is supported by a National Health and Medical Research Council Australian Career Development Award Research Fellowship (#6315005). KF was supported by an Australian Research Council Australian Postgraduate Award Industry scholarship. MN receives a partial fellowship from Penn Health Australia.

Conflicts of Interest

CEC has been a nutrition consultant to SP Health Co; M Neve received a PhD scholarship supplement from SP Health Co; and P Jones is employed by SP Health Co. All other authors declare that they have no competing interests. Scott Penn is the founder and Chairman of SP Health Co Pty Ltd and Anna Crook is the program developer and Director of Product Development at SP Health Co Pty Ltd.

Multimedia Appendix 1

CONSORT eHealth checklist V1.6 [37].

[PDF File (Adobe PDF File), 1MB - jmir_v14i2e57_app1.pdf]

References

1. Ogden CL, Yanovski SZ, Carroll MD, Flegal KM. The epidemiology of obesity. Gastroenterology 2007 May;132(6):2087-2102. [doi: 10.1053/j.gastro.2007.03.052] [Medline: 17498505]
2. Smith A. Home broadband 2010. Washington, DC: Pew Internet & American Life Project; 2010 Aug 11. URL: http://www.pewinternet.org/~/media//Files/Reports/2010/Home%20broadband%202010.pdf [accessed 2011-10-11] [WebCite Cache ID 62LXgiJYD]
3. Australian Bureau of Statistics. 2011 Sep 28. 8153.0: Internet Activity, Australia, June 2011 URL: http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/8153.0Main+Features1June%202011?OpenDocument [accessed 2011-10-11] [WebCite Cache ID 62LZsA8RI]
4. Fox S, Jones S. The social life of health information: Americans' pursuit of health takes place within a widening network of both online and offline sources. Washington, DC: Pew Internet & American Life Project; 2009 Jun. URL: http://www.pewinternet.org/~/media//Files/Reports/2009/PIP_Health_2009.pdf [accessed 2011-10-11] [WebCite Cache ID 62LZZ4g9K]
5. Lustria ML, Cortese J, Noar SM, Glueckauf RL. Computer-tailored health interventions delivered over the Web: review and analysis of key components. Patient Educ Couns 2009 Feb;74(2):156-173. [doi: 10.1016/j.pec.2008.08.023] [Medline: 18947966]
6. Harvey-Berino J, Pintauro S, Buzzell P, DiGiulio M, Casey Gold B, Moldovan C, et al. Does using the Internet facilitate the maintenance of weight loss? Int J Obes Relat Metab Disord 2002 Sep;26(9):1254-1260 [FREE Full text] [doi: 10.1038/sj.ijo.0802051] [Medline: 12187404]
7. Saperstein SL, Atkinson NL, Gold RS. The impact of Internet use for weight loss. Obes Rev 2007 Sep;8(5):459-465. [doi: 10.1111/j.1467-789X.2007.00374.x] [Medline: 17716303]

XSL•FO
RenderX

8. Neve M, Morgan PJ, Jones PR, Collins CE. Effectiveness of web-based interventions in achieving weight loss and weight loss maintenance in overweight and obese adults: a systematic review with meta-analysis. Obes Rev 2010 Apr;11(4):306-321. [doi: 10.1111/j.1467-789X.2009.00646.x] [Medline: 19754633]
9. Krukowski RA, West DS, Harvey-Berino J. Recent advances in internet-delivered, evidence-based weight control programs for adults. J Diabetes Sci Technol 2009 Jan;3(1):184-189 [FREE Full text] [Medline: 20046664]
10. Tsai AG, Wadden TA. Systematic review: an evaluation of major commercial weight loss programs in the United States. Ann Intern Med 2005 Jan 4;142(1):56-66. [Medline: 15630109]
11. Womble LG, Wadden TA, McGuckin BG, Sargent SL, Rothman RA, Krauthamer-Ewing ES. A randomized controlled trial of a commercial internet weight loss program. Obes Res 2004 Jun;12(6):1011-1018. [doi: 10.1038/oby.2004.124] [Medline: 15229342]
12. Gold BC, Burke S, Pintauro S, Buzzell P, Harvey-Berino J. Weight loss on the web: A pilot study comparing a structured behavioral intervention to a commercial program. Obesity (Silver Spring) 2007 Jan;15(1):155-164 [FREE Full text] [doi: 10.1038/oby.2007.520] [Medline: 17228043]
13. Collins CE, Morgan PJ, Jones P, Fletcher K, Martin J, Aguiar EJ, et al. Evaluation of a commercial web-based weight loss and weight loss maintenance program in overweight and obese adults: a randomized controlled trial. BMC Public Health 2010;10:669 [FREE Full text] [doi: 10.1186/1471-2458-10-669] [Medline: 21047432]
14. Norton K. Austrlian Government, Department of Health and Ageing. 2005. Sports Medicine Australia (SMA) Pre-exercise Screening System 2005 URL: http://sma.org.au/wp-content/uploads/2009/05/new_pre_screening.pdf [accessed 2011-10-11] [WebCite Cache ID 62LYPmkuK]
15. Bandura A. Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, NJ: Prentice-Hall; 1986.
16. Neve MJ, Morgan PJ, Collins CE. Participant characteristics and reach of a commercial web-based weight loss program. Nutr Diet 2010;67(4):267-274. [doi: 10.1111/j.1747-0080.2010.01474.x]
17. Neve MJ, Collins CE, Morgan PJ. Dropout, nonusage attrition, and pretreatment predictors of nonusage attrition in a commercial Web-based weight loss program. J Med Internet Res 2010;12(4):e69 [FREE Full text] [doi: 10.2196/jmir.1640] [Medline: 21156470]
18. Neve M, Morgan PJ, Collins CE. Weight change in a commercial web-based weight loss program and its association with website use: cohort study. J Med Internet Res 2011;13(4):e83 [FREE Full text] [doi: 10.2196/jmir.1756] [Medline: 21993231]
19. Watson JF, Collins CE, Sibbritt DW, Dibley MJ, Garg ML. Reproducibility and comparative validity of a food frequency questionnaire for Australian children and adolescents. Int J Behav Nutr Phys Act 2009;6:62 [FREE Full text] [doi: 10.1186/1479-5868-6-62] [Medline: 19744349]
20. Karlsson J, Persson LO, Sjöström L, Sullivan M. Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. Int J Obes Relat Metab Disord 2000 Dec;24(12):1715-1725. [Medline: 11126230]
21. Ware J, Kosinski M, Dewey JE. How to Score Version 2 of the SF-36 Health Survey: Standard & Acute Form. Lincoln, RI: Quality Metric Incorporated; 2001.
22. IPAQ Research Committee. 2005 Nov. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ): Short and Long Forms URL: http://www.ipaq.ki.se/scoring.pdf [accessed 2011-10-11] [WebCite Cache ID 62LZ5ZaZC]
23. Wing RR, Crane MM, Thomas JG, Kumar R, Weinberg B. Improving weight loss outcomes of community interventions by incorporating behavioral strategies. Am J Public Health 2010 Dec;100(12):2513-2519. [doi: 10.2105/AJPH.2009.183616] [Medline: 20966375]
24. Tate DF, Wing RR, Winett RA. Using Internet technology to deliver a behavioral weight loss program. JAMA 2001 Mar 7;285(9):1172-1177 [FREE Full text] [Medline: 11231746]
25. Tate DF, Jackvony EH, Wing RR. A randomized trial comparing human e-mail counseling, computer-automated tailored counseling, and no counseling in an Internet weight loss program. Arch Intern Med 2006;166(15):1620-1625 [FREE Full text] [doi: 10.1001/archinte.166.15.1620] [Medline: 16908795]
26. Tate DF, Jackvony EH, Wing RR. Effects of Internet behavioral counseling on weight loss in adults at risk for type 2 diabetes: a randomized trial. JAMA 2003 Apr 9;289(14):1833-1836 [FREE Full text] [doi: 10.1001/jama.289.14.1833] [Medline: 12684363]
27. Rothert K, Strecher VJ, Doyle LA, Caplan WM, Joyce JS, Jimison HB, et al. Web-based weight management programs in an integrated health care setting: a randomized, controlled trial. Obesity (Silver Spring) 2006 Feb;14(2):266-272 [FREE Full text] [doi: 10.1038/oby.2006.34] [Medline: 16571852]
28. Khaylis A, Yiaslas T, Bergstrom J, Gore-Felton C. A review of efficacious technology-based weight-loss interventions: five key components. Telemed J E Health 2010 Nov;16(9):931-938. [doi: 10.1089/tmj.2010.0065] [Medline: 21091286]
29. Bensley RJ, Brusk JJ, Rivas J. Key principles in internet-based weight management systems. Am J Health Behav 2010;34(2):206-213. [Medline: 19814600]

XSL•FO
RenderX

30. Bennett GG, Herring SJ, Puleo E, Stein EK, Emmons KM, Gillman MW. Web-based weight loss in primary care: a randomized controlled trial. Obesity (Silver Spring) 2010 Feb;18(2):308-313 [FREE Full text] [doi: 10.1038/oby.2009.242] [Medline: 19696764]
31. Morgan PJ, Lubans DR, Collins CE, Warren JM, Callister R. 12-month outcomes and process evaluation of the SHED-IT RCT: an internet-based weight loss program targeting men. Obesity (Silver Spring) 2011 Jan;19(1):142-151 [FREE Full text] [doi: 10.1038/oby.2010.119] [Medline: 20523304]
32. Morgan PJ, Lubans DR, Collins CE, Warren JM, Callister R. The SHED-IT randomized controlled trial: evaluation of an Internet-based weight-loss program for men. Obesity (Silver Spring) 2009 Nov;17(11):2025-2032 [FREE Full text] [doi: 10.1038/oby.2009.85] [Medline: 19343018]
33. McConnon A, Kirk SF, Cockroft JE, Harvey EL, Greenwood DC, Thomas JD, et al. The Internet for weight control in an obese sample: results of a randomised controlled trial. BMC Health Serv Res 2007;7:206 [FREE Full text] [doi: 10.1186/1472-6963-7-206] [Medline: 18093289]
34. Polzien KM, Jakicic JM, Tate DF, Otto AD. The efficacy of a technology-based system in a short-term behavioral weight loss intervention. Obesity (Silver Spring) 2007 Apr;15(4):825-830 [FREE Full text] [doi: 10.1038/oby.2007.584] [Medline: 17426316]
35. Webber KH, Tate DF, Michael Bowling J. A randomized comparison of two motivationally enhanced Internet behavioral weight loss programs. Behav Res Ther 2008 Sep;46(9):1090-1095. [doi: 10.1016/j.brat.2008.06.008] [Medline: 18675402]
36. Elfhag K, Rössner S. Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain. Obes Rev 2005 Feb;6(1):67-85. [doi: 10.1111/j.1467-789X.2005.00170.x] [Medline: 15655039]
37. Eysenbach G, CONSORT-EHEALTH Group. CONSORT-EHEALTH: improving and standardizing evaluation reports of Web-based and mobile health interventions. J Med Internet Res 2011;13(4):e126 [FREE Full text] [doi: 10.2196/jmir.1923] [Medline: 22209829]

Abbreviations

BMI: body mass index
HDL: high-density lipoprotein
LDL: low-density lipoprotein
MET: metabolic equivalent
RCT: randomized controlled trial
TFEQ: Three-Factor Eating Questionnaire-R18

Edited by G Eysenbach; submitted 30.10.11; peer-reviewed by S Patolia; comments to author 15.01.12; accepted 06.02.12; published 25.04.12.

Please cite as:
Collins CE, Morgan PJ, Jones P, Fletcher K, Martin J, Aguiar EJ, Lucas A, Neve MJ, Callister R
A 12-Week Commercial Web-Based Weight-Loss Program for Overweight and Obese Adults: Randomized Controlled Trial Comparing Basic Versus Enhanced Features
J Med Internet Res 2012;14(2):e57
URL: http://www.jmir.org/2012/2/e57/
doi:10.2196/jmir.1980
PMID:22555246

©Clare E Collins, Philip J Morgan, Penelope Jones, Kate Fletcher, Julia Martin, Elroy J Aguiar, Ashlee Lucas, Melinda J Neve, Robin Callister. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 25.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Internet-Based Computer Tailored Feedback on Sunscreen Use

Hein de Vries[1], PhD; Matti Logister[2], MSc; Gertruud Krekels[3], MD, PhD, MBA; Frits Klaasse[2], MSc; Verina Servranckx[2], MSc; Liesbeth van Osch[1], PhD

[1]School for Public Health and Primary Care (CAPHRI), Department of Health Promotion, Maastricht University, Maastricht, Netherlands

[2]Maastricht University, Department of Health Promotion, Maastricht University, Maastricht, Netherlands

[3]Catharina Hospital, Dermatology department, Eindhoven, Netherlands

Corresponding Author:
Hein de Vries, PhD
School for Public Health and Primary Care (CAPHRI)
Department of Health Promotion
Maastricht University
P Debyeplein 1
PO Box 616
Maastricht, 6200 MD
Netherlands
Phone: 31 433882415
Fax: 31 433671032
Email: hein.devries@maastrichtuniversity.nl

Abstract

Background: Skin cancer incidence rates signify the need for effective programs for the prevention of skin cancer and for helping skin cancer patients. Internet and computer tailored (CT) technology fosters the development of highly individualized health communication messages. Yet, reactions to Internet CT programs may differ per level of involvement and education level and remain understudied.

Objective: First, we identified perceptions concerning sunscreen use in Dutch adults and assessed differences in differences between the general public and skin cancer patients, and between low and high educated respondents. Second, we assessed program evaluations of these groups about a new Dutch CT Internet-based program promoting sunscreen use, and potential differences between groups

Methods: A cross-sectional research design was used. In total, 387 respondents participated and filled out an online questionnaire based on the I-Change Model assessing socio-demographics, history of skin cancer, sunscreen use, and beliefs about sunscreen use. The responses were fed into a computer program that generated personal tailored feedback on screen; next we assessed their program evaluations

Results: Of the 132 patients, 92 were female (69.7%) and 40 were male (30.3%). In the general population (N = 225), 139 (54.5%) respondents were female and 116 (45.5%) were male. Men (50.9 years) were 8 years older than women (43.1 years). Most patients were diagnosed with basal cell carcinoma (N = 65; 49.2%), followed by melanoma (N = 28; 21.2%) and squamous cell carcinoma (N = 10; 7.6%); 22% (N = 29) did not remember their skin cancer type. Patients had higher knowledge levels, felt significantly more at risk, were more convinced of the pros of sunscreen, experienced more social support to use sunscreen, had higher self-efficacy, and made more plans to use sunscreen than respondents without skin cancer (N=255; all *P*'s< .01). Low (N=196) educated respondents scored lower on knowledge (*P*<.003) but made more action plans (*P*<.03) than higher educated respondents (N=191). The CT feedback was evaluated positively by all respondents, and scored a 7.8 on a 10 point scale. Yet, patients evaluated the CT program slightly more (*P*<.05) positive (8.1) than non-patients. (7.6). Lower educated respondents were significantly (*P*<.05) more positive about the advantages of the program.

Conclusions: First, involvement with skin cancer was reflected in more positive beliefs toward sunscreen use in patients in comparison with non-patients. Second, the CT Internet program was well accepted by both patients and non-patients, and low and high educated respondents, perhaps because higher educated respondents were more knowledgeable about sunscreen use and skin cancer. Third, a pro-active approach as conducted in our study is very well suited to reach various groups of people and is more likely to be successful than a reactive approach

XSL•FO
RenderX

(J Med Internet Res 2012;14(2):e48) doi:10.2196/jmir.1902

KEYWORDS

Health communication, Computer tailoring; Web-based interventions, Internet

Introduction

Background

The Internet offers vast possibilities for health-communication efforts. Online health communication has the potential to reach large audiences, it can be operational at all times, and costs per visitor can remain low [1]. Internet access in the Netherlands has grown substantially from 16% in 1998 to 93% in 2009 [2]. Internet provides the possibility for reaching many people in the Netherlands [3]. Modern interactive techniques via the Internet foster the delivery of highly interactive and individualized interventions to large numbers of people [3].

Computer tailoring — developed even before the Internet period — fosters the development of highly individualized health communication messages that match each person's unique conditions, characteristics, motivational beliefs (such as knowledge, attitudes, and self-efficacy), and intentions to change and behavior [4]. Internet based, computer tailoring has shown to be effective [5,6] because of working mechanisms such as increasing personal relevance, interest, and frequency of message reading [5,7,8]. Assessment of the reactions of respondents to the CT messages is essential in order to understand their effectiveness.

Rapidly rising skin cancer incidence rates signify the need for effective Internet programs that can contribute to the prevention of skin cancer as well as to education for skin cancer patients [9]. Skin cancer will have a large impact on the demand for health, health care costs and the workload for dermatologists [9,10]. Effective Internet skin cancer programs are available [11,12,13,14]. Assessment of the effects of these programs in subgroups is important given the concerns of potential differential impact of the Internet in groups differing in characteristics such as education and levels of involvement, or relevance of the topic. [1,15,16,17]. For instance, it is conceivable that skin cancer patients are more involved in the issue of skin protection and thus may judge an e-Health program differently than the general population. Given the potential impact of the digital divide, it is important to assess whether Internet approaches are less accepted by groups with a lower education, since this may contribute to increasing health disparities between educational groups [15,16,17,18,19]. Furthermore, it is conceivable that prevention programs may be less appealing to those not at risk. Hence, it is relevant to know whether separate programs for skin cancer patients and non-patients may be needed.

Objectives

In the present study, we first assessed program evaluations of a new, Dutch, Internet CT program on skin cancer. We next assessed potential differences in program reactions between respondents with a high- and low-educational level, as well as between patients and non-patients, by assessing perceived advantages and disadvantages pertaining to items such as relevance, completeness, and credibility of the CT messages [8].

Methods

Design and Procedure

A cross-sectional research design was used, and data collection took place in 2009 from May until August. Skin cancer patients were recruited from a patient database from the Catharina hospital in Eindhoven, the Netherlands. Ethical clearance was provided by the Catharina Hospital in Eindhoven. Patients were sent a letter to their home address with an invitation to participate in this e-study on skin cancer prevention. Additionally, recruitment took place via regional weekly newspapers, social networking sites, and members of an Internet panel. All respondents received a link to complete an online questionnaire about skin protective behavior. Their responses were directly fed into a computer program, which immediately generated personal tailored feedback on-screen.

Questionnaire

In order to be able to receive CT advice on sunscreen a questionnaire assessed several constructs.

Personal and predisposing factors were assessed by questions including gender, year of birth, having children (yes/no), marital status (partner/no partner), education level: low (primary school and vocational education) = 1; high (college and university) = 2, income (above average/below average), and skin cancer history (yes/no). Parental and child skin types were assessed by asking participants to indicate whether they: burn very fast, hardly tan (type 1); burn fast, tan slowly (type 2); do not burn fast, tan easily (type 3); rarely burn, tan easily (type 4); hardly ever burn, tan easily (type 5); or, never burn, easily tan (type 6) [24].

Suntanning behavior was measured by three questions. One question measured how often someone goes outside to be in the sun (1 = "never;" 5 = "as often as possible"). The second question measured how long someone was outside on a day off if the sun shone (1 = "never;" 3= "between one and three hours;" 5 = "as long as possible"). The third question measured on what time people are usually exposed to the sun (1 = "never;" 5 = "between 12 P.M. and 3 P.M.").

Skin protective behavior assessed subjective skin protection and objective skin protection. Subjective skin protection was measured by two questions on a 5-point scale asking the participants whether they think they protect themselves properly on the beach or during outdoor activities. (1 = "I always protect myself sufficiently"; 5 = "I never protect myself sufficiently"). Objective skin protection was measured with three questions concerning their suntanning behavior, three questions regarding seeking shadow ("How often are you in the shade between 12 P.M. and 3 P.M.?"), wearing a hat or cap ("How often do you wear a hat or cap on a sunny day?"), and wearing protective

XSL•FO
RenderX

clothing ("How often do you wear protective clothing if the sun shines?"). Respondents could answer these questions on a 5-point scale from 1 ("never") to 5 ("always").

Knowledge about skin protection, and skin protection, was measured with six questions on a three-point scale (1 = "right," 0 = "wrong" or "don't know"). Two example questions are: "To protect yourself sufficiently, it is enough to use sunscreen once per day" and "you cannot burn in the shadow?"

Cues to action were measured by an index of two questions, assessing: how often someone had seen, heard or read something about skin cancer in the media in the past three months; and how often someone had noticed a change on his or her skin of which he or she thought it might be skin cancer. Both questions used a 5-point answering scale (1 = "never," 5 = "very often"). Lastly, one question assessed whether the respondent knows people that have or have had skin cancer (1 = "yes," 2 = "no"). Low reliability on these three questions assessing perceived media messages about skin cancer, perceived skin changes and experience/occurrence of skin cancer in respondents' social network precluded the formation of one scale.

Risk perception was assessed by three questions on a 5-point scale, assessing perceived likelihood, perceived susceptibility, and perceived severity of getting skin cancer. A sum score was made with perceived likelihood and perceived susceptibility (α =.75).

Attitude was assessed by 20 items using 5-point scales (1 = "totally disagree"; 5 = "totally agree"); 10 items assessed the perceived pros of sunscreen use (α =.85) and 10 items assessed the perceived disadvantages of sunscreen use (α = .85).

Social influences were assessed by nine questions using 6-point scales (α = .78) and assessed the norms about sunscreen use of partner, family and friends, as well as their own sunscreen use and support for sunscreen use.

Self-efficacy was assessed by twelve questions using 5-point scales assessing situations in which they may have different levels of confidence regarding the use of sunscreen (α = .75).

Action plans were measured with nine statements using a 5-point scale to assess whether respondents made specific preparation plans for sunscreen use (α = .83). Examples are: "I plan to bring a sunscreen with SPF 50+ to places where I plan to stay in the sun for a long time," "I plan to bring a parasol to, or rent a parasol at, places where I plan to stay in the sun for a long time," and "I plan to buy sufficient protective clothing and/or a hat or cap."

Intention was measured with three questions using a 5-point scale, with answering categories ranging from 1 ("no, certainly not") to 5 ("yes, certainly"). The three questions asked whether respondents intended to use sunscreen on a sunny day, use sunscreen every two hours, and use sunscreen 30 minutes before going outside in the sun (α = .86).

Program evaluation

Sixteen questions were used to evaluate the tailoring program using strategies from previous studies [8] (also see the results section for a list of all questions in the table). Respondents could indicate their evaluation about the advices on a 5-point scale ranging from 1 ("totally disagree") to 5 ("totally agree"). Examples of statements are: "the advices were relevant to me," "the advices stimulated me to improve my behavior," "the advices were confusing," and "I missed information in the advices." Lastly, respondents were asked to give a school grade for all advices ranging from 1 ("very bad") to 10 ("excellent").

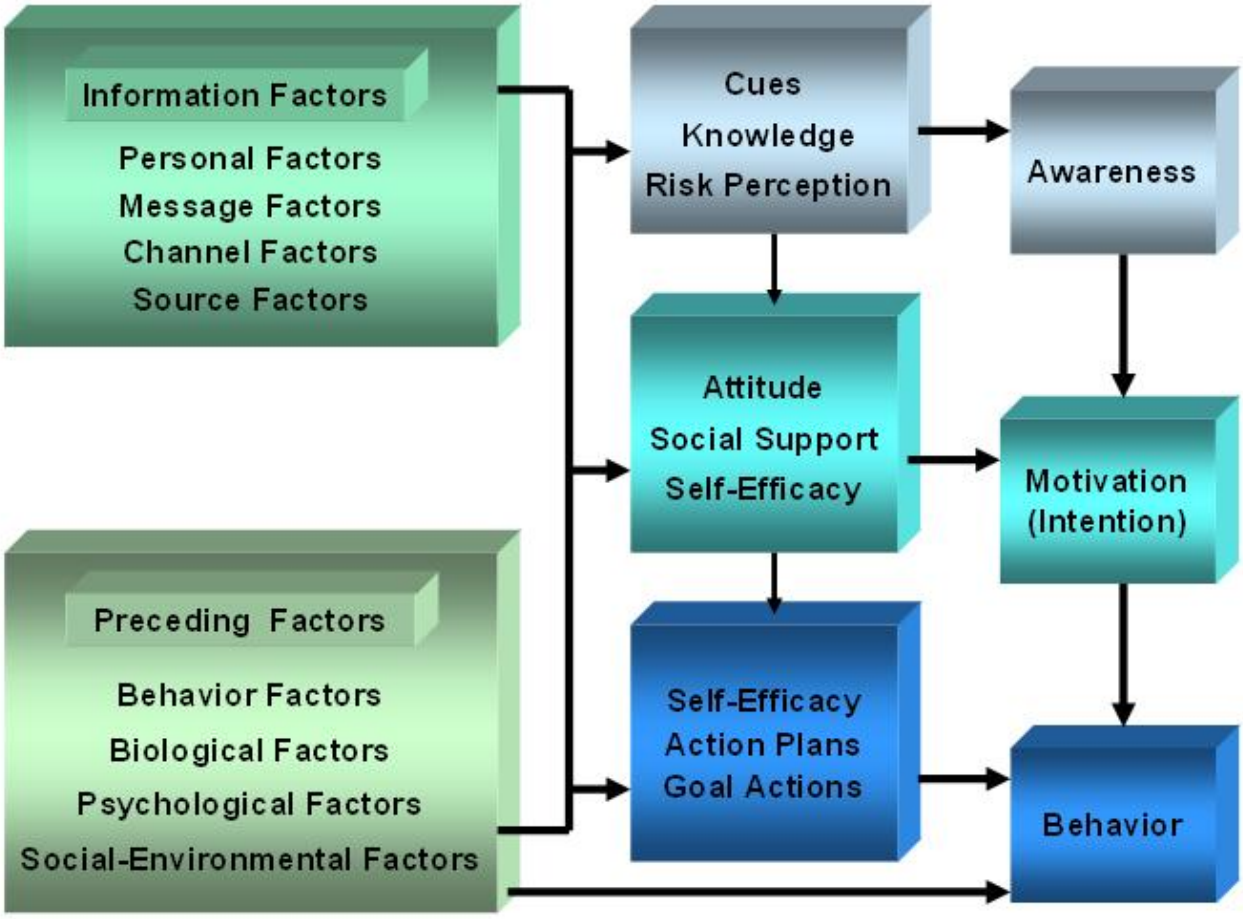
CT program

A first pilot revealed that addressing three behaviors (protective clothing, looking for shade, and sunscreen) would result in too long of a program. This assessment revealed the need to focus on sunscreen use. Next, we assessed the motivational beliefs concerning sunscreen use in the general public and patients and compared the two groups concerning their views regarding sunscreen use. As well, we assessed the factors associated with sunscreen use in both groups using a comprehensive social cognitive model, the I-Change Model [8], postulating that behavior (i.e. sunscreen use) is influenced by action factors (action plans), motivational factors (attitudes, social influence beliefs, self-efficacy), and awareness factors (knowledge, risk perceptions and cues to action) (see Figure 1). The assessment is needed to identify the most important educational needs for program development [20,21].

The new CT program was based on the I-Change model to identify the most important factors to address, and previously conducted strategies and studies on other behaviors that yielded the format that could be used to develop the program [8,25]: such as the utilization of ipsative feedback (Dijkstra & De Vries, 1999), which items to address (van Osch et al.,), and how to use action plans (De Vries et al., 2006;2008; Van Osch et al., 2010). The program provided feedback on the following constructs: sun exposure, sunscreen behavior, type of skin, risk perception, attitudes, social support, self-efficacy, intention and action plans (see Figure 2). A first version was developed and piloted among 11 persons and patients, including one skin cancer expert in order to identify various barriers, such as inconsistencies, unnecessary jargon, and difficult framing. The results were used to improve the final CT program that was used in this study. Results from the pilot as well as from the sample showed that completing the final tailoring program took between 15–25 minutes, including time to read the advices. The time needed did not differ significantly between low- and highly-educated respondents. The process of the CT is summarized in Figure 2, and examples of the CT advices are provided in Table 1.

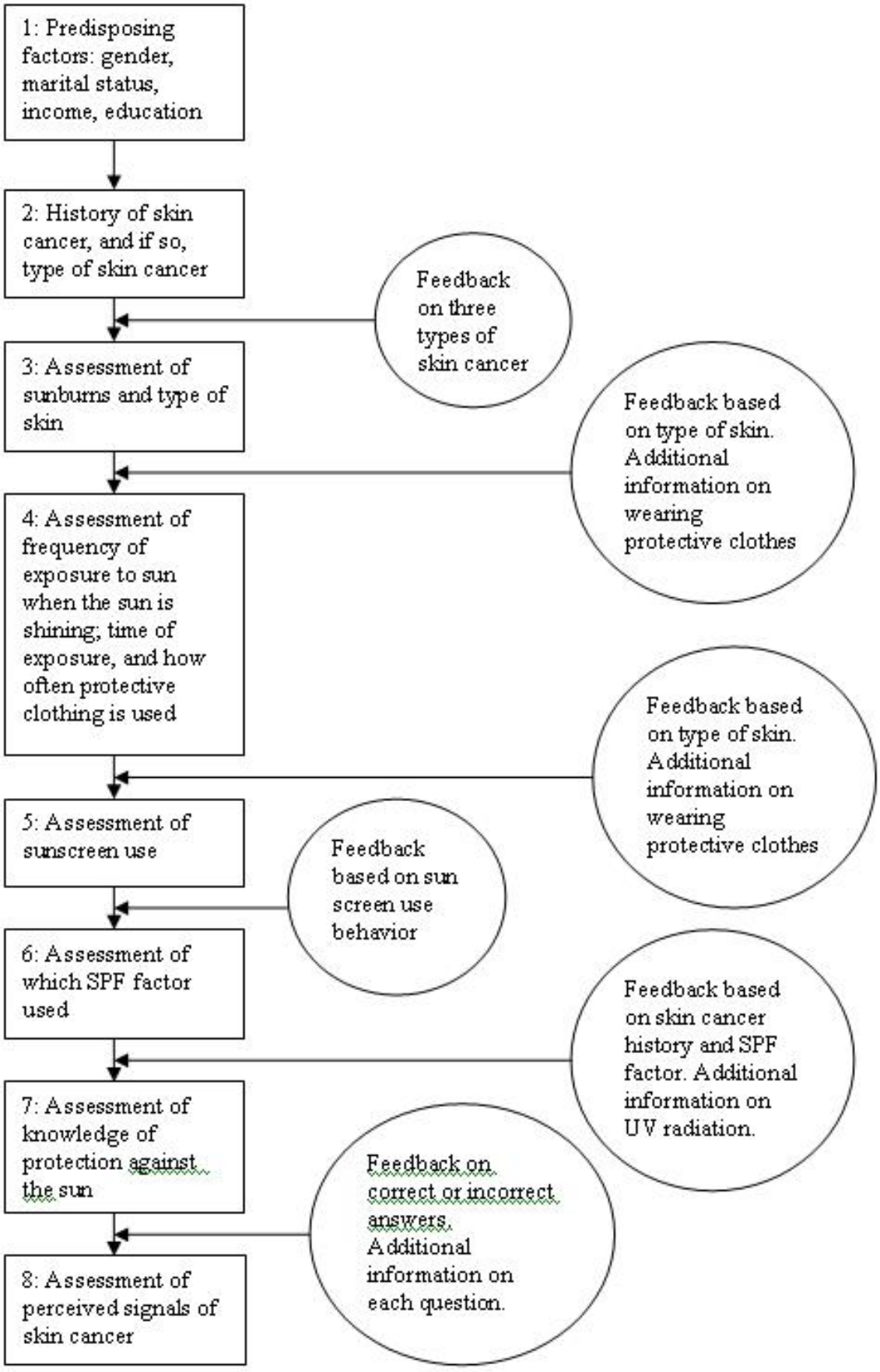
XSL•FO
RenderX

Figure 1. The I-Change Model [8,22].



XSL•FO
RenderX

Figure 2. Overview of the CT program.



XSL•FO
RenderX

Table 1. Examples of feedback messages

Type of skin feedback	"Your answers show that you are not often in the shade between 12 p.m. and 3p.m., and/or that you do not often wear a cap to protect yourself against the sun. As your doctor may have told you, people with a type 1 skin have the largest risk of getting sunburn. Burning of the skin can lead to getting skin cancer (again). Therefore it is important with your light skin type and skin cancer diagnosis to protect yourself very well against the sun."
Sunscreen use feedback	"You mentioned that you use sunblock with protection factor 4. This factor (SPF) indicates the protection against UVB-radiation (sunburn). It is also important to know that SPF is universal. Two products with the same SPF (from whatever brand) will offer the same protection. You mentioned before that you have skin type 1, which means that you use a sunblock with an *insufficiently* protection factor**.** Did you know that there are sunblocks that protect you against UVB-radiation as well as UVA-radiation (aging of the skin)? You can see this on the special logo on the label: A circle with the letters UVA in it."
Attitude feedback	"Your answers show that you see few advantages of protecting your skin. Perhaps you may not know all these advantage. Studies show that if you use proper protection you burn less quickly, and you lower the chance of getting skin cancer. You also lower the chance of getting skin cancer back, in case you have had skin cancer in the past. Furthermore, it slows down the aging of your skin. You will therefore stay young looking for longer, which many people find pleasant."
Social Support feedback	"Your answers show that you do not receive any social support from your family, because of their opinion and behavior. That is unfortunate, because when people feel supported, it is easier for them to perform a certain behavior. Perhaps you can discuss this topic with your family, so that they can see the benefits of responsible tanning."
Self-efficacy feedback	"Your answers show that you find it rather difficult to protect yourself when outside. This is understandable, and you are definitely not the only one! It is not always easy to protect yourself as well as possible in various situations. There will always be situations in which it can be difficult to protect yourself. You can prepare yourself for these difficult situations. Some people think about such situations and then come up with a plan to determine how they can protect themselves in these situations. This helps them, and possibly you too? It never hurts to try! Good luck!"
Intention feedback	"You mention that you do not plan on applying sunscreen on a sunny day. Perhaps you find the use of sunblock awkward or uncomfortable? Did you know that there are currently sunscreens on the market that are not sticky? If you really do not want to use sunblock, you can also use different ways of protection, like staying in the shade as much as possible, or wearing protective clothing and a cap. Perhaps you were already planning on this?"

Statistical analyses

Descriptive statistics were calculated to identify the characteristics of the respondents. T-tests, binomial tests, and chi-squared tests were performed to analyze the demographical differences between the patients and the general population. Analysis of variance (ANOVA) was used to determine the differences between the general population and the skin cancer patients in the program evaluation, and for assessing differences between respondents with a low- and high-level of education. Logistic regression was used to investigate possible confounders for education level and skin cancer history. Linear regression analysis was used to assess the determinants of sunscreen use. All analyses were performed with SPSS 15.0 for Windows. Significant differences are reported when $P < 0.05$.

Results

Characteristics of the Sample

After excluding respondents with missing values (>10%), a sample of 387 respondents remained. This sample contained significantly less men (N = 156; 40.3%) than women (N = 231; 59.7%; x^2= 14.535; df = 1; $P < 0.001$). The characteristics of the overall sample and the subgroups are depicted in Table 2.

XSL•FO
RenderX

Table 2. Demographic characteristics of the overall sample, skin cancer patients, general population, and education levels.

		Total group (N=387)	Low education (N=196)	High education (N=191)	Skin cancer history (N=132)	No skin cancer history (N=255)
Gender	Male	156 (40.3)[c]	83 (42.3)[a]	73 (38.2)[c]	40 (30.3) [c]	116 (45.5)
	Female	231 (59.7)	113 (57.7)	118 (61.8)	92 (69.7)	139 (54.5)
Marital status	No partner	70 (18.1)[c]	29 (14.8)[c]	41 (21.5)[c]	16 (12.1)[c]	54 (21.2)[c]
	Partner	317 (81.9)	167 (85.2)	150 (78.5)	116 (87.9)	201 (78.8)
Children	Yes	256 (68.5)[c]	157 (80.1)[c]	108 (56.5)	105 (79.5)[c]	160 (62.7)[c]
	No	122 (31.5)	39 (19.9)	83 (43.5)	27 (20.5)	95 (37.3)
Skin cancer history	Yes	132 (34.1)[c]	62 (31.6)[c]	70 (36.6)[c]	-	-
	No	255 (65.9)	134 (68.4)	121 (63.4)	-	-
Income	Don't know	64 (16.5)[c]	36 (18.4)	28 (14.7)[c]	24 (18.2)[c]	40 (15.7)[c]
	< Avg.	86 (22.2)	51 (26.0)	35 (18.3)	21 (15.9)	65 (25.5)
	Avg.	84 (21.7)	47 (24.0)	37 (19.4)	30 (22.7)	54 (21.2)
	> Avg.	153 (39.5)	62 (31.6)	91 (47.6)	57 (43.2)	96 (37.6)
Age		46.2	49.2	43.2	46.3	46.2

[a] Significant at the .05 level

[b] Significant at the .01 level;

[c] Significant at the .001 level

Table 2 also shows that for the group of (former) patients 92 of the respondents were female (69.7%) and 40 were male (30.3%). In the general population 139 (54.5%) respondents were female and 116 (45.5%) respondents were male. Men were on average almost 8 years older than women (50.9 years for men; 43.1 years for women. In the group of (former) patients, most respondents were diagnosed with basal cell carcinoma (N = 65; 49.2%), followed by melanoma (N = 28; 21.2%), and squamous cell carcinoma (N = 10; 7.6%). Twenty-two percent of the respondents (N = 29) did not remember which form of skin cancer they had. Of the total sample, 196 respondents (51%) reported to have a low education.

Program evaluation

Table 3 shows the overall program evaluation. Concerning the potential advantages of the program, the respondents indicated they find the program informative, complete, personally relevant, that the feedback was well-readable, contributing them to help them to improve their sunscreen behavior, providing nicely arranged information, credible, and that the feedback matched with the answers that they had given. We furthermore assessed potential drawbacks of the program, which were also acknowledged by the respondents, although to a lesser extent than the positive outcomes. Yet, the respondents felt that sometimes the information load was slightly too much and too long, and that information was missing and confusing. Overall, the ratings by all respondents were quite positive, resulting in a 7.78.

XSL•FO
RenderX

Table 3. Program evaluation based on education.

	Overall sample N=387	Low education N=196	High education N=191	Sig.[a]
Advantages[b]				
Informative	4.19	4.37	4.02	<.001
Complete	4.12	4.26	3.97	<.001
Personally relevant	4.11	4.25	3.97	.001
Well-readable and proper lay-out	4.16	4.25	4.06	.010
Stimulated to improve sunscreen use behavior	3.81	3.93	3.69	.011
Nicely arranged	4.30	4.39	4.22	.013
Helped to improve sunscreen use behavior	3.75	3.86	3.63	.015
Credible	4.36	4.43	4.29	.026
I agree with the advices	4.03	4.12	3.95	.051
Matched my given answers	3.74	3.80	3.69	.245
Disadvantages [b]				
Too much information was given	2.22	2.11	2.35	.036
Too long	2.36	2.27	2.46	.155
Information was missing	2.36	2.30	2.42	.174
Confusing	2.01	2.01	2.00	.849
Grade (1-10)	7.78	7.98	7.58	.001

[a] Covariate: age

[b] 1= totally disagree; 5= totally agree

Differences in Program Evaluation by Low- and High-Educated Respondents

Table 4 depicts the differences between respondents with a low- and high-level of education. Since the two groups differed in their age, we corrected these scores for age. When comparing the two educational groups, Table 2 reveals that respondents with a low education level were significantly more positive about the CT advice than respondents with a high-level of education, resulting in overall scores of 7.98 and 7.58 respectively. Respondents with a low education level were also more positive on most of the advantages of the CT feedback, implying that they found the program more relevant, credible, nicely arranged, informative, well-readable, and complete than those with a higher education. Furthermore, lower educated respondents were more convinced than their higher educated peers that the CT feedback stimulated them to improve their sunscreen behavior. Concerning the disadvantages respondents with a high education level provided, they believed significantly more so, than those with a low education level, that the feedback provided too much information.

Program Evaluation by the General Public and Skin Cancer Patients

The results of the evaluation of the CT advice by the general public and skin cancer patients are presented in Table 4. Since patients and the general public differed concerning their type of skin and frequency of sun exposure, we corrected the process evaluations for these differences.

XSL•FO
RenderX

Table 4. Program evaluation based on skin cancer history.

	Overall sample N=387	Patients N=132	General Population N=255	Sig.[a]
Advantages[b]				
Personally relevant	4.11	4.37	3.98	<.001
I agree with the advices	4.03	4.23	3.93	.001
Credible	4.36	4.49	4.29	.004
Stimulated to improve sunscreen use behavior	3.81	3.99	3.72	.008
Well-readable and proper lay-out	4.16	4.29	4.09	.016
Helped to improve sunscreen use behavior	3.75	3.90	3.67	.027
Nicely arranged	4.30	4.40	4.26	.060
Matched my given answers	3.74	3.85	3.69	.101
Complete	4.12	4.18	4.08	.261
Informative	4.19	4.22	4.18	.676
Disadvantages[b]				
Too long	2.37	2.03	2.53	<.001
Too much information was given	2.22	1.90	2.39	<.001
Confusing	2.01	1.79	2.12	.001
Information was missing	2.36	2.26	2.41	.258
Grade (1-10)	7.78	8.11	7.61	<.001

[a] Covariates: skin type and frequency in the sun

[b] 1= totally disagree; 5= totally agree

Table 4 shows that respondents with a history of skin cancer were significantly more positive about the CT feedback advice than those without a skin cancer history about the advice they received for every single question, with overall scores of respectively 8.11 and 7.61. Patients significantly evaluated the advice more positively than those from the general population for about 9 of the 15 evaluation items. Both groups found the advice equal in terms of being informative, complete, that the advice matched the given answers, and that the advice was nicely arranged.

Discussion

Our results reveal that the CT feedback was evaluated positively by all respondents, and evaluated the sunscreen CT feedback as relevant, credible, nicely arranged, instructive, complete, felt that the advices matched their answers, helpful, and that the advices stimulated them to improve sunscreen use. The overall score on a scale from 1 (“very bad”) to 10 (“excellent”) was 7.8 indicating a positive evaluation despite these comments made. Suggestions concerning improvements pertained to the fact that sometimes information could be more elaborate; but also that the advices were quite long, and sometimes confusing. In-depth process evaluations are therefore needed to find out which particular program components needed to be improved; and also how to deal with the conflict of adding information on the one hand, and to shorten overall message length on the other [12]. The positive evaluation results are congruent with those reported earlier concerning other health behaviors [8,31,32]. One potential reason for these positive findings may be that program development was based on a combination of approaches implying the utilization of a broad, social cognitive model and principles of communication theories [33,34] and social marketing principles [35], implying that messages were developed and piloted in the target group. Hence, as has been noted before, it is important to acknowledge that besides these positive evaluations, computer technology-based interventions have many advantages when compared to human-delivered interventions. These include lower cost to deliver, greater intervention fidelity, and greater flexibility in dissemination channels, which might include in person (for example, clinic setting), mail, Internet, cell phones, or other delivery channels [36]. CT online interventions utilize a great variety of options for assessing individuals, creating and delivering customized health messages, equipping individuals with the tools necessary to maintain or change their behaviors, and keeping them engaged in their own self-care [5]. Our results support that this strategy is appreciated.

An encouraging finding was that fact that, in contrast to our expectations, respondents of a low level of education evaluated the CT feedback more positively than those with a high level of education, although the latter group was also positive in their evaluation. We would not have been surprised to have seen an opposite result, because the CT feedback implied quite some reading—given the concerns expressed by others concerning Internet use by lower educated groups [15,16,17,35,36]. Yet, the pilots of the program were aimed to identify passages that

XSL•FO
RenderX

were difficult and unattractive to read, certainly for respondents with a low level of education. Hence, our results of the program evaluation suggest that this goal has been attained. In our other programs about smoking cessation, physical activity, and nutrition, we also did not find differences in evaluation between the educational groups [8,31]. This suggests that CT feedback can be a very attractive and effective way to reach both low- and high-education level groups.

Patients evaluated the CT feedback slightly, but, significantly, more positively than respondents with no history, who were also very positive concerning the program evaluation. The more positive finding is most likely due to the fact that the topic is more salient to them because of their history of skin cancer. Although they may have received already more information about skin cancer and sunscreen use, they evaluated the feedback very positively. Our findings do not suggest that two separate programs for patients and non-patients are needed.

Limitations

Our results need to be interpreted with a certain level of caution. First, it is not clear why the low education level group evaluated the program more positively. More qualitative research is needed to asses whether this occurred because the program provided more new information for this group and whether the language used was more adapted to this group. Yet, we did not receive complaints from the high education level group concerning too simply formulated messages. Second, it is difficult to assess how representative the online sample is for the total populations. We also had a relatively large group of highly educated respondents. Yet, our main purpose was not to obtain a representative sample, but to compare the differences in evaluation between high- and low-educated groups. Third, suggestions to shorten the messages were made by all subgroups. These suggestions are relevant to take into account, also within a context that revisits of Internet based programs have found to be quite low, also resulting in high drop-out rates in research studies up to 50% or sometimes higher [37]. A challenge will be to find an optimal balance between length and the provision of essential feedback. Fourth, Internet based methods can use a large variety of behavior change techniques and exposure-promoting elements. In order to enhance exposure, peer and counselor support may result in a longer website visit and that email/phone contact and updates of the website result in more log-ins [3,38]. Recent notions about infodemiology describe important factors related with the distribution and determinants of information in an electronic medium, such as analyzing how people search, navigate, and share information that also yield important insights into health-related behavior [40]. Hence, it is recommended to further extend interventions with these elements. Lastly, an effect evaluation is still needed using a randomized control trial to assess ultimate behavioral effects, as well as analysis may be needed to assess potential differences in program evaluation due to seasonal changes.

Conclusions

The most important lesson learned from this study is that CT programs do not necessarily have to be less attractive for lower educated groups. This is encouraging, since this may imply that Internet based interventions can also reach lower educated groups; provided that these interventions are tailored towards the needs and characteristics of lower educated groups. A second lesson learned was that the results of our program evaluation did not suggest a need for the development of separate programs for patients and non-patients.

Acknowledgments

We thank Annerika Slok for her help with an earlier version of this paper.

Conflicts of Interest

Hein de Vries is also scientific director of Vision2Health Inc, a company with the mission to implement evidence based eHealth programs.

References

1. Van 't Riet J, Crutzen R, De Vries H. Investigating predictors of visiting, using, and revisiting an online health-communication program: a longitudinal study. J Med Internet Res 2010;12(3):e37 [FREE Full text] [doi: 10.2196/jmir.1345] [Medline: 20813716]
2. Centraal Bureau voor de Statistiek. 2011 Jul. De digitale economie URL: http://www.cbs.nl/NR/rdonlyres/E87BCAE8-8F0E-4F43-90FE-B44F3D513E8A/0/2009p34pub.pdf [accessed 2011-07-05] [WebCite Cache ID 5zwjpZEjj]
3. Brouwer W, Kroeze W, Crutzen R, de Nooijer J, de Vries NK, Brug J, et al. Which intervention characteristics are related to more exposure to internet-delivered healthy lifestyle promotion interventions? A systematic review. J Med Internet Res 2011;13(1):2 [FREE Full text] [doi: 10.2196/jmir.1639] [Medline: 21212045]
4. de Vries H, Brug J. Computer-tailored interventions motivating people to adopt health promoting behaviours: introduction to a new approach. Patient Educ Couns 1999 Feb;36(2):99-105. [Medline: 10223015]
5. Lustria ML, Cortese J, Noar SM, Glueckauf RL. Computer-tailored health interventions delivered over the Web: review and analysis of key components. Patient Educ Couns 2009 Feb;74(2):156-173. [doi: 10.1016/j.pec.2008.08.023] [Medline: 18947966]

XSL•FO
RenderX

6. Oenema A, Brug J, Dijkstra A, de Weerdt I, de Vries H. Efficacy and use of an internet-delivered computer-tailored lifestyle intervention, targeting saturated fat intake, physical activity and smoking cessation: a randomized controlled trial. Ann Behav Med 2008 Apr;35(2):125-135. [doi: 10.1007/s12160-008-9023-1] [Medline: 18363076]
7. Dijkstra A. Working mechanisms of computer-tailored health education: evidence from smoking cessation. Health Educ Res 2005 Oct;20(5):527-539 [FREE Full text] [doi: 10.1093/her/cyh014] [Medline: 15701665]
8. de Vries H, Kremers SP, Smeets T, Brug J, Eijmael K. The effectiveness of tailored feedback and action plans in an intervention addressing multiple health behaviors. Am J Health Promot 2008;22(6):417-425. [doi: 10.4278/ajhp.22.6.417] [Medline: 18677882]
9. de Vries E, Coebergh JW, van der Rhee H. [Trends, causes, approach and consequences related to the skin-cancer epidemic in the Netherlands and Europe]. Ned Tijdschr Geneeskd 2006 May 20;150(20):1108-1115. [Medline: 16756222]
10. van der Geer S, Reijers HA, van Tuijl HF, de Vries H, Krekels GA. Need for a new skin cancer management strategy. Arch Dermatol 2010 Mar;146(3):332-336. [doi: 10.1001/archdermatol.2010.1] [Medline: 20231509]
11. Prochaska JO, Velicer WF, Redding C, Rossi JS, Goldstein M, DePue J, et al. Stage-based expert systems to guide a population of primary care patients to quit smoking, eat healthier, prevent skin cancer, and receive regular mammograms. Prev Med 2005 Aug;41(2):406-416. [doi: 10.1016/j.ypmed.2004.09.050] [Medline: 15896835]
12. Glanz K, Schoenfeld ER, Steffen A. A randomized trial of tailored skin cancer prevention messages for adults: Project SCAPE. Am J Public Health 2010 Apr;100(4):735-741. [doi: 10.2105/AJPH.2008.155705] [Medline: 20167900]
13. Lewis E, Mayer JA, Slymen D, Belch G, Engelberg M, Walker K, et al. Disseminating a sun safety program to zoological parks: the effects of tailoring. Health Psychol 2005 Sep;24(5):456-462. [doi: 10.1037/0278-6133.24.5.456] [Medline: 16162039]
14. Bernhardt JM. Tailoring Messages and Design in a Web-Based Skin Cancer Prevention Intervention. The International Electronic Journal of Health Education 2001;4:290-297 [FREE Full text]
15. Wang JY, Bennett K, Probst J. Subdividing the digital divide: differences in internet access and use among rural residents with medical limitations. J Med Internet Res 2011;13(1):e25 [FREE Full text] [doi: 10.2196/jmir.1534] [Medline: 21371989]
16. Chinn MD, Fairlie RW. The determinants of the global digital divide: a cross-country analysis of computer and internet penetration. Oxford Economic Papers 2006;59(1):16-44 [FREE Full text]
17. Sarkar U, Karter AJ, Liu JY, Adler NE, Nguyen R, López A, et al. Social disparities in internet patient portal use in diabetes: evidence that the digital divide extends beyond access. J Am Med Inform Assoc 2011 May 1;18(3):318-321. [doi: 10.1136/jamia.2010.006015] [Medline: 21262921]
18. Wagner TH, Bundorf MK, Singer SJ, Baker LC. Free internet access, the digital divide, and health information. Med Care 2005 Apr;43(4):415-420. [Medline: 15778645]
19. Birru MS, Monaco VM, Charles L, Drew H, Njie V, Bierria T, et al. Internet usage by low-literacy adults seeking health information: an observational analysis. J Med Internet Res 2004 Sep 3;6(3):e25 [FREE Full text] [doi: 10.2196/jmir.6.3.e25] [Medline: 15471751]
20. Sarkar U, Karter AJ, Liu JY, Adler NE, Nguyen R, López A, et al. Social disparities in internet patient portal use in diabetes: evidence that the digital divide extends beyond access. J Am Med Inform Assoc 2011 May 1;18(3):318-321. [doi: 10.1136/jamia.2010.006015] [Medline: 21262921]
21. Bartholomew LK, Parcel GS, Kok G. Intervention mapping: a process for developing theory- and evidence-based health education programs. Health Educ Behav 1998 Oct;25(5):545-563. [Medline: 9768376]
22. de Vries H, Mudde A, Leijs I, Charlton A, Vartiainen E, Buijs G, et al. The European Smoking Prevention Framework Approach (EFSA): an example of integral prevention. Health Educ Res 2003 Oct;18(5):611-626 [FREE Full text] [Medline: 14572020]
23. van Osch L, Beenackers M, Reubsaet A, Lechner L, Candel M, de Vries H. Action planning as predictor of health protective and health risk behavior: an investigation of fruit and snack consumption. Int J Behav Nutr Phys Act 2009;69(6) [FREE Full text] [doi: 10.1186/1479-5868-6-69] [Medline: 19825172]
24. Fitzpatrick TB. Soleil et peau. J Med Esthet 1975;2.
25. Dijkstra A, De Vries H. The development of computer-generated tailored interventions. Patient Educ Couns 1999 Feb;36(2):193-203. [Medline: 10223023]
26. Jones F, Abraham C, Harris P, Schulz J, Chrispin C. From knowledge to action regulation: Modeling the cognitive prerequisites of sun screen use in Australian and UK samples. Psychology & Health 2001;16(2):191. [doi: 10.1080/08870440108405499]
27. Turner LR, Mermelstein RJ. Psychosocial characteristics associated with sun protection practices among parents of young children. J Behav Med 2005 Feb;28(1):77-90. [Medline: 15887878]
28. Scherer CW, Cho H. A social network contagion theory of risk perception. Risk Anal 2003 Apr;23(2):261-267. [Medline: 12731811]
29. Van Osch L, Reubsaet A, Lechner L, Candel M, Mercken L, de Vries H. Predicting parental sunscreen use: Disentangling the role of action planning in the intention-behavior relationship. Psychology & Health 2008;23(7):829. [doi: 10.1080/08870440701596577]

XSL•FO
RenderX

30. Armitage CJ, Conner M. Efficacy of the Theory of Planned Behaviour: a meta-analytic review. Br J Soc Psychol 2001 Dec;40(Pt 4):471-499. [Medline: 11795063]
31. Te Poel F, Bolman C, Reubsaet A, de Vries H. Efficacy of a single computer-tailored e-mail for smoking cessation: results after 6 months. Health Educ Res 2009 Dec;24(6):930-940 [FREE Full text] [doi: 10.1093/her/cyp036] [Medline: 19574405]
32. van Stralen MM, de Vries H, Mudde AN, Bolman C, Lechner L. The working mechanisms of an environmentally tailored physical activity intervention for older adults: a randomized controlled trial. Int J Behav Nutr Phys Act 2009;6:83 [FREE Full text] [doi: 10.1186/1479-5868-6-83] [Medline: 19995412]
33. McGuire WJ. Public communication as a strategy for inducing health-promoting behavioral change. Prev Med 1984 May;13(3):299-319. [Medline: 6387698]
34. De Vries H, Van Dillen S. I-PLAN: Planning the prevention of lyme disease, a health promotion approach. In: Nitch PV, editor. Research on Lyme Disease. New York: Novinka Books; 2007:97-122.
35. Hastings G, McDermott L. Putting social marketing into practice. BMJ 2006 May 20;332(7551):1210-1212. [doi: 10.1136/bmj.332.7551.1210] [Medline: 16710004]
36. Noar SM, Black HG, Pierce LB. Efficacy of computer technology-based HIV prevention interventions: a meta-analysis. AIDS 2009 Jan 2;23(1):107-115. [doi: 10.1097/QAD.0b013e32831c5500] [Medline: 19050392]
37. Eysenbach G. The law of attrition. J Med Internet Res 2005;7(1):e11 [FREE Full text] [doi: 10.2196/jmir.7.1.e11] [Medline: 15829473]
38. Armstrong AW, Watson AJ, Makredes M, Frangos JE, Kimball AB, Kvedar JC. Text-message reminders to improve sunscreen use: a randomized, controlled trial using electronic monitoring. Arch Dermatol 2009 Nov;145(11):1230-1236. [doi: 10.1001/archdermatol.2009.269] [Medline: 19917951]
39. Janssen E, van Osch L, de Vries H, Lechner L. Measuring risk perceptions of skin cancer: reliability and validity of different operationalizations. Br J Health Psychol 2011 Feb;16(Pt 1):92-112. [doi: 10.1348/135910710X514120] [Medline: 21226786]
40. Eysenbach G. Infodemiology and infoveillance: framework for an emerging set of public health informatics methods to analyze search, communication and publication behavior on the Internet. J Med Internet Res 2009;11(1):e11 [FREE Full text] [doi: 10.2196/jmir.1157] [Medline: 19329408]

Edited by G Eysenbach; submitted 04.08.11; peer-reviewed by B Eapen, YM Schoenberger; comments to author 19.10.11; revised version received 20.01.12; accepted 20.01.12; published 30.04.12.

Please cite as:
de Vries H, Logister M, Krekels G, Klaasse F, Servranckx V, van Osch L
Internet-Based Computer Tailored Feedback on Sunscreen Use
J Med Internet Res 2012;14(2):e48
URL: http://www.jmir.org/2012/2/e48/
doi:10.2196/jmir.1902
PMID:22547528

©Hein de Vries, Matti Logister, Gertruud Krekels, Frits Klaasse, Verina Servranckx, Liesbeth van Osch. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 30.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Novel Technologies for Assessing Dietary Intake: Evaluating the Usability of a Mobile Telephone Food Record Among Adults and Adolescents

Bethany L Daugherty[1], RD, MS; TusaRebecca E Schap[1], RD, MSc; Reynolette Ettienne-Gittens[2], RD, MS, PhD; Fengqing M Zhu[3], MS, PhD; Marc Bosch[3], MS; Edward J Delp[3], PhD; David S Ebert[3], PhD; Deborah A Kerr[4], PhD; Carol J Boushey[1,2], RD, MPH, PhD

[1]Department of Nutrition, Purdue University, West Lafayette, IN, United States

[2]Epidemiology Program, University of Hawaii Cancer Center, Honolulu, HI, United States

[3]School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, United States

[4]School of Public Health, Curtin University, Perth, Australia

Corresponding Author:
Carol J Boushey, RD, MPH, PhD
Epidemiology Program
University of Hawaii Cancer Center
1236 Lauhala Street
Honolulu, HI, 96813
United States
Phone: 1 808 564 5915
Fax: 1 808 586 2982
Email: cjboushey@cc.hawaii.edu

Abstract

Background: The development of a mobile telephone food record has the potential to ameliorate much of the burden associated with current methods of dietary assessment. When using the mobile telephone food record, respondents capture an image of their foods and beverages before and after eating. Methods of image analysis and volume estimation allow for automatic identification and volume estimation of foods. To obtain a suitable image, all foods and beverages and a fiducial marker must be included in the image.

Objective: To evaluate a defined set of skills among adolescents and adults when using the mobile telephone food record to capture images and to compare the perceptions and preferences between adults and adolescents regarding their use of the mobile telephone food record.

Methods: We recruited 135 volunteers (78 adolescents, 57 adults) to use the mobile telephone food record for one or two meals under controlled conditions. Volunteers received instruction for using the mobile telephone food record prior to their first meal, captured images of foods and beverages before and after eating, and participated in a feedback session. We used chi-square for comparisons of the set of skills, preferences, and perceptions between the adults and adolescents, and McNemar test for comparisons within the adolescents and adults.

Results: Adults were more likely than adolescents to include all foods and beverages in the before and after images, but both age groups had difficulty including the entire fiducial marker. Compared with adolescents, significantly more adults had to capture more than one image before (38% vs 58%, $P = .03$) and after (25% vs 50%, $P = .008$) meal session 1 to obtain a suitable image. Despite being less efficient when using the mobile telephone food record, adults were more likely than adolescents to perceive remembering to capture images as easy ($P < .001$).

Conclusions: A majority of both age groups were able to follow the defined set of skills; however, adults were less efficient when using the mobile telephone food record. Additional interactive training will likely be necessary for all users to provide extra practice in capturing images before entering a free-living situation. These results will inform age-specific development of the mobile telephone food record that may translate to a more accurate method of dietary assessment.

(J Med Internet Res 2012;14(2):e58) doi:10.2196/jmir.1967

XSL•FO
RenderX

KEYWORDS

Mobile telephone food record; dietary assessment; technology; image analysis; volume estimation

Introduction

Dietary intake is an important environmental exposure to consider when evaluating an individual's or population's risk for chronic disease. A link between diet and the development of certain cancers, cardiovascular disease, liver disease, and type 2 diabetes has been established. However, scientific evidence linking diet and genetics to these diseases continues to emerge [1]. The development of genome-wide association studies has led to the identification of genetic variations associated with risk for diseases such as type 2 diabetes [2], atherosclerosis [3], and Crohn disease [4]. Diet and genetics may play a shared role in the etiology of or protection from many diseases. Methodological issues with dietary assessment, however, have limited the ability to identify gene–nutrient interactions.

Dietary assessment is difficult due to the increasing complexity of the food supply and day-to-day variability in a person's diet [5]. Traditional self-report methods of dietary assessment, including the 24-hour dietary recall, food record, and food frequency questionnaire [6], rely on the respondent's memory and ability to estimate portion sizes. Both adults and adolescents tend to underreport total energy intake by as much as 30% [7-12]. Developing diet assessment methods that can be incorporated into the lifestyle of adolescents is especially difficult. Adolescents are in a rapid phase of growth requiring increased energy, eat more frequently, and have more unstructured eating events outside of the home [13]. There is much day-to-day variability in the composition and timing of their eating occasions, leading to forgetfulness and lack of compliance in recording their dietary intake [14]. Adolescents also report becoming irritated with their parents reminding them to complete their food records [15]. Adults, on the other hand, follow a more regular routine than adolescents. Senior adults may have more consistent meal times, while working adults may be more influenced by the demands and characteristics of their working environment. However, all adults may encounter occasions where their more structured routines are disrupted by events that make accurate recording via the current assessment methods more difficult. In addition to being burdensome to the respondent, these methods can be expensive and labor intensive for the researcher. The Genes, Environment and Health Initiative of the National Institutes of Health in the United States is attempting to address many of these shortcomings by supporting the development of novel methods to assess diet and of high-throughput methods to assess genetic profiles in individuals and populations [16].

Researchers have been striving to harness the potential of new digital technologies to improve the effectiveness of their work, and researchers in the field of dietary assessment are no different. The past 10 to 15 years has seen steadily increasing usage of mobile communication devices [17]. Significant advances in the capabilities of these devices have coincided with mobile phones achieving the status of an essential communication tool, so that mobile computing devices, such as mobile telephones with cameras known as smart phones, are now poised to realize their potential as a computing device with specific health applications. Personal digital assistants (PDAs) were the first generation of mobile computers used for data collection [18,19]. However, some of the initial studies using PDAs were not promising [20], as earlier PDAs used technology that lacked user-friendly options, and backlit screens made their content difficult to see. As a result of these limitations, early investigators concluded that the technology was a barrier to collecting accurate information.

However, with the rapid advancement in the capabilities of mobile devices, researchers are now pursuing image-based methods as a way of addressing the limitations of traditional dietary assessment methods [21-23]. The use of mobile applications to assist in the monitoring of diabetes, physical activity, and smoking cessation has previously been discussed in the literature [24-26] and has informed the use of these tools for new diet assessment methods. The development of a mobile telephone food record for adults and adolescents for use in a new, image-based dietary assessment method, partially supported by the Genes, Environment and Health Initiative, was the subject of this study.

The design of the mobile telephone food record has been described previously [27]. For all users, the task of recording images of their food should be relatively quick and easy for it to be acceptable. Briefly, participants would use the mobile telephone food record application to capture images of their foods and beverages before and after eating. Methods of image analysis [28,29] are used to automatically identify the food in the image. With the inclusion of a fiducial marker, an object of known dimension and size, the volume of consumption can be estimated. The information from image analysis and volume estimation can be linked to a nutrient database to compute the energy and nutrients consumed, so this method will not have to rely on the respondent's memory and ability to estimate portion sizes. Additionally, real-time data collection eliminates the need for researchers to enter and code food records. Ideally, the ease of use of mobile telephone food record will result in an accurate dietary assessment tool for both adults and adolescents.

There are challenges related to using smart phones in this new dietary assessment method. For example, for adolescents to use the device, school administrators must accept its use on the school campus, as young people are in school most days of the week. Adults are often less facile than adolescents with using new technology. Therefore, the mobile telephone food record design needs to address these concerns.

Evidence-based development is a crucial step in designing the mobile telephone food record for use by both adults and adolescents [30]. The form of evidence-based development of the mobile telephone food record is an interaction design, which is the discipline of defining the characteristics of products that a user can interact with in their everyday and working lives [30]. The mobile telephone food record design process, when

XSL•FO
RenderX

applying interaction design, is an iterative cycle of usability testing in which the user feedback is applied to the next version of the mobile telephone food record, which is tested again [27]. Using this process has allowed the design of the mobile telephone food record to evolve from the perspective of the user or client, resulting in a more positive experience for the user.

The objectives of this study were to evaluate a defined set of user skills for both adults and adolescents—that is, successful image capturing of an eating occasion, while using the mobile telephone food record—and to compare the perceptions and preferences between adults and adolescents regarding their use of the mobile telephone food record. A priori, our hypothesis was that statistically significant differences between adults and adolescents would emerge that would need to be translated into different mobile telephone food record designs to accommodate lifestyles and abilities to use a new technology.

Methods

Study Design and Participant Recruitment

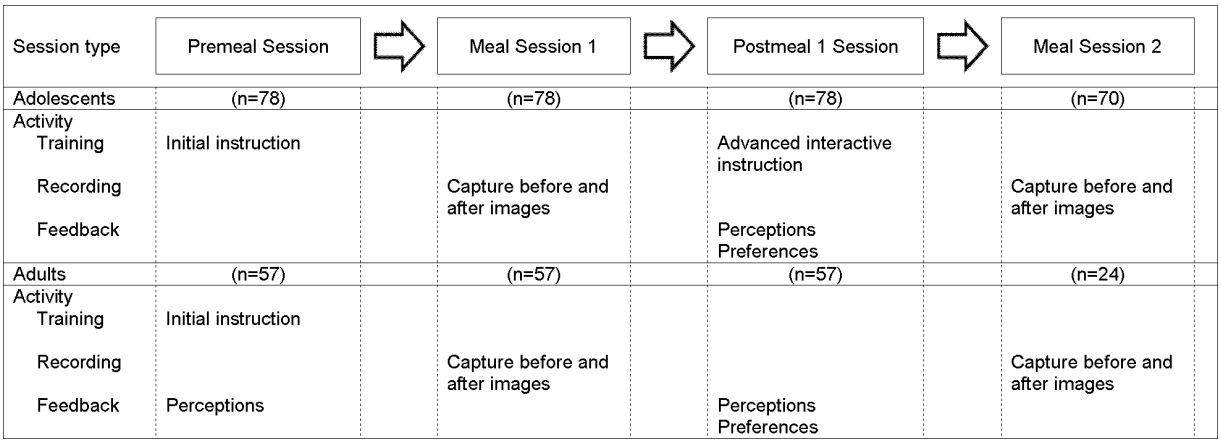
We collected data from two samples of adolescent participants [27] and one sample of adult participants. The data collected from the adolescent samples are combined in this analysis (n = 78). The study methods for all samples were approved by the Purdue University Institutional Review Board. Informed assent and consent were obtained from the adolescent participants and their parents, respectively. The adults completed informed consent prior to participation.

The first adolescent sample was drawn from summer camps for adolescents, ages 11–18 years, taking place on the campus of Purdue University in 2008. A total of 63 participants from these camps used the mobile telephone food record for meal session 1, and 55 (87%) returned for meal session 2 the following day. After using the mobile telephone food record for meal session 1, participants provided feedback and received additional training during the postmeal 1 session. During this session, the participants responded to a series of statements regarding their perceptions of the mobile telephone food record and preferences when using the mobile telephone food record. The advanced interactive instruction included activities in which the participants practiced taking images in potentially problematic snacking scenarios.

The second adolescent sample was a convenience sample drawn from the local community [31]. A total of 15 participants, ages 11–18 years, received all meals and snacks for a 24-hour period while being monitored under controlled conditions. These participants also took part in the feedback and advanced interactive instruction session after using the mobile telephone food record for meal session 1. Data from their first two meal sessions during the 24-hour period are included in this analysis. Figure 1 shows the data collection flow for the two samples of adolescents.

The adult sample was a convenience sample drawn from the campus of Purdue University and the local community during the fall of 2008. A total of 57 participants, ages 21–65 years, used the mobile telephone food record for meal session 1, and 24 (42%) returned for meal session 2 on a subsequent day (Figure 1). During the premeal session, the participants provided feedback regarding their perceptions of the mobile telephone food record, as well as their current use of mobile telephones and digital cameras, by responding to a series of statements and questions. After using the mobile telephone food record in meal session 1, the participants provided additional feedback during the postmeal 1 session, during which they responded to a series of statements regarding their perceptions of the mobile telephone food record and preferences when using the mobile telephone food record.

Figure 1. Study design, activities, and measures of participants using the mobile telephone food record. For 15 of the adolescent participants, meal session 2 was later in the same day. For the remainder of participants, meal session 2 occurred on a different day. Adult participants were offered dessert as a separate course. For meal session 1, 39 selected dessert, and for meal session 2, 15 selected dessert.



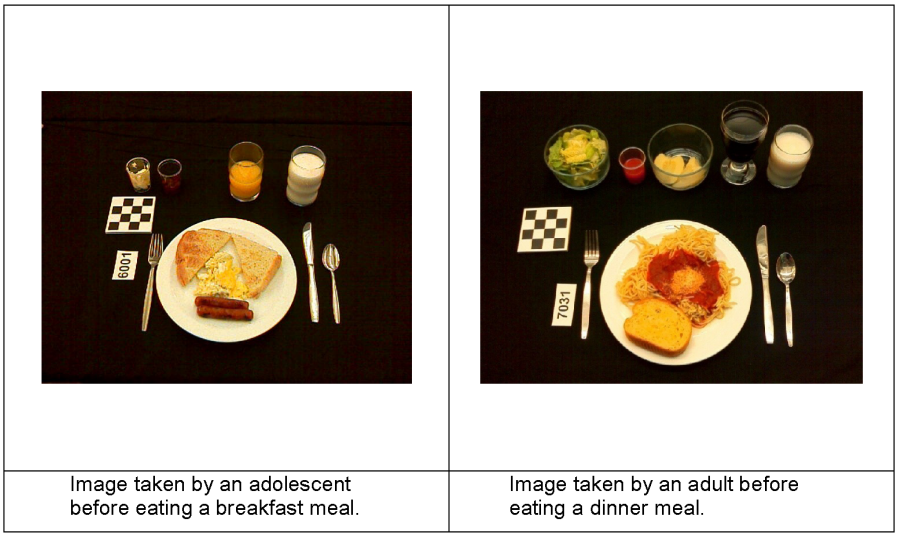
XSL•FO
RenderX

Meal Sessions

The menus served to the adolescents have been described previously [27]. For the adults, one breakfast menu and four dinner menus were cycled between the sessions. Figure 2 shows examples of meals served to adults and adolescents. Participants received instruction for using the mobile telephone food record during the premeal session (Figure 1). Use of the mobile telephone food record involves recording images of a meal before and after eating. Participants were instructed to include two items in each image: (1) all food and beverage, and (2) the entire fiducial marker (Figure 2). A fiducial marker is an object of known dimensions and markings, which serves as a size reference and must be included in the image [27]. The only instruction provided to participants for placement of the fiducial marker was to avoid placing it near beverages to prevent damage to the object. The meal environment was set up to mimic a restaurant dining atmosphere; however, participants were instructed not to mix or share their foods. The participants took an image of their meal prior to eating, saved the image, took an image of their meal after eating, and saved the image. Participants ate to satiation and, if they requested more, were served a second meal. At three of the four adult dinner meals, dessert was offered as a separate course. The process of capturing images was repeated for these desserts and any additional portions served.

We used HTC p4351 mobile telephones (HTC Corporation, Taoyuan, Taiwan) running Windows Mobile 6.0 Professional (2007; Microsoft Corporation, Redmond, WA, USA). The software, described previously [28,29], guided the user to select the meal occasion and capture an image of foods and beverages. After capturing the image, the user was prompted to review the image and was then given a choice to either retake or save the image. Once the user was satisfied with the image, the mobile telephone prompted the user to eat before proceeding to the next screen. At the next screen, the user was prompted to take an image of the place setting regardless of whether foods and beverages remained. The final screen showed the before and after images prior to exiting the program. If questions arose, the participants were assisted during meals by trained nutrition students. These students also recorded the number of image-capturing attempts before and after meals, as well as the number of images taken by each participant before capturing a satisfactory image and whether participants sat or stood to take images. Participants in the first adolescent sample were compensated US $5 per meal. The second adolescent sample participated for a 24-hour period and they were compensated US $85 for their time. Participants in the adult sample were compensated US $5 for the first meal session and US $15 for the second meal session.

Figure 2. Images that demonstrate meeting two skills required for using the mobile telephone food record: included in the image are all foods and beverages and the entire fiducial marker (checkerboard square).



XSL•FO
RenderX

Image Evaluation: Skill Set

To assess the two skills of including all foods and beverages and the entire fiducial marker in the image, the before and after meal images were evaluated for the inclusion of these two required items. When evaluating the inclusion of all foods and beverages, the images were coded as yes if all of the foods and beverages were visible in the image, no if any of the food or beverage was not visible, or software programming error if the image was unavailable due to software malfunction. When evaluating for the inclusion of the entire fiducial marker, the images were coded as yes if the entire fiducial marker was visible in the image, no if a portion of the fiducial marker was cut off, or software programming error. To evaluate the skill of efficiently taking only one image, the number of images taken by each participant before and after meal sessions was coded as one image or greater than one image.

Feedback Session: Perceptions and Preferences

During the feedback sessions, we showed statements regarding possible perceptions of the mobile telephone food record and preferences when using the mobile telephone food record using PowerPoint (Office 2007, PowerPoint 2007; Microsoft Corporation). The participants responded to these statements using a 5-category ordinal response scale (ie, strongly agree, agree, neutral, disagree, and strongly disagree).

We showed the following five statements regarding perceptions to all participants: (1) I think it would be easy to remember to take an image before meals, (2) I think it would be easy to remember to take an image after meals, (3) I think it would be easy to remember to take an image before snacks, (4) I think it would be easy to remember to take an image after snacks, and (5) the software was easy to use.

We showed the following four statements regarding preferences to all participants: (1) I think it would be easy to carry and use a credit card-sized fiducial marker, (2) I think it would be easy to carry and use a USB-sized fiducial marker (to denote size, this was defined to participants as USB flash drive, USB memory stick, USB jump drive, or USB thumb drive), (3) I prefer to stand while taking an image, and (4) I prefer to sit while taking an image.

The adolescents responded to these nine statements at the start of the postmeal 1 session, followed by the advanced interactive instruction. The adolescents' responses were collected with the *e*Instruction Classroom Performance System (*e*Instruction, Cincinnati, OH, USA).

During the premeal session, participants in the adult sample responded to perception statements 1–4. We asked the adults questions to assess their previous experience capturing images with digital cameras and mobile telephones. These were (1) Do you own a digital camera? (2) How often have you taken pictures with a digital camera? and (3) How often have you taken pictures with a mobile telephone?

The response choices for these latter questions were frequently, occasionally, and never or rarely. The adult participants responded to the nine statements above in the postmeal 1 session. The adults recorded their responses on a paper form.

Statistical Analysis

We used data that we collected using the same methods among the adults and the adolescents for statistical comparisons. To further delineate differences by age, we divided the adolescent sample into early and late adolescence: 11–14 years and 15–18 years, respectively. The adult sample was divided into early and middle adulthood: 21–40 years and 41–65 years, respectively. Descriptive analysis included frequencies and percentages. Within both the adolescent and the adult samples, we analyzed differences in age groups and gender using chi-square. McNemar test was used for comparisons of the set of skills for capturing images within the adolescents and within the adults. For those comparisons, each skill (eg, all foods being in image) was classified as yes (demonstrating the skill) or no (not demonstrating the skill). Chi-square was used for comparisons of the skill set between the adults and adolescents; for these comparisons, we grouped no and software programming error together. The 5-category ordinal response scales used by the participants to provide their preferences and perceptions were recoded as agree, neutral, or disagree. We compared perceptions and preferences between adults and adolescents using chi-square. For comparisons with an expected cell count of less than 5, limiting the comparison to agree and disagree eliminated the inadequate cell counts. We used SPSS 17.0 (IBM Corporation, Somers, NY, USA) for all statistical analyses.

Results

A total of 135 participants (78 adolescents, 57 adults) used the mobile telephone food record for meal session 1, and 94 (70 adolescents, 24 adults) returned to use the mobile telephone food record for meal session 2. The descriptive characteristics of both samples are in Table 1. The average meal duration was 14 minutes for adolescents and 20 minutes for adults. The participants were of diverse ethnic backgrounds. Among the adults, 87% (39/45) claimed to own a digital camera and almost half (22/45, 49%) frequently used it to take pictures. All of the adult participants owned a mobile telephone, but only 16% (7/45) frequently took pictures with their mobile telephone.

Software programming errors occurred when saving the image on the mobile telephone food record, making them unavailable for the analysis. These errors resulted in partial loss of images, either a before or an after image; however, no images were available for only one adult participant, leaving 56 adults for this analysis. Changes to the software were made after testing it with the adolescents, which likely accounted for the reduction in programming errors experienced by the adults. Table 2 shows an evaluation of the participants' ability to follow a defined set of skills when capturing images with the mobile telephone food record. The majority of adults (53/56, 95%) were able to include all foods and beverages in both the before and after images for meal session 1, while 96% (23/24) were able to do the same for meal session 2. A statistically significantly lower proportion of adolescents than adults were able to include all foods and beverages in both the before and after images for meal session 1 (P = .008). This proportion improved to being similar to that of the adults for meal session 2, as Table 2 shows.

XSL•FO
RenderX

For both adults and adolescents, inclusion of the fiducial marker in the image was more problematic than inclusion of all of the foods and beverages (Table 2). There were no significant differences between the adolescents and the adults. Among the adult participants self-selecting desserts, the inclusion of all the dessert and the fiducial marker was very high (Table 2). A significantly higher proportion of adults than of adolescents had to capture more than one image before (P = .03) and after (P = .008) meal session 1 to obtain an image suitable for image analysis (Table 3). This was also the case before and after meal session 2 between adults and adolescents, although this difference was not statistically significant. The adolescents significantly improved their efficiency with capturing suitable images from meal session 1 to meal session 2 (P = .04).

Table 4 shows perceptions of the mobile telephone food record and preferences when using the mobile telephone food record. The majority of both age groups (52/57, 91% of adults; 55/78, 71% of adolescents) agreed that the software was easy to use. Although the adults needed to take more images, they still perceived that capturing images with the mobile telephone food record was easy; however, the proportion was not significantly different from that of the adolescents. Compared with adults, adolescents were less likely to agree that it would be easy to take images before and after meals (P < .001).

Adolescents had a stronger preference than adults for the size of the fiducial marker that they would be willing to use (Table 4). The majority of adolescents (55/71, 77%) and adults (52/57, 91%) reported being willing to use a credit card-sized fiducial marker, but adolescents were less likely to prefer a USB-sized fiducial marker (P = .002). Adolescents reported they would prefer to stand while taking images (P < .001) while adults preferred to sit (P = .002) while taking images. For all analyses regarding skills, preferences, and perceptions, there were no significant differences by gender, early adolescence and middle adolescence, or early adulthood and middle adulthood.

Table 1. Characteristics of adults and adolescents testing the usability of the mobile telephone food record.

Characteristic	Adolescents (n = 78), n (%)	Adults (n = 57) n (%)
Gender		
Male	26 (33%)	18 (32%)
Female	52 (67%)	39 (68%)
Age group (years)		
11–14	45 (58%)	NA[a]
15–18	33 (42%)	NA
21–40	NA	27 (47%)
41–65	NA	30 (53%)
Ethnic group		
Asian	1 (1%)	4 (7%)
Hispanic	7 (9%)	0 (0%)
Non-Hispanic white	55 (70%)	45 (79%)
Black/African American	10 (13%)	2 (4%)
Multiple	5 (6%)	6 (11%)

[a] Not applicable.

XSL•FO
RenderX

Table 2. Evaluation of participants' set of skills when capturing images with the mobile telephone food record.

Skill	Adolescents (n = 78)			Adults (n = 56)[a]		
	Yes, n (%)	No, n (%)	Software error[b], n (%)	Yes n (%)	No, n (%)	Software error, n (%)
All foods and beverages included in image						
Meal session 1[c]	61 (78%)	7 (9%)	10 (13%)	53 (95%)	0 (0%)	3 (5%)
Meal session 2	59 (84%)	9 (13%)	2 (3%)	23 (96%)	0 (0%)	1 (4%)
Dessert session 1[d]	NA[e]	NA	NA	39 (100%)	0 (0%)	0 (0%)
Dessert session 2[d]	NA	NA	NA	14 (93%)	0 (0%)	1 (7%)
Entire fiducial marker included in image						
Meal session 1	54 (69%)	14 (18%)	10 (13%)	44 (79%)	9 (16%)	3 (5%)
Meal session 2	53 (76%)	15 (21%)	2 (3%)	18 (75%)	5 (21%)	1 (4%)
Dessert session 1[d]	NA	NA	NA	37 (95%)	2 (5%)	0 (0%)
Dessert session 2[d]	NA	NA	NA	11 (73%)	3 (20%)	1 (7%)

[a] Due to software programming error, n = 56 instead of 57.

[b] Paired images unavailable due to software programming errors.

[c] $P = .008$ using chi-square and comparing adolescents versus adults.

[d] Dessert was served as a separate course for adult participants. For meal session 1, 39 selected dessert, and for meal session 2, 15 selected dessert.

[e] Not applicable.

XSL•FO
RenderX

Table 3. Comparisons between and within adolescents and adults of the number of images acquired prior to obtaining a suitable image.

Group	Adolescents (n = 63 meal session 1, n = 55 meal session 2)			Adults (n = 56[a] meal session 1, n = 24 meal session 2)		
	1 image, n (%)	>1 image, n (%)	Data recording error[b], n	1 image, n (%)	>1 image, n (%)	Data recording error[b], n
All participants						
Meal session 1						
Before image[c,d]	38 (62%)	23 (38%)	2	21 (42%)	29 (58%)	6
After image[c,e]	44 (75%)	15 (25%)	4	25 (50%)	25 (50%)	6
Meal session 2						
Before image	39 (77%)	12 (24%)	4	13 (59%)	9 (41%)	2
After image	40 (78%)	11 (22%)	4	16 (73%)	6 (27%)	0
Matched participants [f]						
Meal session 1						
Before image	28 (58%)	20 (42%)[g,h]	NA[i]	9 (45%)	11 (55%)	NA
After image[c,j]	36 (75%)	12 (25%)	NA	7 (35%)	13 (65%)	NA
Meal session 2						
Before image	38 (79%)	10 (21%)[g,h]	NA	12 (60%)	8 (40%)	NA
After image	37 (77%)	11 (23%)	NA	14 (70%)	6 (30%)	NA

[a] Due to software programming errors, n = 56 instead of 57.

[b] Data recording error on the part of staff; therefore, numbers not included in percentages, which represent only users' abilities.

[c] Comparison between adolescents and adults.

[d] $P = .03$.

[e] $P = .008$.

[f] Number of before and after meal images these participants took was recorded for both meal session 1 and meal session 2 (n = 48 session pairs for adolescents; n = 20 session pairs for adults).

[g] Comparison between meal session 1 (before) and meal session 2 (before) within adolescents.

[h] $P = .04$

[i] Not applicable.

[j] $P = .002$.

XSL•FO
RenderX

Table 4. Comparison of perceptions and preferences between adolescents and adults regarding use of the mobile telephone food record[a].

Perceptions and preferences	Adolescents (n = 78)[b]			Adults (n = 57)		
	Agree, n (%)	Neutral, n (%)	Disagree, n (%)	Agree, n (%)	Neutral, n (%)	Disagree, n (%)
Perceptions						
The software was easy to use	55 (71%)	9 (13%)	6 (9%)	52 (91%)	1 (2%)	4 (7%)
I think it would be easy to remember to take an image before meals[c]	26 (37%)	22 (31%)	22 (31%)	47 (83%)	5 (9%)	5 (9%)
I think it would be easy to remember to take an image after meals[c]	29 (41%)	27 (38%)	15 (21%)	42 (74%)	8 (14%)	7 (12%)
I think it would be easy to remember to take an image before snacks	8 (11%)	16 (23%)	46 (66%)	15 (26%)	12 (21%)	30 (53%)
I think it would be easy to remember to take an image after snacks	15 (21%)	19 (27%)	37 (52%)	19 (33%)	13 (23%)	25 (44%)
Preferences						
I think it would be easy to carry and use a credit card-sized fiducial marker	55 (77%)	10 (14%)	6 (8%)	52 (91%)	4 (7%)	1 (2%)
I think it would be easy to carry and use a USB-sized fiducial marker[d]	30 (42%)	19 (27%)	22 (31%)	38 (67%)	15 (26%)	4 (7%)
I prefer to stand while taking an image[c]	43 (63%)	14 (21%)	11 (16%)	13 (23%)	12 (21%)	32 (56%)
I prefer to sit while taking an image[d]	25 (36%)	21 (30%)	23 (33%)	39 (68%)	8 (14%)	10 (18%)

[a] Percentages do not add to 100% due to rounding.

[b] Missing values due to a malfunction of the *e*Instruction Classroom Performance System.

[c] $P < .001$ using chi-square and comparing adolescents versus adults.

[d] $P = .002$ using chi-square and comparing adolescents versus adults.

Discussion

This is the first study to systematically evaluate the abilities of adolescents and adults to provide accurate images of an eating occasion. A priori, we assumed that huge differences in skills with technology between adolescents and adults would emerge; however, other than number of images captured, nothing else became obvious. The adolescents were more efficient: they took fewer images than the adults. By the second meal, the adolescents became even more efficient, whereas the adults made insignificant gains. Also, by the second meal, the inclusion of all foods in the images was the same between adults and adolescents, whereas inclusion of the important nonedible item (ie, the fiducial marker) was more problematic for both adolescents and adults. These results support that the fiducial marker was too large. As such, it was difficult to include in images without being partially covered by a plate or utensil. Evaluation of the images for the placement of the fiducial marker revealed that the participants placed the fiducial marker in various locations in the meal setting. Thus, work to reduce the size of the fiducial marker is justified. For both age groups, a notification from the device that the entire fiducial marker is not in the camera's field of view may be helpful in reminding participants to include the entire fiducial marker when capturing images. Clear instruction on the desired placement of the fiducial marker may prevent the participant from spending time deciding where to locate it in the meal setting, which might reduce the burden of this task and translate to better cooperation with this step.

We have also established that the perceptions and preferences of adolescents and adults regarding use of the mobile telephone food record were more disparate than their skill set. In particular, adolescents were less likely than adults to agree that capturing images of meals before and after would be easy. Adolescents were more opinionated about preferring a credit card-sized fiducial marker. The adolescents may have preferred a credit card-sized fiducial marker because it could be easily carried in a wallet. Finally, adolescents stated a preference to stand while using the mobile telephone food record and adults preferred sitting. This preference for standing is consistent with irregular eating patterns and selecting snacks that are easily portable and often eaten while standing [32,33].

Adolescents are typically the earlier and more eager adopters of new technology [17]. Previous dietary assessment research on adolescents showed that they preferred methods using technology over typical paper or pencil methods [32]. In the current study, adults were noticeably less confident than the adolescents in using this new technology. Whereas the adolescents were eager to use the mobile telephone food record and quickly started taking images, the adults were much more cautious and asked more questions prior to taking an image. This could explain the adults being more likely to include all foods and beverages in the image. However, the adolescents'

XSL•FO
RenderX

skills matched the adults' after extensive training, a phenomenon previously documented by Six and colleagues [27]. In all cases, it is impossible to separate the participants' skill in using the mobile telephone food record from motivation to follow the instructions given.

Despite the adolescents being observed as more confident and comfortable when using the mobile telephone food record, they were less likely to agree that it was easy to capture pre and post meal images. This could be a result of differences in daily schedules between the two age groups and may reflect adolescents having more irregular meal times than adults [14,15]. Alternatively, the adolescents may have higher expectations of and demands from the technologies they use [17].Therefore, for adolescents, improvements to the mobile telephone food record might include more reminders throughout the day to ensure that they capture both before and after meal images. For all users, a reminder system, such as an alarm or pop-up message, will likely be needed to remind participants to record their snacks.

Based on the length of time between the before and after images, the average meal duration was shorter for adolescents than for adults. This information provides a basis for programming age-specific software to start timing after the first meal image is captured to initiate a reminder for taking the after image. Next steps include testing the mobile telephone food record with participants in a free-living environment to ascertain the true level of burden, duration of cooperation, and accuracy of recorded energy intake using a biomarker for energy, such as doubly labeled water. There were minimal differences regarding preferences, which will simplify the design process for the mobile telephone food record for adults and adolescents.

Conclusions

The results of these studies will translate to minimal design differences of the mobile telephone food record between adolescents and adults. The majority of both adults and adolescents were able to follow the defined set of skills when capturing before and after images of their meals; however, these results do provide evidence for the need for some age-specific development of the mobile telephone food record, such as reminder programming. The adults were more cautious than the adolescents when taking images and as a result were more likely to include all food and the fiducial marker, which are necessary to capture an image suitable for image analysis. However, adults had to take more images than adolescents before capturing satisfactory ones. Although they were less efficient, the adults perceived that remembering to capture images with the mobile telephone food record would be easy. Additional use of the mobile telephone food record improved adolescents' perceptions and set of skills when capturing images. Additional interactive training will likely be necessary for all users to provide extra practice in taking images before entering a free-living situation. The adolescents had a stronger opinion about the size of the fiducial marker than the adults, suggesting that the fiducial marker design needs to accommodate adolescents over adults. Software improvements between the adolescent and adult meal sessions greatly reduced the number of software programming errors. Some problems will likely never be entirely eliminated due to low battery power and other software-related difficulties, but advances in technology will ensure that these errors will become less frequent.

A more accurate method of dietary assessment will help strengthen the ability of researchers to identify diet–disease and diet–gene relationships. The data generated from a tool such as the mobile telephone food record could be combined with measures of the built environment to inform public policy and assist in the development of nutrition interventions. Further, novel dietary assessment methods will contribute to the growth of mobile applications to enhance self-monitoring for diabetes, weight control, and other diet-related diseases.

Acknowledgments

Support for this work came from the National Cancer Institute (NCI; 1U01CA130784-01), the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK; 1R01-DK073711-01A1), and the NCI, Nutritional and Behavioral Cancer Prevention in a Multiethnic Population postdoctoral fellowship (R25 CA 90956; REG). The contents of this publication do not necessarily reflect the views or policies of the NCI or NIDDK, nor does mention of trade names, commercial products, or organizations imply endorsement from the US government.

Authors' Contributions

All authors contributed equally to this work.

Conflicts of Interest

None declared.

References

1. Seedorf U, Schulte H, Assmann G. Genes, diet and public health. Genes Nutr 2007 Oct;2(1):75-80. [doi: 10.1007/s12263-007-0001-1] [Medline: 18850146]
2. Sladek R, Rocheleau G, Rung J, Dina C, Shen L, Serre D, et al. A genome-wide association study identifies novel risk loci for type 2 diabetes. Nature 2007 Feb 22;445(7130):881-885. [doi: 10.1038/nature05616] [Medline: 17293876]

XSL•FO
RenderX

3. O'Donnell CJ, Cupples LA, D'Agostino RB, Fox CS, Hoffmann U, Hwang SJ, et al. Genome-wide association study for subclinical atherosclerosis in major arterial territories in the NHLBI's Framingham Heart Study. BMC Med Genet 2007;8 Suppl 1:S4 [FREE Full text] [doi: 10.1186/1471-2350-8-S1-S4] [Medline: 17903303]
4. Rioux JD, Xavier RJ, Taylor KD, Silverberg MS, Goyette P, Huett A, et al. Genome-wide association study identifies new susceptibility loci for Crohn disease and implicates autophagy in disease pathogenesis. Nat Genet 2007 May;39(5):596-604. [doi: 10.1038/ng2032] [Medline: 17435756]
5. Favé G, Beckmann ME, Draper JH, Mathers JC. Measurement of dietary exposure: a challenging problem which may be overcome thanks to metabolomics? Genes Nutr 2009 Jun;4(2):135-141. [doi: 10.1007/s12263-009-0120-y] [Medline: 19340473]
6. Tucker KL. Assessment of usual dietary intake in population studies of gene-diet interaction. Nutr Metab Cardiovasc Dis 2007 Feb;17(2):74-81. [doi: 10.1016/j.numecd.2006.07.010] [Medline: 17046222]
7. Mahabir S, Baer DJ, Giffen C, Subar A, Campbell W, Hartman TJ, et al. Calorie intake misreporting by diet record and food frequency questionnaire compared to doubly labeled water among postmenopausal women. Eur J Clin Nutr 2006 Apr;60(4):561-565. [doi: 10.1038/sj.ejcn.1602359] [Medline: 16391574]
8. Blanton CA, Moshfegh AJ, Baer DJ, Kretsch MJ. The USDA Automated Multiple-Pass Method accurately estimates group total energy and nutrient intake. J Nutr 2006 Oct;136(10):2594-2599 [FREE Full text] [Medline: 16988132]
9. Subar AF, Kipnis V, Troiano RP, Midthune D, Schoeller DA, Bingham S, et al. Using intake biomarkers to evaluate the extent of dietary misreporting in a large sample of adults: the OPEN study. Am J Epidemiol 2003 Jul 1;158(1):1-13 [FREE Full text] [Medline: 12835280]
10. Champagne CM, Bray GA, Kurtz AA, Monteiro JB, Tucker E, Volaufova J, et al. Energy intake and energy expenditure: a controlled study comparing dietitians and non-dietitians. J Am Diet Assoc 2002 Oct;102(10):1428-1432. [Medline: 12396160]
11. Champagne CM, Baker NB, DeLany JP, Harsha DW, Bray GA. Assessment of energy intake underreporting by doubly labeled water and observations on reported nutrient intakes in children. J Am Diet Assoc 1998 Apr;98(4):426-433. [doi: 10.1016/S0002-8223(98)00097-2] [Medline: 9550166]
12. Bandini LG, Must A, Cyr H, Anderson SE, Spadano JL, Dietz WH. Longitudinal changes in the accuracy of reported energy intake in girls 10-15 y of age. Am J Clin Nutr 2003 Sep;78(3):480-484 [FREE Full text] [Medline: 12936932]
13. Neumark-Sztainer D, Story M, Perry C, Casey MA. Factors influencing food choices of adolescents: findings from focus-group discussions with adolescents. J Am Diet Assoc 1999 Aug;99(8):929-937. [doi: 10.1016/S0002-8223(99)00222-9] [Medline: 10450307]
14. Livingstone MB, Robson PJ, Wallace JM. Issues in dietary intake assessment of children and adolescents. Br J Nutr 2004 Oct;92 Suppl 2:S213-S222. [Medline: 15522159]
15. Goodwin RA, Brulé D, Junkins EA, Dubois S, Beer-Borst S. Development of a food and activity record and a portion-size model booklet for use by 6- to 17-year olds: a review of focus-group testing. J Am Diet Assoc 2001 Aug;101(8):926-928. [doi: 10.1016/S0002-8223(01)00229-2] [Medline: 11501871]
16. Thompson FE, Subar AF, Loria CM, Reedy JL, Baranowski T. Need for technological innovation in dietary assessment. J Am Diet Assoc 2010 Jan;110(1):48-51. [doi: 10.1016/j.jada.2009.10.008] [Medline: 20102826]
17. Lenhart A, Ling R, Campbell S, Purcell K. Teens and mobile phones. Washington, DC: Pew Internet & American Life Project; 2010 Apr 20. URL: http://www.pewinternet.org/~/media/ /Files/Reports/2010/PIP-Teens-and-Mobile-2010-with-topline.pdf [accessed 2012-04-05] [WebCite Cache ID 66hNwpCB3]
18. Wang DH, Kogashiwa M, Ohta S, Kira S. Validity and reliability of a dietary assessment method: the application of a digital camera with a mobile phone card attachment. J Nutr Sci Vitaminol (Tokyo) 2002 Dec;48(6):498-504. [Medline: 12775117]
19. Kretsch MJ, Blanton CA, Baer D, Saples R, Horn WF, Keim NL. Measuring energy expenditure with simple low-cost tools. J Am Diet Assoc 2004 Aug;104(Suppl 2):A-13.
20. Yon BA, Johnson RK, Harvey-Berino J, Gold BC. The use of a personal digital assistant for dietary self-monitoring does not improve the validity of self-reports of energy intake. J Am Diet Assoc 2006 Aug;106(8):1256-1259. [doi: 10.1016/j.jada.2006.05.004] [Medline: 16863723]
21. Martin CK, Han H, Coulon SM, Allen HR, Champagne CM, Anton SD. A novel method to remotely measure food intake of free-living individuals in real time: the remote food photography method. Br J Nutr 2009 Feb;101(3):446-456. [doi: 10.1017/S0007114508027438] [Medline: 18616837]
22. Sun M, Fernstrom JD, Jia W, Hackworth SA, Yao N, Li Y, et al. A wearable electronic system for objective dietary assessment. J Am Diet Assoc 2010 Jan;110(1):45-47. [doi: 10.1016/j.jada.2009.10.013] [Medline: 20102825]
23. Weiss R, Stumbo PJ, Divakaran A. Automatic food documentation and volume computation using digital imaging and electronic transmission. J Am Diet Assoc 2010 Jan;110(1):42-44. [doi: 10.1016/j.jada.2009.10.011] [Medline: 20102824]
24. Chomutare T, Fernandez-Luque L, Arsand E, Hartvigsen G. Features of mobile diabetes applications: review of the literature and analysis of current applications compared against evidence-based guidelines. J Med Internet Res 2011;13(3):e65 [FREE Full text] [doi: 10.2196/jmir.1874] [Medline: 21979293]

XSL•FO
RenderX

25. Bexelius C, Löf M, Sandin S, Trolle Lagerros Y, Forsum E, Litton JE. Measures of physical activity using cell phones: validation using criterion methods. J Med Internet Res 2010 Jan;12(1):e2 [FREE Full text] [doi: 10.2196/jmir.1298] [Medline: 20118036]
26. Whittaker R, Maddison R, McRobbie H, Bullen C, Denny S, Dorey E, et al. A multimedia mobile phone-based youth smoking cessation intervention: findings from content development and piloting studies. J Med Internet Res 2008 Nov;10(5):e49 [FREE Full text] [doi: 10.2196/jmir.1007] [Medline: 19033148]
27. Six BL, Schap TE, Zhu FM, Mariappan A, Bosch M, Delp EJ, et al. Evidence-based development of a mobile telephone food record. J Am Diet Assoc 2010 Jan;110(1):74-79. [doi: 10.1016/j.jada.2009.10.010] [Medline: 20102830]
28. Zhu F, Mariappan A, Boushey CJ, Kerr D, Lutes KD, Ebert DS, et al. Technology-Assisted Dietary Assessment. Proc SPIE 2008 Mar 20;6814:681411. [doi: 10.1117/12.778616] [Medline: 22128303]
29. Mariappan A, Bosch M, Zhu F, Boushey CJ, Kerr DA, Ebert DS, et al. Personal dietary assessment using mobile devices. Proc SPIE 2009 Jan 1;7246. [doi: 10.1117/12.813556] [Medline: 21660219]
30. Hertzum M, Simonsen J. Evidence-based development: a viable approach? In: Proceedings. New York, NY: ACM Press; 2004 Presented at: Third Nordic Conference on Human-Computer Interaction; Oct 23-27, 2004; Tampere, Finland. [doi: 10.1145/1028014.1028076]
31. Schap TE, Six BL, Delp EJ, Ebert DS, Kerr DA, Boushey CJ. Adolescents in the United States can identify familiar foods at the time of consumption and when prompted with an image 14 h postprandial, but poorly estimate portions. Public Health Nutr 2011 Jul;14(7):1184-1191. [doi: 10.1017/S1368980010003794] [Medline: 21324224]
32. Boushey CJ, Kerr DA, Wright J, Lutes KD, Ebert DS, Delp EJ. Use of technology in children's dietary assessment. Eur J Clin Nutr 2009 Feb;63 Suppl 1:S50-S57. [doi: 10.1038/ejcn.2008.65] [Medline: 19190645]
33. Laska MN, Graham D, Moe SG, Lytle L, Fulkerson J. Situational characteristics of young adults' eating occasions: a real-time data collection using Personal Digital Assistants. Public Health Nutr 2010 Dec 8:1-8. [doi: 10.1017/S1368980010003186] [Medline: 21138611]

Abbreviations

mpFR: mobile telephone food record
PDA: personal digital assistant

Edited by G Eysenbach; submitted 18.10.11; peer-reviewed by P Stumbo, E Sazonov, PhD; comments to author 16.12.11; revised version received 10.02.12; accepted 09.03.12; published 13.04.12.

Please cite as:
Daugherty BL, Schap TE, Ettienne-Gittens R, Zhu FM, Bosch M, Delp EJ, Ebert DS, Kerr DA, Boushey CJ
Novel Technologies for Assessing Dietary Intake: Evaluating the Usability of a Mobile Telephone Food Record Among Adults and Adolescents
J Med Internet Res 2012;14(2):e58
URL: http://www.jmir.org/2012/2/e58/
doi:10.2196/jmir.1967
PMID:22504018

©Bethany L Daugherty, TusaRebecca E Schap, Reynolette Ettienne-Gittens, Fengqing M Zhu, Marc Bosch, Edward J Delp, David S Ebert, Deborah A Kerr, Carol J Boushey. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 13.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Improving Adherence to Antiretroviral Therapy for Youth Living with HIV/AIDS: A Pilot Study Using Personalized, Interactive, Daily Text Message Reminders

Nadia Dowshen[1,2], MD; Lisa M Kuhns[3,4], MPH, PhD; Amy Johnson[3], MSW; Brian James Holoyda[4], BS; Robert Garofalo[3,4], MPH, MD

[1]Craig-Dalsimer Division of Adolescent Medicine, The Children's Hospital of Philadelphia, Philadelphia, PA, United States

[2]School of Medicine, University of Pennsylvania, Philadelphia, PA, United States

[3]Division of General Academic Pediatrics, Children's Memorial Hospital, Chicago, IL, United States

[4]Feinberg School of Medicine, Northwestern University, Chicago, IL, United States

Corresponding Author:
Nadia Dowshen, MD
Craig-Dalsimer Division of Adolescent Medicine
The Children's Hospital of Philadelphia
3535 Market St, Rm 1542
Philadelphia, PA, 19104
United States
Phone: 1 267 426 2591
Fax: 1 267 426 0380
Email: dowshenn@email.chop.edu

Abstract

Background: For youth living with human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS), nonadherence to antiretroviral therapy (ART) can lead to poor health outcomes and significantly decreased life expectancy.

Objective: To evaluate the feasability, acceptability, and preliminary efficacy of short message service (SMS) or text message reminders to improve adherence to ART for youth living with HIV/AIDS.

Methods: We conducted this prospective pilot study using a pre–post design from 2009 to 2010 at a community-based health center providing clinical services to youth living with HIV/AIDS. Eligibility criteria included HIV-positive serostatus, age 14–29 years, use of a personal cell phone, English-speaking, and being on ART with documented poor adherence. During the 24-week study period, participants received personalized daily SMS reminders and a follow-up message 1 hour later assessing whether they took the medication, and asking participants to respond via text message with the number 1 if they took the medication and 2 if they did not. Outcome measures were feasibility, acceptability, and adherence. Self-reported adherence was determined using the visual analog scale (VAS) and AIDS Clinical Trial Group (ACTG) questionnaire 4-day recall. Viral load and CD4 cell count were followed as biomarkers of adherence and disease progression at 0, 12, and 24 weeks.

Results: Participants (N = 25) were mean age 23 (range 14–29) years, 92% (n = 23) male, 60% (n = 15) black, and 84% (n = 21) infected through unprotected sex. Mean VAS scores significantly increased at 12 and 24 weeks in comparison with baseline (week 0: 74.7, week 12: 93.3, $P < .001$; week 24: 93.1, $P < .001$). ACTG questionnaire 4-day recall also improved (week 0: 2.33, week 12: 3.24, $P = .002$; week 24: 3.19, $P = .005$). There was no significant difference in CD4 cell count or viral load between baseline and 12- or 24-week follow-up, although there was a trend toward improvement of these biomarkers and a small to moderate standardized effect size (range of Cohen d: –0.51 to 0.22). Of 25 participants, 21 (84%) were retained, and 20 of the 21 (95%) participants who completed the study found the intervention helpful to avoid missing doses.

Conclusions: In this pilot study, personalized, interactive, daily SMS reminders were feasible and acceptable, and they significantly improved self-reported adherence. Larger controlled studies are needed to determine the impact of this intervention on ART adherence and other related health outcomes for youth living with HIV/AIDS.

(J Med Internet Res 2012;14(2):e51) doi:10.2196/jmir.2015

XSL•FO
RenderX

KEYWORDS

Adolescents; HIV/AIDS; adherence; text messaging; short message service; SMS; mobile health intervention

Introduction

Over one million people in the United States are living with human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS). Youth aged 12–29 years account for more than a third of the approximately 50,000 new HIV infections each year [1,2]. Nonadherence to antiretroviral therapy (ART) can lead to poor health outcomes and significantly decreased life expectancy, and it may increase the risk of secondary transmission and the development of resistant viral strains [3-7]. Challenges to adherence include pill burden, dosing schedule, food restrictions, and side effects [8-11]. However, forgetting is the most commonly cited reason for missing doses [12]. A range of strategies to improve adherence to ART have been shown to be helpful for youth living with HIV/AIDS, including directly observed therapy, reminder devices, counseling, and telephone calls, but many of these strategies are expensive, time consuming, and potentially intrusive [13-17].

With over 230 million cell phones in use and 7 billion text messages sent every month in the United States, text messaging or short message service (SMS) has become a common mode of communication among youth, including those who are economically disadvantaged [18]. This low-cost, convenient technology has provided benefit in a variety of health care settings and has been shown to be an effective tool for behavior change [19,20]. Evidence suggests that text messaging interventions may increase medication adherence among children and adolescents living with other chronic diseases such as asthma and diabetes [21-25]. Several studies have used both daily and weekly unidirectional, standardized SMS medication reminders for HIV-positive individuals in low-resource settings, but no published data have evaluated SMS medication reminders among youth living with HIV/AIDS in the United States [26-28].

In particular, text messaging is well suited as a vehicle for ecological momentary interventions; that is, mobile technology can provide treatment to patients in real time and in their natural environments [29]. Additionally, recent reviews of the literature on text messaging interventions for health behavior change have identified key characteristics for success, including interactivity and tailoring of messages, which were associated with higher retention rates in multiple studies [30].

The purpose of this pilot study was to evaluate the feasability, acceptability, and preliminary efficacy of an interactive text message reminder intervention for HIV-positive youth aged 14–29 years with demonstrated poor ART adherence. In particular, we sought to establish the feasibility of using personal cell phones for the intervention and our ability to retain youth living with HIV/AIDS as participants over the study period. We chose to pilot this intervention among youth with difficulty adhering to ART, since they could potentially benefit most from the reminders. We did not include a control condition given the lack of any pilot data to support this approach; therefore, the aims of this study were largely exploratory and meant to assess initial efficacy for a larger controlled trial.

Methods

Eligibility criteria included HIV-positive serostatus, age 14–29 years, use of personal cell phone, English-speaking, and being on ART with poor adherence. We defined poor adherence as (1) missing more than 3 medication doses in the last month, or (2) missing any doses in the last month and not achieving viral supression after 24 weeks of an appropriate regimen, or (3) being referred from a clinician who documented poor adherence in the medical record defined by a report of any missed doses to any member of the care team or not achieving viral supression in the expected time period on an appropriate regimen. Possible participants were recruited primarily from a multidisciplinary program providing medical care and other support services to youth living with HIV/AIDS, located at a lesbian, gay, bisexual, and transgender-focused health center, and serving mainly young men who have sex with men of color who have acquired HIV through sexual activity. In this convenience sample, participants were recruited and enrolled consecutively from June to November 2009 and agreed to receive text messages over a 24-week study period. Participants received a US $40 incentive at each visit to compensate for time, transportation costs, and any additional charges incurred from the daily text messages.

At baseline, we collected demographic information and screened participants for depression and substance abuse, as these have been identified as factors affecting adherence [10,31]. We collaborated with Intelecare, a Health Insurance Portability and Accountability Act- and Health Information Technology for Economic and Clinical Health Act-compliant vendor of SMS health-related reminder services. At the time of enrollment, patients worked with the study coordinator to design their own personalized SMS reminder messages, which were programmed through Intelecare's website to be delivered daily at the time(s) specified. Participants also designed a personalized follow-up message 1 hour later assessing whether they took the medication, and asking participants to respond via text message with the number 1 if they took the medication and 2 if they did not. Patients were encouraged to consider developing messages that would respect their privacy if they did not want to disclose their HIV diagnosis. Participants were able to contact the study coordinator to change the message at any time throughout the study period, and patients were asked to contact the study coordinator to reprogram the message if at any time their mobile service was interrupted.

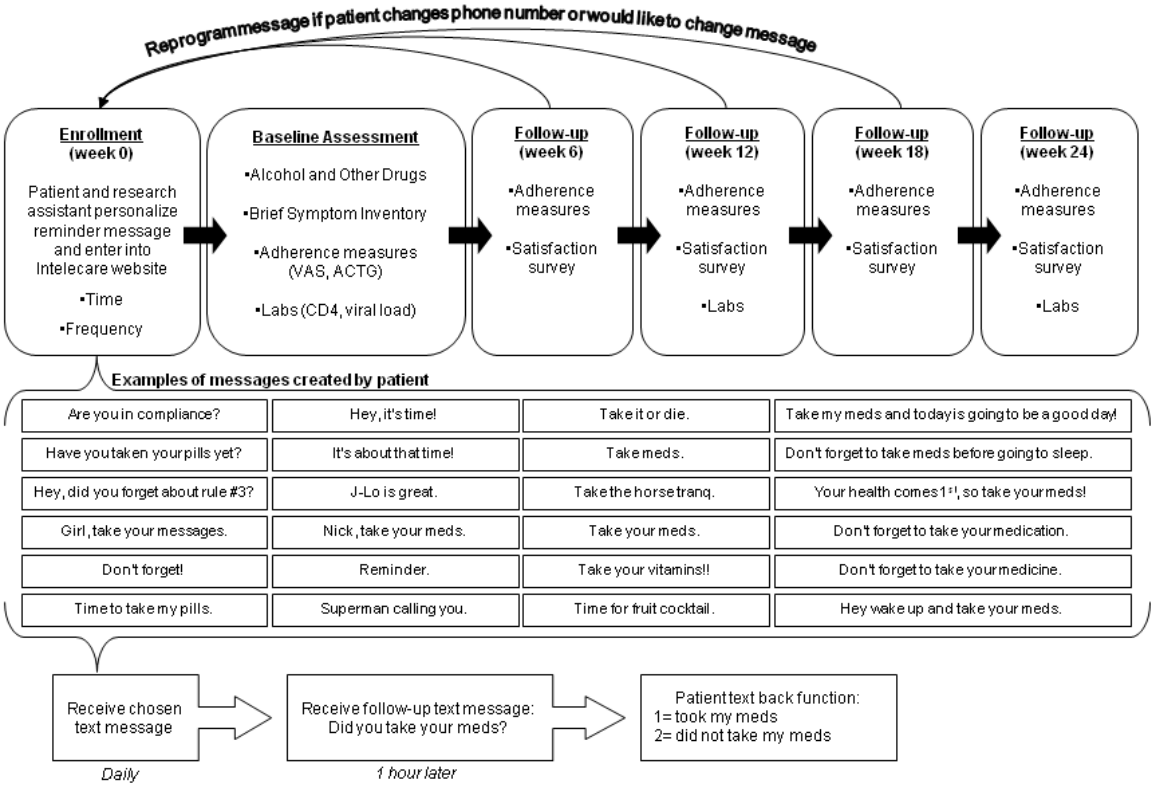
Follow-up visits at 6, 12, 18, and 24 weeks included assessments of adherence by visual analog scale (VAS) and the AIDS Clinical Trials Group (ACTG) adherence questionnaire and satisfaction surveys. The VAS prompts participants to rate adherence in the last 4 weeks on a scale of 0% to 100%. The VAS correlates highly with unannounced pill counts, 3-day adherence recall, and viral load (ie, $r > .7$) [32,33]. Additionally, participants responded to the following question from the ACTG

XSL•FO
RenderX

adherence questionnaire (on a scale of 0 = never to 4 = all the time): "Over the past 4 days, how closely did you follow your specific medication schedule?" Viral load (HIV type 1 ribonucleic acid quantification) and CD4 cell count (absolute and percentage) were abstracted from the patient's chart at baseline and at 12 and 24 weeks. See Figure 1 for details of the study design and Multimedia Appendix 1 for screenshots of the Intelecare platform used to send, recieve, and manage text message data. Study completion was defined as attendance at all study visits; responding daily to text messages was encouraged but not required for study completion.

Descriptive and distributional analyses were performed to describe the sample. Pre–post comparison of mean values and related effect sizes (standardized and unstandardized) were used to evaluate outcomes of interest. This pilot study was not powered to detect statistically significant differences. For assessment of pre–post changes in adherence levels and biomarkers, we compared scores using a *t* test for paired samples, with a significance level set at $P \leq .05$ (2-tailed test), with Cohen *d* calculated as a standardized measure of effect size (controlling for dependency in paired values).

Figure 1. Study design. ACTG = AIDS Clinical Trials Group; Labs = laboratory tests; meds = medications; VAS = visual analog scale.



Results

Participants were primarily male and of racial ethnic minorities, and had acquired HIV through unprotected sex (see Table 1). The main outcome of interest was change in adherence at the 12- and 24-week follow-ups (in comparison with baseline) as measured on the VAS. Mean VAS scores and responses on the ACTG 4-day adherence recall significantly increased at the 12- and 24-week follow-ups in comparison with baseline (see Table 2 and Table 3). On average, participants increased from a baseline value of 74.7 on the VAS to over 90.0 at both the 12- and 24-week follow-ups, with a standardized effects size (Cohen *d*) greater than 1.0 at both follow-up points. Improvements in adherence measures were seen as early as 6 weeks and sustained throughout the 24-week study period. There was no significant difference in CD4 cell count or viral load between baseline and the 12- or 24-week follow-ups, although there was a trend toward improvement of these biomarkers and a small to moderate standardized effect size (range of Cohen *d*: –0.51 to 0.22).

XSL•FO
RenderX

Table 1. Participants' demographics characteristics (n = 25).

Characteristic	Mean or n	SD or %	Range
Age (years), mean (SD)	23	3.08	14–29
Time since diagnosis (months), mean (SD)	41	43.4[b]	7–180
Time since starting current ART[a] regimen (months), mean (SD)	37	59.4[b]	1–240
Gender, n (%)			
Male	23	92%	
Female	2	8%	
Race/ethnicity, n (%)			
Black	15	60%	
White	2	8%	
Latino	6	24%	
Multiracial	2	8%	
Mode of transmission, n (%)			
Perinatal	3	12%	
Sexual contact	21	84%	
Unsure	1	4%	
Medication regimen frequency, n (%)			
Daily	20	80%	
Twice daily	5	20%	

[a] Antiretroviral therapy.

[b] Time on ART longer than time since diagnosis reflects delayed disclosure of diagnosis to perinatally infected youth.

Table 2. Baseline and follow-up adherence and biomarker outcomes (n = 21 of 25).

Outcome measure	Baseline		12 weeks			24 weeks		
	Mean	SD	Mean	SD	*P* value	Mean	SD	*P* value
Adherence (VAS[a])	74.7	16.5	93.3	6.6	<.001	93.1	7.7	<.001
Prior 4-day adherence (ACTG[b])	2.33	1.1	3.24	0.4	.002	3.19	0.9	.005
Viral load	2750.2	8930.8	240.5	521.1	.26	28.5	47.5	.23
CD4 cell count	501.5	239.2	552.8	234.3	.12	544.8	228.7	.37

[a] Visual analog scale.

[b] AIDS Clinical Trials Group. Response scale: 0 = never, 4 = all the time.

XSL•FO
RenderX

Table 3. Effect sizes and changes in adherence and biomarker outcomes from baseline to 12 and 24 weeks (n = 21 of 25).

Outcome measure	12 weeks				24 weeks			
	Change	95% CI[a]	*P* value	Effect size (Cohen *d*)	Change	95% CI	*P* value	Effect size (Cohen *d*)
Adherence (VAS[b])	18.6	10.4–27.0	<.001	1.18	18.5	10.5–26.5	<.001	1.13
Prior 4-day adherence (ACTG[c])	0.9	0.4–1.4	.002	0.87	0.9	0.3–1.4	.005	0.73
Viral load[d]	–2509.7	–7067.0 to 2047.6	.26	–0.41	–2721.7	–7306.7 to 1863.3	.23	–0.51
CD4 cell count[d]	51.3	–15.05 to 117.6	.12	0.4	43.3	–56.3 to 142.9	.37	0.22

[a] Confidence interval.

[b] Visual analog scale.

[c] AIDS Clinical Trials Group. Response scale: 0 = never, 4 = all the time.

[d] Sample size n = 17 for viral load and CD4 cell count due to additional missing participants at 24 weeks.

Enrollment and retention of the study population was feasible with 25 participants enrolled over a 6-month period (approximately 4 participants enrolled per month), and with 23 of 25 (92%) and 21 of 25 (84%) of participants completing all visits at 12 and 24 weeks, respectively (see Table 4). Of the 4 participants who did not complete the study, only 3 were lost to follow-up; 1 had to be removed because of cell phone service incompatibility with Intelecare technology. Of note, several participants experienced a lapse in cell phone service (some due to change in phone number, failure of payment, or a lost phone, and 1 patient had the mobile phone stolen during an assault), and none reported it directly to the study coordinator, but all reported the interruption to their medical provider or case manager during routine care, and the study coordinator was then notified and messages were reprogrammed.

The intervention was rated highly on indicators of satisfaction: at the 24-week follow-up, 17 of 21 (81%) participants who completed the study said they would like to continue to receive text messages after the end of the study, and 20 of 21 (95%) participants indicated that the text messages helped them "very much" to miss fewer doses of medication. Reasons why participants did not find reminders helpful included being at work during the day when they received the text message and wanting to take their medications but not being able to check messages; not having medications on hand; living temporarily at a friend's house where they were unable to store medications; and being in a public place where they felt uncomfortable taking their medications. Of note, all participants who completed the study (n = 21) felt that the intervention would have been helpful when they first started taking medication.

During the study period 15,387 messages were sent and received through the Intelecare platform. Of the outgoing messages sent 1167 messages were not delivered and 14,220 messages were successfully sent. Of the 7110 messages requesting a response, 3414 (48.02%) text message replies were sent by participants indicating whether they took their medications.

Table 4. Feasibility and acceptability of the study intervention.

	n	%
Feasibility (n = 25)		
Rate of study completion	21	84%
Acceptability (n = 21)		
Helpful to avoid missed doses?	20	95%
Helpful to remember refills?	16	76%
Helpful to remember medical appointments?	15	71%
Messages respected privacy?	21	100%
Received all messages?	17	81%
Would like to continue to receive reminders?	17	81%
Reminders would have been helpful when starting medications?	21	100%

XSL•FO
RenderX

Discussion

In this sample of 25 HIV-positive youth with previous difficulty adhering to ART, personalized, daily text messaging significantly improved self-reported adherence from baseline to 12 and 24 weeks. Retention in the study was excellent, participants reported high levels of satisfaction, and the vast majority wanted to continue receiving reminders after the 24-week study period was completed. The lack of a significant difference in biomarkers (CD4 cell count and viral load) was likely due to the small sample size.

Major limitations of the study include absence of a control group and lack of long-term follow-up after completion of the intervention. However, given the paucity of data showing any effective intervention to improve adherence among youth living with HIV/AIDS, the pre–post difference reported in this study is an important finding. In one study that did show improvement with weekly text reminders and no improvement with daily reminders among poorly adherent adults living with HIV/AIDS, patients in the control group had worse virologic and self-reported adherence than at baseline [26]. In the present study, rates of self-reported adherence and virologic suppression improved beginning at 6 weeks and were sustained over the 24-week study period, in contrast to Pop-Eleches and colleagues' study, where standardized weekly and daily texts had a waning effect on self-reported adherence and treatment interruptions over time [26]. A recent randomized controlled trial of 19 adults living with HIV with poor adherence showed a similar improvement in adherence by self-report for those participants randomly assigned to text message reminders personalized by topic versus no change in adherence for those randomly assigned to a reminder beep on a pager [34]. This study followed patients for 6 weeks and did not include any biomarkers for adherence. The similar rates of improved self-reported adherence sustained over a longer period in our study, along with a trend toward improvement and a moderate standardized effect size for the difference in viral load from baseline to 24 weeks, further support the possible utility of this intervention.

Additionally, previous studies of text messaging interventions to improve adherence have used an interactive function and tailored messages, but none have included a daily, real-time interactive feature, and messages were not created individually by participants. This study showed that it is feasible to employ this intervention for a difficult-to-reach population using their own mobile phones. The unique, interactive feature of this intervention may provide additional information about timing of missed doses and help to uncover barriers to adherence, other than simply forgetting, that medical providers could use to problem solve with patients. For example, algorithms could be programmed so that if a patient did not respond for a certain number of days the provider and patient could be alerted to contact each other and address any issues in real time as opposed to waiting for the next routine clinic visit.

In summary, this pilot study demonstrates that a daily, interactive, personalized text message reminder intervention is both feasable and acceptable and shows promise as a tool to help HIV-positive youth adhere to ART. Larger controlled studies are needed to determine the potential of this intervention, not only to improve adherence to ART, but also to affect a broad range of related health outcomes for youth living with HIV/AIDS.

Acknowledgments

The authors would like to acknowledge the Howard Brown Health Center research and clinical staff, and Intelecare for their support of this study, as well as Susan S Lee for her assistance in preparing the manuscript.

Authors' Contributions

All of the authors are responsible and qualified for the reported research. They have all participated in the concept and design, analysis and interpretation of data, and drafting and revision of the manuscript, and approve the manuscript as submitted. All of the authors have had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Intelecare platform for creating, sending, receiving, and managing text messages.

[PDF File (Adobe PDF File), 1MB - jmir_v14i2e51_app1.pdf]

References

1. Centers for Disease Control and Prevention. 2011 Jul 11. HIV Surveillance Report URL: http://www.cdc.gov/hiv/topics/surveillance/resources/reports/index.htm [accessed 2011-11-16] [WebCite Cache ID 63FLXcxx2]
2. Centers for Disease Control and Prevention. 2011 Jul 14. HIV Surveillance in Adolescents and Young Adults URL: http://www.cdc.gov/hiv/topics/surveillance/resources/slides/adolescents/index.htm [accessed 2011-11-16] [WebCite Cache ID 63FMBuwCx]

XSL•FO
RenderX

3. Flynn PM, Rudy BJ, Douglas SD, Lathey J, Spector SA, Martinez J, Pediatric AIDS Clinical Trial Group 381 Study Team. Virologic and immunologic outcomes after 24 weeks in HIV type 1-infected adolescents receiving highly active antiretroviral therapy. J Infect Dis 2004 Jul 15;190(2):271-279 [FREE Full text] [doi: 10.1086/421521] [Medline: 15216461]
4. Gross R, Bilker WB, Friedman HM, Strom BL. Effect of adherence to newly initiated antiretroviral therapy on plasma viral load. AIDS 2001 Nov 9;15(16):2109-2117. [Medline: 11684930]
5. Paterson DL, Swindells S, Mohr J, Brester M, Vergis EN, Squier C, et al. Adherence to protease inhibitor therapy and outcomes in patients with HIV infection. Ann Intern Med 2000 Jul 4;133(1):21-30. [Medline: 10877736]
6. Quinn TC, Wawer MJ, Sewankambo N, Serwadda D, Li C, Wabwire-Mangen F, et al. Viral load and heterosexual transmission of human immunodeficiency virus type 1. Rakai Project Study Group. N Engl J Med 2000 Mar 30;342(13):921-929 [FREE Full text] [doi: 10.1056/NEJM200003303421303] [Medline: 10738050]
7. Tang JW, Pillay D. Transmission of HIV-1 drug resistance. J Clin Virol 2004 May;30(1):1-10. [doi: 10.1016/j.jcv.2003.12.002] [Medline: 15072747]
8. Belzer ME, Fuchs DN, Luftman GS, Tucker DJ. Antiretroviral adherence issues among HIV-positive adolescents and young adults. J Adolesc Health 1999 Nov;25(5):316-319. [Medline: 10551660]
9. Murphy DA, Wilson CM, Durako SJ, Muenz LR, Belzer M, Adolescent Medicine HIV/AIDS Research Network. Antiretroviral medication adherence among the REACH HIV-infected adolescent cohort in the USA. AIDS Care 2001 Feb;13(1):27-40. [doi: 10.1080/09540120020018161] [Medline: 11177463]
10. Naar-King S, Templin T, Wright K, Frey M, Parsons JT, Lam P. Psychosocial factors and medication adherence in HIV-positive youth. AIDS Patient Care STDS 2006 Jan;20(1):44-47. [doi: 10.1089/apc.2006.20.44] [Medline: 16426155]
11. Rao D, Kekwaletswe TC, Hosek S, Martinez J, Rodriguez F. Stigma and social barriers to medication adherence with urban youth living with HIV. AIDS Care 2007 Jan;19(1):28-33. [doi: 10.1080/09540120600652303] [Medline: 17129855]
12. Chesney MA, Ickovics JR, Chambers DB, Gifford AL, Neidig J, Zwickl B, et al. Self-reported adherence to antiretroviral medications among participants in HIV clinical trials: the AACTG adherence instruments. Patient Care Committee & Adherence Working Group of the Outcomes Committee of the Adult AIDS Clinical Trials Group (AACTG). AIDS Care 2000 Jun;12(3):255-266. [doi: 10.1080/09540120050042891] [Medline: 10928201]
13. Glikman D, Walsh L, Valkenburg J, Mangat PD, Marcinak JF. Hospital-based directly observed therapy for HIV-infected children and adolescents to assess adherence to antiretroviral medications. Pediatrics 2007 May;119(5):e1142-e1148 [FREE Full text] [doi: 10.1542/peds.2006-2614] [Medline: 17452493]
14. Parsons GN, Siberry GK, Parsons JK, Christensen JR, Joyner ML, Lee SL, et al. Multidisciplinary, inpatient directly observed therapy for HIV-1-infected children and adolescents failing HAART: A retrospective study. AIDS Patient Care STDS 2006 Apr;20(4):275-284. [doi: 10.1089/apc.2006.20.275] [Medline: 16623626]
15. Puccio JA, Belzer M, Olson J, Martinez M, Salata C, Tucker D, et al. The use of cell phone reminder calls for assisting HIV-infected adolescents and young adults to adhere to highly active antiretroviral therapy: a pilot study. AIDS Patient Care STDS 2006 Jun;20(6):438-444. [doi: 10.1089/apc.2006.20.438] [Medline: 16789857]
16. Purdy JB, Freeman AF, Martin SC, Ryder C, Elliott-DeSorbo DK, Zeichner S, et al. Virologic response using directly observed therapy in adolescents with HIV: an adherence tool. J Assoc Nurses AIDS Care 2008;19(2):158-165. [doi: 10.1016/j.jana.2007.08.003] [Medline: 18328966]
17. Rogers AS, Miller S, Murphy DA, Tanney M, Fortune T. The TREAT (Therapeutic Regimens Enhancing Adherence in Teens) program: theory and preliminary results. J Adolesc Health 2001 Sep;29(3 Suppl):30-38. [Medline: 11530301]
18. Lenhart A, Ling R, Campbell S, Purcell K. Teens and mobile phones. Washington, DC: Pew Internet & American Life Project; 2010 Apr 20. URL: http://www.pewinternet.org/~/media/ /Files/Reports/2010/PIP-Teens-and-Mobile-2010-with-topline.pdf [accessed 2011-11-16] [WebCite Cache ID 63F9k9rny]
19. Fjeldsoe BS, Marshall AL, Miller YD. Behavior change interventions delivered by mobile telephone short-message service. Am J Prev Med 2009 Feb;36(2):165-173. [doi: 10.1016/j.amepre.2008.09.040] [Medline: 19135907]
20. Wei J, Hollin I, Kachnowski S. A review of the use of mobile phone text messaging in clinical and healthy behaviour interventions. J Telemed Telecare 2011;17(1):41-48. [doi: 10.1258/jtt.2010.100322] [Medline: 21097565]
21. Hung SH, Tseng HC, Tsai WH, Lin HH, Cheng JH, Chang YM. Care for Asthma via Mobile Phone (CAMP). Stud Health Technol Inform 2007;126:137-143. [Medline: 17476056]
22. Neville R, Greene A, McLeod J, Tracey A, Tracy A, Surie J. Mobile phone text messaging can help young people manage asthma. BMJ 2002 Sep 14;325(7364):600. [Medline: 12228151]
23. Franklin V, Waller A, Pagliari C, Greene S. "Sweet Talk": text messaging support for intensive insulin therapy for young people with diabetes. Diabetes Technol Ther 2003;5(6):991-996. [doi: 10.1089/152091503322641042] [Medline: 14709202]
24. Franklin VL, Waller A, Pagliari C, Greene SA. A randomized controlled trial of Sweet Talk, a text-messaging system to support young people with diabetes. Diabet Med 2006 Dec;23(12):1332-1338. [doi: 10.1111/j.1464-5491.2006.01989.x] [Medline: 17116184]
25. Miloh T, Annunziato R, Arnon R, Warshaw J, Parkar S, Suchy FJ, et al. Improved adherence and outcomes for pediatric liver transplant recipients by using text messaging. Pediatrics 2009 Nov;124(5):e844-e850 [FREE Full text] [doi: 10.1542/peds.2009-0415] [Medline: 19822583]

XSL•FO
RenderX

26. Pop-Eleches C, Thirumurthy H, Habyarimana JP, Zivin JG, Goldstein MP, de Walque D, et al. Mobile phone technologies improve adherence to antiretroviral treatment in a resource-limited setting: a randomized controlled trial of text message reminders. AIDS 2011 Mar 27;25(6):825-834. [doi: 10.1097/QAD.0b013e32834380c1] [Medline: 21252632]
27. De Costa A, Shet A, Kumarasamy N, Ashorn P, Eriksson B, Bogg L, HIVIND study team. Design of a randomized trial to evaluate the influence of mobile phone reminders on adherence to first line antiretroviral treatment in South India--the HIVIND study protocol. BMC Med Res Methodol 2010;10:25 [FREE Full text] [doi: 10.1186/1471-2288-10-25] [Medline: 20346136]
28. Lester RT, Mills EJ, Kariri A, Ritvo P, Chung M, Jack W, et al. The HAART cell phone adherence trial (WelTel Kenya1): a randomized controlled trial protocol. Trials 2009;10:87 [FREE Full text] [doi: 10.1186/1745-6215-10-87] [Medline: 19772596]
29. Heron KE, Smyth JM. Ecological momentary interventions: incorporating mobile technology into psychosocial and health behaviour treatments. Br J Health Psychol 2010 Feb;15(Pt 1):1-39. [doi: 10.1348/135910709X466063] [Medline: 19646331]
30. Cole-Lewis H, Kershaw T. Text messaging as a tool for behavior change in disease prevention and management. Epidemiol Rev 2010 Apr;32(1):56-69. [doi: 10.1093/epirev/mxq004] [Medline: 20354039]
31. Nugent NR, Brown LK, Belzer M, Harper GW, Nachman S, Naar-King S, Adolescent Trials Network for HIV/AIDS Interventions. Youth living with HIV and problem substance use: elevated distress is associated with nonadherence and sexual risk. J Int Assoc Physicians AIDS Care (Chic) 2010;9(2):113-115. [doi: 10.1177/1545109709357472] [Medline: 20133498]
32. Walsh JC, Mandalia S, Gazzard BG. Responses to a 1 month self-report on adherence to antiretroviral therapy are consistent with electronic data and virological treatment outcome. AIDS 2002 Jan 25;16(2):269-277. [Medline: 11807312]
33. Giordano TP, Guzman D, Clark R, Charlebois ED, Bangsberg DR. Measuring adherence to antiretroviral therapy in a diverse population using a visual analogue scale. HIV Clin Trials 2004;5(2):74-79 [FREE Full text] [Medline: 15116282]
34. Hardy H, Kumar V, Doros G, Farmer E, Drainoni ML, Rybin D, et al. Randomized controlled trial of a personalized cellular phone reminder system to enhance adherence to antiretroviral therapy. AIDS Patient Care STDS 2011 Mar;25(3):153-161. [doi: 10.1089/apc.2010.0006] [Medline: 21323532]

Abbreviations

ACTG: AIDS Clinical Trial Group
AIDS: acquired immunodeficiency syndrome
ART: antiretroviral therapy
HIV: human immunodeficiency virus
SMS: short message service
VAS: visual analog scale

Edited by G Eysenbach; submitted 26.11.11; peer-reviewed by K MacDonell; comments to author 15.01.12; revised version received 18.01.12; accepted 19.01.12; published 05.04.12.

Please cite as:
Dowshen N, Kuhns LM, Johnson A, Holoyda BJ, Garofalo R
Improving Adherence to Antiretroviral Therapy for Youth Living with HIV/AIDS: A Pilot Study Using Personalized, Interactive, Daily Text Message Reminders
J Med Internet Res 2012;14(2):e51
URL: http://www.jmir.org/2012/2/e51/
doi:10.2196/jmir.2015
PMID:22481246

©Nadia Dowshen, Lisa M Kuhns, Amy Johnson, Brian James Holoyda, Robert Garofalo. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 05.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Using Smartphone Technology to Monitor Physical Activity in the 10,000 Steps Program: A Matched Case–Control Trial

Morwenna Kirwan[1]; Mitch J Duncan[1], PhD; Corneel Vandelanotte[1], PhD; W Kerry Mummery[2], PhD

[1]Centre for Physical Activity Studies, Institute for Health and Social Sciences Research, CQUniversity, North Rockhampton, Australia

[2]Faculty of Physical Education and Recreation, University of Alberta, Edmonton, AB, Canada

Corresponding Author:
Morwenna Kirwan
Centre for Physical Activity Studies
Institute for Health and Social Sciences Research
CQUniversity
Building 18, Bruce Highway
North Rockhampton, 4702
Australia
Phone: 61 749232546
Fax: 61 749306781
Email: m.kirwan@cqu.edu.au

Abstract

Background: Website-delivered physical activity interventions are successful in producing short-term behavior change. However, problems with engagement and retention of participants in these programs prevent long-term behavior change. New ways of accessing online content (eg, via smartphones) may enhance engagement in these interventions, which in turn may improve the effectiveness of the programs.

Objective: To measure the potential of a newly developed smartphone application to improve health behaviors in existing members of a website-delivered physical activity program (10,000 Steps, Australia). The aims of the study were to (1) examine the effect of the smartphone application on self-monitoring and self-reported physical activity levels, (2) measure the perceived usefulness and usability of the application, and (3) examine the relationship between the perceived usefulness and usability of the application and its actual use.

Methods: All participants were existing members of the 10,000 Steps program. We recruited the intervention group (n = 50) via email and instructed them to install the application on their smartphone and use it for 3 months. Participants in this group were able to log their steps by using either the smartphone application or the 10,000 Steps website. Following the study, the intervention group completed an online questionnaire assessing perceived usability and usefulness of the smartphone application. We selected control group participants (n = 150), matched for age, gender, level of self-monitoring, preintervention physical activity level, and length of membership in the 10,000 Steps program, after the intervention was completed. We collected website and smartphone usage statistics during the entire intervention period.

Results: Over the study period (90 days), the intervention group logged steps on an average of 62 days, compared with 41 days in the matched group. Intervention participants used the application 71.22% (2210/3103) of the time to log their steps. Logistic regression analyses revealed that use of the application was associated with an increased likelihood to log steps daily during the intervention period compared with those not using the application (odds ratio 3.56, 95% confidence interval 1.72–7.39). Additionally, use of the application was associated with an increased likelihood to log greater than 10,000 steps on each entry (odds ratio 20.64, 95% confidence interval 9.19–46.39). Linear regression analysis revealed a nonsignificant relationship between perceived usability (r = .216, P = .21) and usefulness (r = .229, P = .17) of the application and frequency of logging steps in the intervention group.

Conclusion: Using a smartphone application as an additional delivery method to a website-delivered physical activity intervention may assist in maintaining participant engagement and behavior change. However, due to study design limitations, these outcomes should be interpreted with caution. More research, using larger samples and longer follow-up periods, is needed to replicate the findings of this study.

(J Med Internet Res 2012;14(2):e55) doi:10.2196/jmir.1950

XSL•FO
RenderX

KEYWORDS

smartphone; health behavior; physical activity; matched case-control study; intervention

Introduction

Physical inactivity has been identified as the fourth-leading risk factor for global mortality, causing an estimated 3.2 million deaths annually worldwide [1]. Regardless of the widespread understanding of the benefits of a physically active lifestyle, globally 60% of the population are considered insufficiently active to receive any health benefits [2]. In an attempt to reduce rates of physical inactivity, many behavioral modification programs have been developed [3-5]. Health promotion researchers have been quick to capitalize on the exponential growth of the Internet, and over the past decade an increasing number of interventions have been delivered online [6-11]. There is substantial evidence that online physical activity promotion programs are successful in producing short-term behavior change [12-14]. However, problems with engagement and retention of participants in online physical activity programs have been cited as an important issue preventing long-term behavior change [15]. In a review of website-delivered physical activity interventions, attrition ranged from 7% to 69%, with 9 of the 15 studies having an attrition of greater than 20% [15]. Several studies in this review also reported low exposure to intervention materials, due to a decline in website logins as the intervention progressed [15]. For example, in one study, website visits significantly declined over the intervention; 77% of all hits on the website were recorded in the first 2 weeks of the 8-week intervention [16]. It has been suggested that adjunctive delivery modes may enhance engagement in online physical activity interventions, which in turn may improve the effectiveness of the programs [17,18]. For example, the use of mobile phones in addition to an intervention website might be beneficial, as phones offer additional convenience and flexibility for the user, which may increase exposure to intervention materials [19].

Over the past two decades, mobile phones have evolved dramatically in both design and function, from simple call and text devices to the more sophisticated mini-personal computers known as smartphones. Mobile phones are more prevalent than computers or Internet access across the globe [20,21], with smartphones the fastest growing segment of the mobile handset market [22]. Unlike traditional mobile phones, smartphones allow individual users to install, configure, and run specialized applications of their choosing. At the end of 2010, over 17,000 smartphone health applications were available for consumers to download in major application stores [23]. It is estimated that 500 million people globally, out of a total of 1.4 billion smartphone users, will be using health-related smartphone applications by 2015 [23]. Despite the plethora of health- and fitness-related smartphone applications available, there is limited research into the effectiveness of these applications to promote health behavior change [24,25]. It should be noted, however, that technologies [26-28] relating to the self-monitoring of physical activity show promise, but these applications have yet to establish efficacy in terms of health behavior change. With consumers estimated to spend approximately a cumulative of 80 minutes per day using smartphone applications [29], there is a great potential for these devices to assist in health behavior change.

Some online physical activity programs have successfully included strategies to engage participants in self-monitoring behaviors as a means of increasing and maintaining activity levels [30-32]. One such program is 10,000 Steps (www.10000steps.org.au). 10,000 Steps is a freely accessible, ongoing, nonprofit, online physical activity health promotion program that encourages the use of step-counting pedometers to monitor daily physical activity levels [33,34]. With over 143,500 members [35] the 10,000 Steps program offers members multiple online interactive features to encourage participants to be active. One of the most prominent features of the website is the Step Log, where participants can record and monitor their daily physical activity levels [36]. The Step Log function on the 10,000 Steps website is the catalyst for members to record and monitor their activity levels. Evidence indicates that 10,000 Steps members engage with the website for approximately 44 days on average over their membership period [37]. Providing an alternative tool to log steps for the 10,000 Steps members, such as a smartphone application, may increase the duration of engagement in the intervention, due to the increased convenience such applications provide in eliminating the need to be at a computer to log steps. This may be important, as there is substantial evidence that the more frequently individuals engage with an online health intervention, the more likely they are to improve or maintain health-related behaviors [38]. To our knowledge this remains untested in regard to the self-monitoring of physical activity using both smartphone and website platforms.

Thus, the purpose of this study was to measure the effectiveness of a smartphone application, the iStepLog, to improve health behaviors in existing members of an online physical activity program (10,000 Steps, Australia). The aims of the study were to (1) examine the effect of the smartphone application on self-monitoring and self-reported physical activity levels, (2) measure the perceived usefulness and usability of the application, and (3) examine the relationship between the perceived usefulness and usability of the application and its actual use.

Methods

Participants

In a first step to test the potential of the iStepLog, we recruited intervention participants from the 10,000 Steps program, via an email (n = 6067) to members who had remained engaged with the intervention over a period of time (logged steps on at least one occasion in the 3 months preintervention). A total of 91 individuals responded, of whom 50 (24 women) met the inclusion criteria of having access to an iPhone or iPod touch for the duration of the study, as the iStepLog application was designed for the Apple platform. The study design was a 2-arm matched case–control trial. Intervention participants were

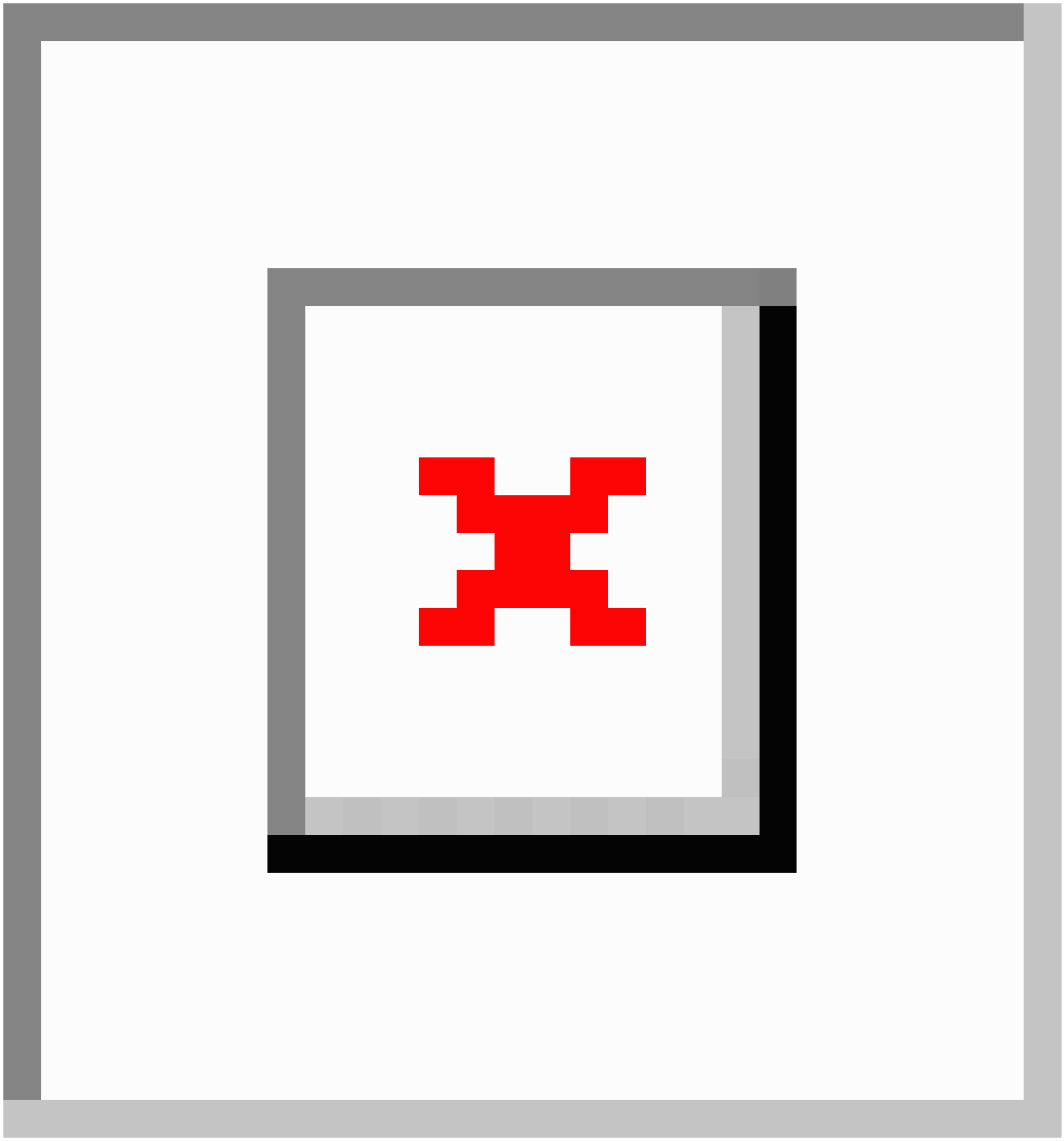
XSL•FO
RenderX

matched to a control group (n = 150) of current 10,000 Steps members who were comparable in age, gender, length of membership, and average number and frequency of steps logged for the 3 months immediately preintervention. We specifically chose these matching characteristics, as they are potential confounding variables when comparing the two groups.

Application

The iStepLog application was designed to allow members of the 10,000 Steps program to record their daily physical activity levels on their mobile device and synchronize this information with their online Step Log (see Figure 1). Built-in tracking software was integrated into the application to allow researchers to monitor how much time participants spent using the application, how often they used the application to log steps, and which features of the application were most popular. Prior to this research, 10,000 Steps staff conducted a laboratory-based usability study using qualitative and quantitative measures to systematically improve the usability of the design of the iStepLog application. The outcomes of this research revealed that improvements to the iStepLog application in both aesthetic design and functionality resulted in increased performance of the application, in terms of both efficiency of use and a decreased number of problems experienced by users.

Figure 1. Design of iStepLog application. Top, left to right: login screen, step log screen, enter steps screen. Bottom, left to right: review steps screen, sync to Web screen, syncing screen.



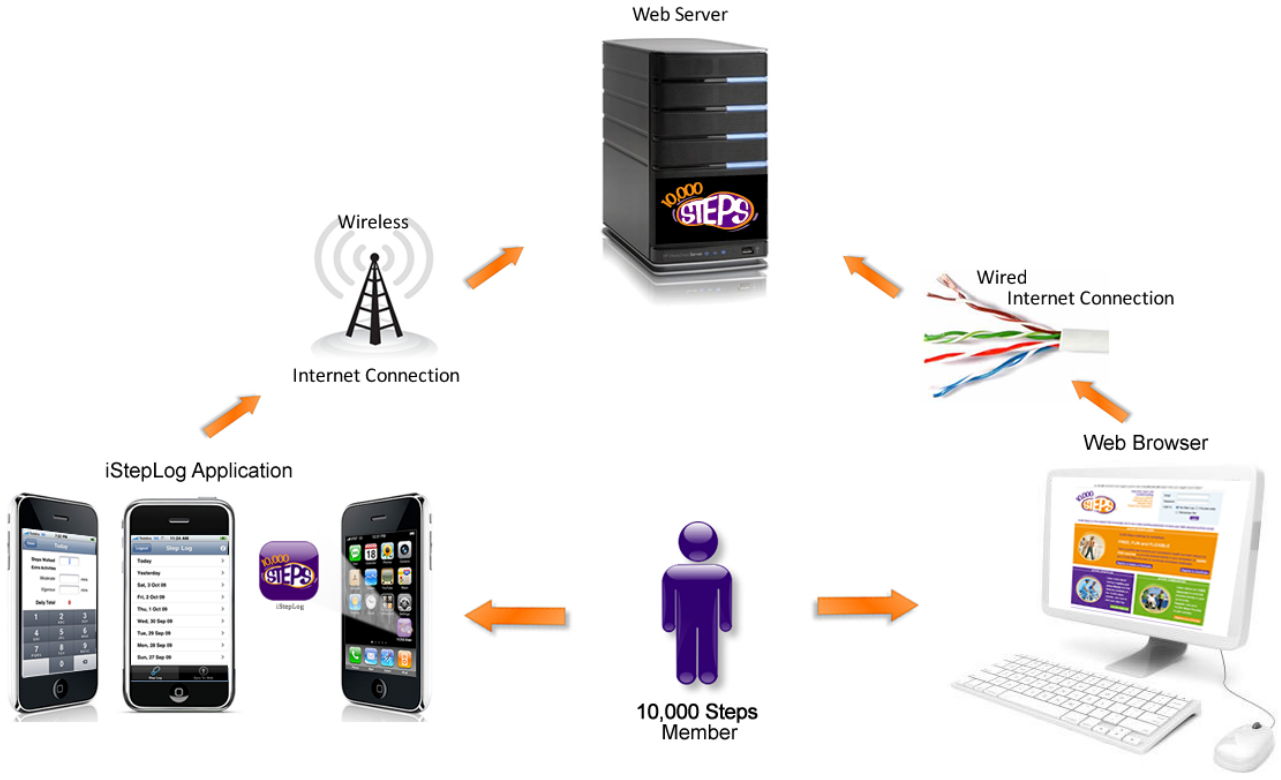
XSL•FO
RenderX

Procedures

After providing informed consent, the intervention group received the iStepLog application, to use on their own iPhone or iPod touch for 3 months. Participants in the intervention group were emailed an attachment with the iStepLog application, with instructions on how to install it on their smartphone. Over the course of the 3-month intervention (August to October 2009), these participants were able to log their steps either by using the iStepLog application on their device or by using the 10,000 Steps website (see Figure 2). Intervention participants were free to use either technology as they preferred; we did not require participants to continue to use the website during the intervention. Immediately following the study, we asked the intervention participants to complete a 10-item questionnaire concerning the usability and usefulness of the iStepLog application (see Table 1).

We selected matched group participants retrospectively, with the primary investigator blinded to the study period data and a strict protocol adopted. The matching procedure was performed for each intervention participant. The protocol followed was to first identify those individuals comparable in age (within 1 year either side) and of the same gender of the intervention participant. Of these individuals, we then isolated a cohort of possible matches. Possible matches had to be comparable for the number of steps logged each month (within 1000 steps either side) for the 3 months preintervention, as well as the frequency at which steps were logged each month (within one entry either side). From this selection, we chose the 3 individuals who most closely matched the length of time the intervention participant had been a member of 10,000 Steps. Matched group participants did not have access to the iSteplog application until after the completion of the study, when the application was officially launched in November 2009 and became available for dowload in Apple's online store (as of March 2012, more than 20,000 downloads of the application have been registered by Apple iTunes). On joining the 10,000 Steps program, the matched group participants had provided consent for their data to be used for research purposes. Ethics approval was gained from CQUniversity Human Research Ethics Committee prior to commencement.

Figure 2. Procedure for intervention participants to upload their daily steps to the 10,000 Steps Web server.



Measures

Data concerning participants' usage of the iStepLog application and 10,000 Steps website were collected. This information included total number of steps logged over the period of the intervention; total number of days steps were logged; total number of days steps were logged via the application compared with a Web browser; and time spent using the iStepLog application on each occasion over the intervention period. As the iStepLog was not designed to automatically monitor steps, participants self-reported their step count and may have used a 10,000 Steps-supported pedometer (Yamax Digiwalker; Yamasa Tokei Keiki Co, Ltd, Tokyo, Japan), which is known to have high reliability [39] and validity [40], or they may have used a pedometer of another brand; we did not know the participants' choice of pedometer.

When completing the usability and usefulness questionnaire, intervention participants rated their experience using a 5-point Likert scale (ranging from 1, strongly disagree to 5, strongly agree). The questions were based on a similar survey from a study evaluating the usability of the 10,000 Steps website [41].

XSL•FO
RenderX

Statistical Analysis

We calculated descriptive statistics and means for all variables. The continuous variable of total number of days on which steps were logged was dichotomized to those participants who logged steps every day and those who did not log steps every day, regardless of the device used to log steps (computer or smartphone). We selected this dichotomization because it has been suggested that the daily monitoring of physical activity levels alone may be enough to facilitate a change in behavior [42]. Logistic regression analyses were conducted to calculate the odds ratios and 95% confidence intervals of the intervention group logging steps on a daily basis and recording over 10,000 steps on each entry, compared with the matched group. Measured by Likert scale data, subjective usability and usefulness survey items from the intervention group were reverse scored so that higher values represented more favorable responses to the questions. We performed factor analysis using principal components analysis and varimax rotation on the overall scale to identify factors within the overall scale. Factor analysis provided two definable factors with eigenvalues over 1.0, and all items had factor loadings of at least 0.5; both factors contained five questions each. One item (question 6) displayed significant cross-loading on both factors, and we determined that from a theoretical perspective this item aligns more closely with the second factor; we therefore included this item on the second factor for all subsequent analysis. Table 1 lists questions included in the first factor, defined as usability (questions 1 to 5). We defined the second factor (questions 6 to 10) as usefulness.

Table 1. Outcomes of the usability and usefulness questionnaire (n = 44), rated on a scale from 1 (strongly disagree) to 5 (strongly agree).

Questionnaire item		Rating, mean (SD)	Agree or strongly agree, n (%)
Usability			
1	I think the iStepLog application is user-friendly	4.45 (0.66)	91% (40/44)
2	I like the overall presentation and layout of the iStepLog application	4.24 (0.66)	89% (39/44)
3	I was able to easily find my way around the iStepLog application	4.48 (0.59)	95% (42/44)
4	I was able to easily enter and edit my steps in the application	4.39 (0.65)	91% (40/44)
5	I was able to easily sync my steps to the 10,000 Steps website	4.21 (0.81)	80% (35/44)
Scale average of questions 1 to 5		4.35 (0.67)	89% (39/44)
Usefulness			
6	It was convenient for me to use the iStepLog application	4.50 (0.70)	89% (39/44)
7	I prefer to use the iStepLog application rather than go to the 10,000 Steps website to enter my steps	4.35 (0.75)	84% (37/44)
8	The iStepLog encouraged me to log my steps more often than before it was available	4.00 (0.83)	80% (35/44)
9	I didn't visit the 10,000 Steps website as often because I used the iStepLog application	4.33 (0.76)	84% (37/44)
10	I would like to continue using the iStepLog application	4.47 (0.70)	89% (39/44)
Scale average of questions 6 to 10		4.33 (0.75)	84% (36.8/44)

Usability and usefulness scores were calculated as the mean of scale items. We used separate linear regression models to examine the relationship between use of the application (dependent variable), in terms of total number of days participants logged steps, and the perceived usability and usefulness of the application (independent variables). We used PASW version 18.0 (IBM Corporation, Somers, NY, USA), with the significance level being set at alpha =.05.

Results

Table 2 outlines the variables matched for both groups. The average age of intervention group participants was 39.3 (SD 12.8) years and covered a wide age range (17 to 64 years); and 48% (n = 24) were women. As the intervention sample was matched with 10,000 Steps participants with similar demographics, the average age in the matched group was 40.1 (SD 12.1) years and 48% (n = 72) were also women. Intervention and matched participants were matched on the amount of time they had been members of the 10,000 Steps program, ranging from 40 to 820 days. An independent *t* test revealed no significant difference in the duration of membership (t_{198} = 0.779, P = .44) between the intervention and matched participants.

Table 3 outlines the findings concerning use of the iStepLog application of the 10,000 Steps program. Over the study period, the frequency with which participants logged steps declined significantly in the matched group (61 days preintervention, 41 days intervention), compared with the intervention group, which maintained their frequency of logging (61 days preintervention, 62 days intervention). In the 3 months preintervention, both groups were logging on average 10,000 steps on each occasion. During the study period the intervention group maintained their step count, but the matched group logged a significantly lower number (mean 6274.73, SD 2106.11 steps, P < .001). Logistic

XSL•FO
RenderX

regression analyses revealed that use of the application was associated with an increased likelihood to log steps on a daily basis during the intervention period compared with those not using the application (odds ratio 3.56, 95% confidence interval 1.72–7.39). Additionally, we found that the use of the application was associated with an increased likelihood to log greater than 10,000 steps on each entry (odds ratio 20.64, 95% confidence interval 9.19–46.39). Further analysis revealed that that the intervention group used the iStepLog application 71.22% (2210/3103) of the time to log steps when compared with a traditional Web browser (893/3103, 28.8%). Participants spent approximately 9 seconds using the application on each occasion.

Table 2. Matched variables for the intervention and matched groups.

	Intervention (n =50)	Matched (n = 150)	*P* value
Age (years), mean (SD)	39.3 (12.8)	40.1 (12.1)	.97
Gender (female), n (%)	24 (48%)	72 (48%)	
Length of membership (days), mean (SD)	426.79 (373.18)	430.31 (389.24)	.44
Steps logged per day in the 3 months preintervention, mean (SD)	10980.33 (3308.36)	10635.43 (3987.20)	.67
Total days steps logged 3 months preintervention, mean (SD)	60.90 (11.02)	61.30 (10.06)	.94

Table 3. Self-monitoring results for the intervention and matched groups over the 3-month intervention period.

	Intervention (n = 50)	Matched (n = 150)
Total days steps logged, mean (SD)	62.06 (12.48)	41.36 (12.25)*
Daily steps logged across study period, mean (SD)	11140.22 (4121.33)	6274.73 (2106.11)*
Ratio of steps logged using iStepLog application, n (%)	2210/3103 (71.22%)	NA[a]
Total time iStepLog application used per participant (minutes over intervention period), mean (SD)	11.1 (3.74)	NA[a]
Time per usage (seconds), mean (SD)	9.33 (3.21)	NA[a]

[a] Not applicable.

Table 1 shows the mean scores for the 10 usefulness and usability questionnaire items. In the intervention group, 6 participants did not complete the final questionnaire. Over 80% of respondents reported either agreeing or strongly agreeing with each item, which resulted in a high mean overall score for usefulness (mean 4.33, SD 0.75) and usability (mean 4.35, SD 0.67). Internal consistency (Cronbach alpha) for the usability (alpha = .88) and usefulness questionnaire items (alpha = .88) was high, indicating acceptable reliability of the measure. Linear regression analysis on both factors revealed a nonsignificant relationship between perceived usability (r = .216, P = .21) and usefulness (r = .229, P = .17) of the application and frequency of logging steps within the intervention group.

Discussion

This study examined the effectiveness of a smartphone application in increasing the frequency of self-monitoring of physical activity in active members of the online-delivered 10,000 Steps program. There is limited research measuring the usage of a health-related smartphone application and its effect on the behavior of users. The majority of health applications available for consumers are funded by commercial organizations, which are disinclined to distribute their usage information in a competitive market.

The iStepLog application was developed as an additional mode of delivery, to supplement the existing online method of interaction with the 10,000 Steps program. This research revealed that the iStepLog application assisted participants in maintaining engagement with the program. This is in contrast to the matched group, which had a significant decline in the frequency and number of steps logged over the intervention period. The difference in average daily steps between the groups is important from a health perspective because, according to established guidelines [43], the intervention group was considered to be active before the intervention and maintained this level of physical activity during the intervention period. Similarly, the matched group was considered to be active prior to the study period; however, this group declined to a level considered as somewhat active. The finding that the intervention group maintained their frequency of logging steps and the amount of activity over the study period is encouraging, as there is substantial evidence that the more frequently individuals engage with an online health intervention, the more likely they are to improve or maintain health-related behaviors [38]. Glasgow and colleagues [44] measured usage patterns of their diabetes self-management website and found that greater use of the website, and especially engagement in self-monitoring, was related to greater improvement in physical activity. Over the 4-month intervention period (112 days), diabetes patients logged their activity levels on average 53% of the time (59 days). In comparison, our study, conducted over 3 months (90

XSL•FO
RenderX

days), found that intervention participants logged their activity levels 69% of the time (62 days). The frequency with which participants logged steps was much higher in our study, and this may be attributed to the addition of the iStepLog application. Further research needs to be conducted to evaluate the long-term impact on health outcomes, incorporating objective measures of physical activity.

The high usage frequency (average of 40 times during the study period) and proportion of time (71% smartphone vs 29% website) the iStepLog application was used, and the high usability and usefulness scores suggest that intervention participants not only liked the design of the application, but also found it convenient and used it frequently. In our research, usability and usefulness of the iStepLog application were not significantly correlated with usage. This is likely due to the high usability and usefulness scores recorded across all intervention participants; this ceiling effect limits the variability in the scores to enable such a correlation.

Usage of the iStepLog application was high, when compared with a recent survey conducted by the Consumer Health Information Corporation, which found that smartphone applications have a high rate of dropouts, with 26% being used only once and 74% being discontinued by the 10th use [45]. This is encouraging, as it is established that for a user to adopt and frequently use a smartphone application they must consider it both usable and useful [46]. Considering that lack of usability and usefulness are top reasons for users to discontinue smartphone application usage [45], our findings illustrate how important it is not only to measure uptake and usage of smartphone applications, but also to consider measuring usability and usefulness, as this influences long-term adoption [47]. The average time spent using the application on each occasion in this study (9.3 seconds) is at the lower end of the range reported by others, ranging from 10 to 250 seconds [48]. In light of the intent of the iStepLog application to log steps and of the high usability scores in this study, we do not view this as a negative; rather it is consistent with the intent and design of the application to provide participants with a time-efficient mode of logging steps.

The effectiveness of smartphone applications to improve health behaviors is an emerging field of research. Abroms and colleagues [49] have examined the quality of the content provided in smoking cessation smartphone applications. They found that the 47 applications had low levels of adherence to established guidelines for smoking cessation [49]. Abroms and colleagues recommended that current applications be revised and all future applications be developed around evidence-based practices. With no current regulation of the health advice provided in smartphone applications, their recommendations are pertinent. Quality control is definitely a concern and very relevant considering the plethora of health applications (17,000) available for smartphone users [23]. Companies such as Apple have established guidelines for smartphone applications development, but these guiding principles relate solely to aesthetic design and functionality, and not to content. As Abroms and colleagues' [49] research highlighted, many health-related smartphone applications are providing misinformation. Further research needs to be conducted to establish both the quality of information provided and the efficacy of these applications in improving consumer health.

Several limitations of this study should be noted. This study design was a matched case–control trial of short duration with a small sample size, and this limits the generalizability of the findings. Due to the low response rate and eligibility criteria (being a 10,000 Steps member and owning an iPhone), intervention group participants were not representative of the wider population. The intervention group was also self-selected and may have been more motivated than the matched group; however, we attempted to limit this by matching this group on key demographic variables. A further limitation is that intervention participants knew they were part of a research study and were given an innovative self-monitoring tool, and this may have influenced their behavior, whereas this was not the case in the control group. Concomitantly the matched group did not receive a stimulus, and this may explain their lack of engagement and interaction with the 10,000 Steps program over the study period. Despite these limitations, this research contributes to a paucity of work concerning smartphone applications and their use as a health promotion tool. The results of this study highlight the importance of continuing to evaluate the effectiveness of smartphone applications to influence health behaviors.

The outcomes of this study suggest that the use of a smartphone application to self-monitor physical activity may assist in maintaining an active lifestyle. Further, providing a smartphone application as an adjunct tool for the delivery of an online physical activity promotion program may assist with maintaining participant engagement. From this study we have gained insight into the potential of smartphone applications to improve health behaviors. However, due to study design limitations, the outcomes should be interpreted with caution. More research is needed to determine the long-term outcomes of adopting this third generation of wireless technology as a tool in health promotion. In particular, examining the effectiveness of the iStepLog application among new users not previously exposed to a physical activity intervention could provide important insight into the effectiveness of this technology in supporting behavior change.

Acknowledgments

Queensland Health provided the funding to Central Queensland University for the development of 10,000 Steps. The development of the iStepLog application was funded by 10,000 Steps. C Vandelanotte is supported by a National Health and Medical Research Council of Australia (#519778) and National Heart Foundation of Australia (#PH 07B 3303) postdoctoral research fellowship. M Kirwan is supported by a Queensland Government, Department of Tourism, Regional Development and Industry SmartFutures PhD Scholarship.

XSL•FO
RenderX

Conflicts of Interest

None declared.

References

1. Virot P. World Health Organization. 2011 Sep. 10 Facts on Physical Activity URL: http://www.who.int/features/factfiles/physical_activity/en/ [accessed 2012-03-26] [WebCite Cache ID 66SUxR7RP]
2. World Health Organization. 2011. Physical Inactivity: A Global Public Health Problem URL: http://www.who.int/features/factfiles/physical_activity/en/ [accessed 2012-03-27] [WebCite Cache ID 66UWOBxGz]
3. Centers for Disease Control and Prevention. Guidelines for school and community programs to promote lifelong physical activity among young people. Centers for Disease Control and Prevention. MMWR Recomm Rep 1997 Mar 7;46(RR-6):1-36 [FREE Full text] [Medline: 9072670]
4. Calfas KJ, Long BJ, Sallis JF, Wooten WJ, Pratt M, Patrick K. A controlled trial of physician counseling to promote the adoption of physical activity. Prev Med 1996;25(3):225-233. [doi: 10.1006/pmed.1996.0050] [Medline: 8780999]
5. King AC, Sallis JF, Dunn AL, Simons-Morton DG, Albright CA, Cohen S, et al. Overview of the Activity Counseling Trial (ACT) intervention for promoting physical activity in primary health care settings. Activity Counseling Trial Research Group. Med Sci Sports Exerc 1998 Jul;30(7):1086-1096. [Medline: 9662678]
6. Glasgow RE, Boles SM, McKay HG, Feil EG, Barrera M. The D-Net diabetes self-management program: long-term implementation, outcomes, and generalization results. Prev Med 2003 Apr;36(4):410-419. [Medline: 12649049]
7. Feil EG, Glasgow RE, Boles S, McKay HG. Who participates in Internet-based self-management programs? A study among novice computer users in a primary care setting. Diabetes Educ 2000;26(5):806-811. [Medline: 11140008]
8. Hageman PA, Walker SN, Pullen CH. Tailored versus standard internet-delivered interventions to promote physical activity in older women. J Geriatr Phys Ther 2005;28(1):28-33. [Medline: 16236225]
9. Kosma M, Cardinal BJ, McCubbin JA. A pilot study of a web-based physical activity motivational program for adults with physical disabilities. Disabil Rehabil 2005 Dec 15;27(23):1435-1442. [doi: 10.1080/09638280500242713] [Medline: 16418058]
10. Ritterband LM, Thorndike FP, Cox DJ, Kovatchev BP, Gonder-Frederick LA. A behavior change model for internet interventions. Ann Behav Med 2009 Aug;38(1):18-27. [doi: 10.1007/s12160-009-9133-4] [Medline: 19802647]
11. Murray E, Khadjesari Z, White IR, Kalaitzaki E, Godfrey C, McCambridge J, et al. Methodological challenges in online trials. J Med Internet Res 2009;11(2):e9 [FREE Full text] [doi: 10.2196/jmir.1052] [Medline: 19403465]
12. McKay HG, King D, Eakin EG, Seeley JR, Glasgow RE. The diabetes network internet-based physical activity intervention: a randomized pilot study. Diabetes Care 2001 Aug;24(8):1328-1334. [Medline: 11473065]
13. Napolitano MA, Fotheringham M, Tate D, Sciamanna C, Leslie E, Owen N, et al. Evaluation of an internet-based physical activity intervention: a preliminary investigation. Ann Behav Med 2003;25(2):92-99. [Medline: 12704010]
14. Spittaels H, De Bourdeaudhuij I, Vandelanotte C. Evaluation of a website-delivered computer-tailored intervention for increasing physical activity in the general population. Prev Med 2007 Mar;44(3):209-217. [doi: 10.1016/j.ypmed.2006.11.010] [Medline: 17197015]
15. Vandelanotte C, Spathonis KM, Eakin EG, Owen N. Website-delivered physical activity interventions a review of the literature. Am J Prev Med 2007 Jul;33(1):54-64. [doi: 10.1016/j.amepre.2007.02.041] [Medline: 17572313]
16. Leslie E, Marshall AL, Owen N, Bauman A. Engagement and retention of participants in a physical activity website. Prev Med 2005 Jan;40(1):54-59. [doi: 10.1016/j.ypmed.2004.05.002] [Medline: 15530581]
17. Webb TL, Joseph J, Yardley L, Michie S. Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. J Med Internet Res 2010;12(1):e4 [FREE Full text] [doi: 10.2196/jmir.1376] [Medline: 20164043]
18. Plotnikoff RC, Karunamuni N. Steps towards permanently increasing physical activity in the population. Curr Opin Psychiatry 2011 Mar;24(2):162-167. [doi: 10.1097/YCO.0b013e3283438107] [Medline: 21206271]
19. Wei J, Hollin I, Kachnowski S. A review of the use of mobile phone text messaging in clinical and healthy behaviour interventions. J Telemed Telecare 2011;17(1):41-48. [doi: 10.1258/jtt.2010.100322] [Medline: 21097565]
20. Kolko BE, Rose EJ, Johnson EJ. Communication as information-seeking: the case for mobile social software for developing regions. 2007 Presented at: 16th International World Wide Web Conference; May 8-12, 2007; Banff, AB, Canada.
21. Donner J. Research approaches to mobile use in the developing world: a review of the literature. The Inf Soc 2008;24(3):140-159. [doi: 10.1080/01972240802019970]
22. Anonymous. Infonetics Research. 2008 Dec 3. The Mobile Internet Transformation URL: http://www.infonetics.com/whitepapers/2008-Infonetics-White-Paper-Mobile-Internet-Transformation-120308.pdf [accessed 2012-03-28] [WebCite Cache ID 66UQHis7g]
23. research2guidance. The Impact Of Smartphone Applications On The Mobile Health Industry (Vol. 2). 2012 Jan 09. Mobile Health Market Report 2011-2016 URL: http://www.research2guidance.com/shop/index.php/downloadable/download/sample/sample_id/160/ [accessed 2012-03-28] [WebCite Cache ID 66UQz9vEh]

XSL•FO
RenderX

24. Burns MN, Begale M, Duffecy J, Gergle D, Karr CJ, Giangrande E, et al. Harnessing context sensing to develop a mobile intervention for depression. J Med Internet Res 2011;13(3):e55 [FREE Full text] [doi: 10.2196/jmir.1838] [Medline: 21840837]
25. Chomutare T, Fernandez-Luque L, Arsand E, Hartvigsen G. Features of mobile diabetes applications: review of the literature and analysis of current applications compared against evidence-based guidelines. J Med Internet Res 2011;13(3):e65 [FREE Full text] [doi: 10.2196/jmir.1874] [Medline: 21979293]
26. Consolvo S, Klasnja P, McDonald DW, Avrahami D, Froehlich J, LeGrand L, et al. Flowers or a robot army? Encouraging awareness & activity with personal, mobile displays. 2008 Presented at: UbiComp 2008 Tenth International Conference on Ubiquitous Computing; Sep 21-24, 2008; Seoul, South Korea.
27. Tsai C, Lee G, Raab F, Norman G, Sohn T, Griswold W, et al. Usability and feasibility of PmEB: a mobile phone application for monitoring real time caloric balance. Mob Netw Appl 2007;12(2):173-184.
28. Thatte G, Li M, Lee S, Emken A, Narayanan S, Mitra U, et al. KNOWME: an energy-efficient, multimodal body area network for physical activity monitoring. ACM Trans Embed Comput Syst 2010 [FREE Full text]
29. Anonymous. Admob. 2010 May. May 2010 Mobile Metrics Report: iPhone and Android Platforms URL: http://www.metrics.admob.com [accessed 2011-02-01] [WebCite Cache ID 61u55YIOS]
30. Harvey-Berino J, Pintauro S, Buzzell P, Gold EC. Effect of internet support on the long-term maintenance of weight loss. Obes Res 2004 Feb;12(2):320-329. [doi: 10.1038/oby.2004.40] [Medline: 14981225]
31. Harvey-Berino J, Pintauro SJ, Gold EC. The feasibility of using Internet support for the maintenance of weight loss. Behav Modif 2002 Jan;26(1):103-116. [Medline: 11799651]
32. Anderson-Bill ES, Winett RA, Wojcik JR, Williams DM. Aging and the social cognitive determinants of physical activity behavior and behavior change: evidence from the guide to health trial. J Aging Res 2011;2011:505928 [FREE Full text] [doi: 10.4061/2011/505928] [Medline: 21629762]
33. Brown W, Mummery WK, Eakin E, Schofield G. 10,000 Steps Rockhampton: evaluation of a whole community approach to improving population levels of physical activity. J Phys Act Health 2006;3(1):1-14 [FREE Full text]
34. Brown W, Eakin E, Mummery WK, Trost S. 10,000 Steps Rockhampton: establishing a multi-strategy physical activity promotion in a community. Health Promot J Austr 2003;14(2):95-100.
35. Hooker C, Hall S, Connolly K, Duncan M. Institute for Health and Social Science Research, Central Queensland University. 2011 Jan. 10,000 Steps Working Paper Series, Paper 13: Awareness of the 10,000 Steps Program across Queensland, 2010 URL: http://www.10000steps.org.au/library/working-papers/ [accessed 2011-12-01] [WebCite Cache ID 61u5KSulM]
36. Joyner K. 10,000 Steps Project Office, Central Queensland University. 2006. 10,000 Steps Working Paper Series, Paper 3: Survey of Current 10,000 Steps Step Log Users. Sep URL: http://www.10000steps.org.au/pdfs/workingpapers_paper3_web_000.pdf [accessed 2012-03-28] [WebCite Cache ID 66UVrKemo]
37. Mummery K, Hinchcliffe A, Joyner K, Duncan M, Caperchione C. E-Health promotion: a descriptive analysis of participant use of an online physical activity step log. 2008 Presented at: 10th International Congress of Behavioral Medicine; Aug 27-30, 2008; Tokyo, Japan.
38. Wantland DJ, Portillo CJ, Holzemer WL, Slaughter R, McGhee EM. The effectiveness of Web-based vs. non-Web-based interventions: a meta-analysis of behavioral change outcomes. J Med Internet Res 2004 Nov 10;6(4):e40 [FREE Full text] [doi: 10.2196/jmir.6.4.e40] [Medline: 15631964]
39. Schneider PL, Crouter SE, Lukajic O, Bassett DR. Accuracy and reliability of 10 pedometers for measuring steps over a 400-m walk. Med Sci Sports Exerc 2003 Oct;35(10):1779-1784. [doi: 10.1249/01.MSS.0000089342.96098.C4] [Medline: 14523320]
40. Crouter SE, Schneider PL, Karabulut M, Bassett DR. Validity of 10 electronic pedometers for measuring steps, distance, and energy cost. Med Sci Sports Exerc 2003 Aug;35(8):1455-1460. [doi: 10.1249/01.MSS.0000078932.61440.A2] [Medline: 12900704]
41. Hinchliffe A, Mummery WK. Applying usability testing techniques to improve a health promotion website. Health Promot J Austr 2008 Apr;19(1):29-35. [Medline: 18481929]
42. Helsel DL, Jakicic JM, Otto AD. Comparison of techniques for self-monitoring eating and exercise behaviors on weight loss in a correspondence-based intervention. J Am Diet Assoc 2007 Oct;107(10):1807-1810. [doi: 10.1016/j.jada.2007.07.014] [Medline: 17904942]
43. Tudor-Locke C, Bassett DR. How many steps/day are enough? Preliminary pedometer indices for public health. Sports Med 2004;34(1):1-8. [Medline: 14715035]
44. Glasgow RE, Christiansen SM, Kurz D, King DK, Woolley T, Faber AJ, et al. Engagement in a diabetes self-management website: usage patterns and generalizability of program use. J Med Internet Res 2011;13(1):e9 [FREE Full text] [doi: 10.2196/jmir.1391] [Medline: 21371992]
45. Vang C. PRWeb, Consumer Health Information Corporation. 2011 Apr 25. Motivating Patients to Use Smartphone Health Apps URL: http://www.prweb.com/releases/2011/04/prweb5268884.htm [accessed 2011-09-22] [WebCite Cache ID 61u5gJ3k5]
46. Verkasalo H, López-Nicolás C, Molina-Castillo F, Bouwman H. Analysis of users and non-users of smartphone applications. Telemat Inform 2010;27(3):242-255. [doi: 10.1016/j.tele.2009.11.001]

XSL•FO
RenderX

47. Wichansky AM. Usability testing in 2000 and beyond. Ergonomics 2000 Jul;43(7):998-1006. [doi: 10.1080/001401300409170] [Medline: 10929833]
48. Falaki H, Mahajan R, Kandula S, Lymberopoulos D, Govindan R, Estrin D. Diversity in smartphone usage. In: MobiSys 2010. 2010 Presented at: 8th Annual International Conference on Mobile Systems, Applications and Services; Jun 15-18, 2010; San Francisco, CA, USA.
49. Abroms LC, Padmanabhan N, Thaweethai L, Phillips T. iPhone apps for smoking cessation: a content analysis. Am J Prev Med 2011 Mar;40(3):279-285. [doi: 10.1016/j.amepre.2010.10.032] [Medline: 21335258]

Edited by G Eysenbach; submitted 27.09.11; peer-reviewed by E Anderson-Bill, J Thomas, K De Cocker; comments to author 18.10.11; revised version received 08.03.12; accepted 08.03.12; published 20.04.12.

Please cite as:
Kirwan M, Duncan MJ, Vandelanotte C, Mummery WK
Using Smartphone Technology to Monitor Physical Activity in the 10,000 Steps Program: A Matched Case–Control Trial
J Med Internet Res 2012;14(2):e55
URL: http://www.jmir.org/2012/2/e55/
doi:10.2196/jmir.1950
PMID:22522112

©Morwenna Kirwan, Mitch J Duncan, Corneel Vandelanotte, W Kerry Mummery. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 20.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Viewpoint

Crowdsourced Health Research Studies: An Important Emerging Complement to Clinical Trials in the Public Health Research Ecosystem

Melanie Swan[1], MBA

MS Futures Group, Palo Alto, CA, United States

Corresponding Author:
Melanie Swan, MBA
MS Futures Group
PO Box 61258
Palo Alto, CA, 94306
United States
Phone: 1 6506819482
Fax: 1 5416967726
Email: m@melanieswan.com

Abstract

Background: Crowdsourced health research studies are the nexus of three contemporary trends: 1) citizen science (non-professionally trained individuals conducting science-related activities); 2) crowdsourcing (use of web-based technologies to recruit project participants); and 3) medicine 2.0 / health 2.0 (active participation of individuals in their health care particularly using web 2.0 technologies). Crowdsourced health research studies have arisen as a natural extension of the activities of health social networks (online health interest communities), and can be researcher-organized or participant-organized. In the last few years, professional researchers have been crowdsourcing cohorts from health social networks for the conduct of traditional studies. Participants have also begun to organize their own research studies through health social networks and health collaboration communities created especially for the purpose of self-experimentation and the investigation of health-related concerns.

Objective: The objective of this analysis is to undertake a comprehensive narrative review of crowdsourced health research studies. This review will assess the status, impact, and prospects of crowdsourced health research studies.

Methods: Crowdsourced health research studies were identified through a search of literature published from 2000 to 2011 and informal interviews conducted 2008-2011. Keyword terms related to crowdsourcing were sought in Medline/PubMed. Papers that presented results from human health studies that included crowdsourced populations were selected for inclusion. Crowdsourced health research studies not published in the scientific literature were identified by attending industry conferences and events, interviewing attendees, and reviewing related websites.

Results: Participatory health is a growing area with individuals using health social networks, crowdsourced studies, smartphone health applications, and personal health records to achieve positive outcomes for a variety of health conditions. PatientsLikeMe and 23andMe are the leading operators of researcher-organized, crowdsourced health research studies. These operators have published findings in the areas of disease research, drug response, user experience in crowdsourced studies, and genetic association. Quantified Self, Genomera, and DIYgenomics are communities of participant-organized health research studies where individuals conduct self-experimentation and group studies. Crowdsourced health research studies have a diversity of intended outcomes and levels of scientific rigor.

Conclusions: Participatory health initiatives are becoming part of the public health ecosystem and their rapid growth is facilitated by Internet and social networking influences. Large-scale parameter-stratified cohorts have potential to facilitate a next-generation understanding of disease and drug response. Not only is the large size of crowdsourced cohorts an asset to medical discovery, too is the near-immediate speed at which medical findings might be tested and applied. Participatory health initiatives are expanding the scope of medicine from a traditional focus on disease cure to a personalized preventive approach. Crowdsourced health research studies are a promising complement and extension to traditional clinical trials as a model for the conduct of health research.

(J Med Internet Res 2012;14(2):e46) doi:10.2196/jmir.1988

XSL•FO
RenderX

KEYWORDS

Community-Based Participatory Research; Preventive Medicine; Personalized Medicine; Individualized Medicine; Consumer Participation; Health Services Research; Health Care Research; Public Health; Genomics; Medicine

Introduction

Crowdsourced health research studies are the nexus of three contemporary trends: citizen science (non-professionally trained individuals conducting science-related activities), crowdsourcing (use of web-based technologies to recruit project participants), and medicine 2.0 / health 2.0 (active participation of individuals in their health care particularly using web 2.0 technologies). Crowdsourced health research studies have arisen as a natural extension of the activities of online health social networks and communities. Studies may be researcher-organized or participant-organized. Professional researchers crowdsource cohorts from health social networks for the conduct of traditional studies. In contrast, participants organize their own health research studies through health social networks and health collaboration communities; these communities are created for the purpose of self-experimentation and for the investigation of shared health concerns together in groups. Before embarking on a narrative overview of crowdsourced research studies, I will first consider the definition of citizen science, crowdsourcing, medicine 2.0 / health 2.0, and crowdsourced health research studies. I will then provide an overview of crowdsourced health research studies that have been conducted by professional researchers and/or participants. Finally, I will discuss the limitations of these methods, and offer conclusions.

Citizen Science

Citizen science is the conduct of science-related activities by individuals who have no formal training in a field specific to the topic of investigation. Citizen science practitioners may include laypersons, scientists, or professionals trained in other fields. Citizen science projects have been in existence for hundreds of years; the professional scientist is a relatively recent incarnation. One prominent example of citizen science is the National Audubon Society's annual Christmas bird watch, in its 112th year with tens of thousands of participants in 2011 [1]. Another high-profile project is Galaxy Zoo, where over 250,000 individuals have annotated astronomical data from the Sloan Digital Sky Survey, surprising project organizers by completing 50 million images in the first year as opposed to an anticipated 1 million [2]. A citizen science referral and advocacy website, SciStarter [3], listed 340 projects for participation as of January 2012 in 20 areas ranging from the environment to health. The Citizen Science Alliance [4] is another industry group which supports citizen science and coordinates Galaxy Zoo and other astronomy-related projects.

Crowdsourcing

Crowdsoucing is the practice of obtaining participants, services, ideas, or content by soliciting contributions from a large group of people, especially via the Internet [5]. Canvasing vast numbers of individuals through an open call facilitates self-selection. In particular, there is potential for crowdsourcing to capitalize on the input of interested and fit individuals who have the best ideas and bring a diverse set of skills and backgrounds to bear on the current task. Some notable examples of successfully crowdsourced projects are discussed in *The Wisdom of Crowds* [6] and *Wikinomics* [7].

Medicine 2.0 / Health 2.0 and Participatory Medicine

Some of the early definitional discussions of medicine 2.0 / health 2.0 (which are largely used synonymously [8]) occurred in 2008 and focused on the deployment of social media in the health context; that is, that medicine 2.0 / health 2.0 is the use of web 2.0 tools (eg, blogs, podcasts, tagging, search, wikis, video) by health care actors to improve collaboration and personalize health care [8,9]. In 2010, a related concept, participatory medicine, was introduced to emphasize the active participation of individuals: "This new definition devised by the board of the Society of Participatory Medicine is a movement in which networked patients shift from being mere passengers to responsible drivers of their health, and in which providers encourage and value them as full partners [10]."

These definitions have helped to undergird the medicine 2.0 / health 2.0 and participatory medicine movement. A Pew Internet study found that 27% of US Internet users had tracked health data online and 18% had sought to locate others with similar health concerns via the Internet [11]. At present, individuals have the opportunity to self-manage their health using web 2.0 tools, smartphone health applications, online personal health records, and health social networks. Health social networks, essentially Facebook or LinkedIn for health interest areas, are online communities where individuals may find and discuss information about conditions, symptoms, and treatments; provide and receive support; enter and monitor data; and join health studies [12]. Health social networks exemplify the predicted progression of engagement in online communities, escalating in three stages from information-sharing, to cooperating, to participating in collaborative action [13]. As of January 2012, some of the largest health social networks for patients are MedHelp (claiming over 12 million monthly visitors), PatientsLikeMe, DailyStrength, Tudiabetes, CureTogether, and Asthmapolis; and for physicians, Sermo, Ozmosis, and RadRounds [14].

Crowdsourced Health Research Studies

The nexus of these trends—citizen science, crowdsourcing, and medicine 2.0 / health 2.0—is crowdsourced health research studies. One indication of the relative newness, growth, and interest in this area is the exponential rise in recent Internet activity in crowdsourced health research. In 2011, 1,920,000 results were returned for a Google search of the terms 'crowdsourcing and health'; in 2010 and 2009 the comparative figure was 669,000 and 318,000 respectively. In January 2012, the term 'crowdsourcing' in a PubMed search yielded 16 publications, 13 of which were published in 2011.

Crowdsourced health research studies may be a blend of crowdsourcing and citizen science. In addition, these terms are often used interchangeably. This lack of precision in language

XSL•FO
RenderX

is an artifact of the relative newness of these concepts that are being defined through use. Within crowdsourced studies, participants are recruited via crowdsourcing (eg, recruited online with a website or an open call to a large potential audience using Internet-related technologies). In crowdsourced studies participants could be subjects not performing any science-related activities themselves, and therefore would not be considered citizen scientists. The use of the term 'citizen scientist' denotes the conduct of science-related activities by participants. Examples are citizen scientists being crowdsourced to annotate astronomical data in the Galaxy Zoo projects, or when an online crowd analyzed scientific images of cells in a tuberculosis study [15]. There may be many other permutations. Citizen scientists might be crowdsourced for idea generation and hypothesis formation, data collection, results analysis, results dissemination, and/or study funding ('crowdfunding').

In addition to opportunity for participant engagement, crowdsourced research may be different to traditional studies in other ways. First, crowdsourced research provides opportunity for more levels of openness and privacy, as participants decide what data to share with whom. One potential result is that there is less regulated protection of research subjects. Instead individuals take responsibility for informing themselves (possibly in consultation with physicians) about self-experimentation or study participation. Second, within crowdsourced research the rewards may accrue more directly to study participants and health communities as opposed to study funders in the more traditional model. Third, funding may come from alternative sources such as academia, industry, patient advocacy groups, research foundations, social venture capital, crowdfunding, and self-funding.

In this article, the term 'crowdsourced health research studies' is used to indicate that health study participants are recruited with crowdsourcing (eg, Internet-based) techniques. Study participants may or may not be acting as citizen scientists (ie, conducting science-related activities).

Participant Motivations and Expectations

Individuals have a variety of motivations for participating in crowdsourced health research studies. On a personal level, they may be drawn by natural curiosity, wanting to tinker and test hypotheses in a health interest area. Individuals taking a broader societal perspective may wish to participate in, contribute to, impact on, and at times conduct, projects that are outside the scope of traditional research. Another dimension of the broader societal perspective is how individuals may view themselves in relation to society. There is a developing notion of biocitizenry: that being a citizen scientist, and sharing personal health information, or using it as a currency for gaining access to studies could be considered acts of citizenship [16,17].

The direct and personal connection that individuals have to health makes crowdsourced health research distinct from other crowdsourced studies. Perhaps due to this personal connection, and the ease of self-tracking and experimenting with interventions, the role of the participant is expanding more quickly in health compared to other citizen science areas. In particular, the participant is engaging not just as a provider of outsourced data collection, but also helping with data analysis, and possibly the design and conduct of studies. Participant expectations of their engagement in crowdsourced studies are also different as they make demands on study organizers to return study data, provide interpretive personalized recommendations, and want the ability to communicate with other study participants [18].

Types and Methods of Crowdsourced Health Research Studies

Crowdsourced health research studies can be researcher-organized or participant-organized. Researcher-organized studies are typically traditional studies organized by institutionally-trained researchers using crowdsourced health social network cohorts or crowdsourced data as the input or research focus; for example, studies organized by PatientsLikeMe [19] and 23andMe [20]. Participant-organized studies are usually designed and operated by citizen scientists; for example, those conducted by PatientsLikeMe patients, DIYgenomics citizen scientists [21], and Quantified Self individual experimenters [22].

The research methods available in crowdsourced health research studies are detailed in Table 1.

Table 1. Research methods employed to date in crowdsourced health research studies.

	Study organizer	Research methods and types of data available
Researcher-organized studies		
	PatientsLikeMe	Self-reported data, survey questionnaires
	23andMe	Genotyping data, survey questionnaires
Participant-organized studies		
	Genomera, Althea Health, DIYgenomics	Genotyping data, blood test result PDF files, self-reported data, survey questionnaires
	Quantified Self	Self-tracking device data (eg, myZeo, FitBit, TelCare, etc.), self-reported data (manually collected)

Principal Aim of This Study

The principal aim of this analysis is to provide an overview of crowdsourced health research studies. The narrative will characterize the nature of current activity and highlight differences between crowdsourcing and traditional methodologies.

XSL•FO
RenderX

Methods

An analysis of crowdsourced health research studies was undertaken through a literature search and interviews. The literature review consisted of first generating a list of potential published studies for inclusion by searching the keyword terms 'crowdsourcing, crowdsourced, patient-organized, participatory, self-experimentation, PatientsLikeMe, and 23andMe' in Medline/PubMed, ISI Web of Science, and Google Scholar. Further searches in the same engines were then conducted for other papers by authors of the publications found in the initial search. Additional papers were also selected from the bibliographies of initially retrieved articles. Searches were conducted of papers published from 2000 to 2011. The inclusion criteria were that papers needed to report on (1) a human health study, (2) a study conducted on a crowdsourced population, and (3) a study with protocol details and results. Crowdsourced health research studies not published in the scientific literature were identified by attending 5 larger conferences (Medicine 2.0 congress, also known as the World Congress on Social Media, Mobile Apps, and Web 2.0 in Health and Medicine [23], Quantified Self, HealthCamp [24]) and over twenty Quantified Self meetups [22] in different cities from 2008 to 2011. Discussions and follow-up discussions were held with event participants, and related websites were reviewed (Medicine 2.0 [23], Quantified Self [22], Genomera [25], Althea Health [26], and DIYgenomics).

Results

Researcher-Organized Studies: PatientsLikeMe, 23andMe

PatientsLikeMe Crowdsourced Studies

PatientsLikeMe (PLM) is currently the largest operator of crowdsourced health research studies with one of the largest open patient registries and online health social networks (more than 125,000 members in 1000 condition-based communities as of January 2012). Amongst other initiatives, the company aims to connect 1 million rare disease patients by the end of 2012 [27]. Members may enter demographic information and track their treatments, symptoms, and outcomes, and find other patients like themselves matched by demographic and clinical characteristics (see Figure 1). Over 25 PLM-authored papers have been published in peer-reviewed journals such as the *Journal of Medical Internet Research*, *Nature Biotechnology*, the *Proceedings of the National Academy of Sciences*, and recognized neurology journals, many of which present the results of researcher-organized crowdsourced studies.

One of the best known PLM studies is the lithium study [28], which is also an interesting model of how patient-organized crowdsourced studies, researcher-organized crowdsourced studies, and traditional randomized controlled trials (RCTs) may be complementary phases in the overall investigatory process. In one of the first reported cases of patient-organized studies, a PLM community member with amyotrophic lateral sclerosis (ALS) found a small blinded Italian study (16 cases and 28 controls) [29] where lithium was found to slow disease progression in ALS patients, but which also warned that the model might not be applicable in other circumstances. The PLM community member convinced others to collaborate in a participative study where patients would apply the published findings in the Italian study to themselves. Initially, 348 PLM patients began the off-label use of lithium, overseen by their physicians. At the end of the study, self-reported data were available for 149 patients who took lithium for at least two months, and 78 patients who took lithium for 12 months. Ultimately, lithium was found not to have a positive impact in slowing disease progression in ALS patients in three tiers of study: initially through PLM patient self-experimentation, then through an observational study conducted by PLM researchers by comparing the 149 cases with 447 controls based on disease progression, and later in traditional randomized studies [30,31]. The distinguishing feature of the patient-organized portion of the study that characterizes it as citizen science was the instigative role of the patients in identifying and applying the study to themselves, self-collecting and reporting data, and seeking the drug directly rather than having it sponsored by a drug company. In the future, self-experimentation in citizen science cohorts might act as a real-time sensor network or barometer for early indications that could be later confirmed in more structured studies or RCTs.

XSL•FO
RenderX

Figure 1. Charts comprising the personal profile of a user on PatientsLikeMe (Image Source: Frost & Massagli, Journal of Medical Internet Research [74], licensed under Creative Commons Attribution License 2.0).



Amyotrophic Lateral Sclerosis (ALS)-Specific Research

ALS is PLM's flagship community and a key research area. A recent study used questionnaires to investigate a potential connection between the physical use of a limb and disease onset, and found that there was concordance for handedness but not footedness in the limb onset of ALS in 343 patients. The study found that this could be due to 1 arm typically dominating in upper-body activities but both limbs being used equally in lower-body activities such as standing and walking. Cortical factors could also be related [32]. Another study used questionnaires, taking the standardized disease measurement scale for ALS as a starting point for improving the lack of detailed measures of patient function sensitivity in advanced ALS. Of 10 new items investigated, 3 were suggested for inclusion in the scale: the ability to use fingers to manipulate devices, show emotional expression in the face, and get around inside the home [33]. Other work employed questionnaires to determine some of the reasons for low participation in ALS studies, and found patients are not being invited to enroll, have concerns about the cost of participation, and are confused over aspects of the studies [34].

One benefit of the new crowdsourced methodologies, having over 1000 conditions on the PLM platform for example, is the ability to conduct comparative research. One study identified that the tendency towards pathological gambling in Parkinson's disease patients also may exist in ALS patients, although to a lesser degree (13% versus 3% respectively) [35].

Health Social Network Findings Related to Prescription Drug Use

Health social networks can be a useful resource for investigating drug-related activity such as off-label use, side effects, product safety, and patient sentiment. Off-label drug use is commonplace (21% of US prescriptions) as physicians may use a side effect as a main effect. However, scientific evidence for off-label drug use is lacking for 73% of cases, and wasteful or harmful treatment may occur [36]. Additionally, prescribers may not have enough cases or appropriate experimental processes to establish statistically meaningful off-label use. The larger numbers of patients available in health social networks can help in a more systematic investigation of off-label drug use. In one study, PLM analyzed off-label drug use for amitriptyline and modafinil, respectively approved for treating depression, and narcolepsy or sleep apnea. The study found that 91% (n = 1089) of amitriptyline users took the drug for an off-label use, as did 99% (n = 1737) of modafinil users. The off-label use was specific to disease conditions and showed a benefit. Taking advantage of a normally unpleasant dry mouth side effect, 40% of amitriptyline users with ALS reported a reduction in unwanted excess saliva. Likewise, 36% of wakefulness-promoting agent modafinil users with multiple sclerosis (MS) and Parkinson's disease reported an improvement

XSL•FO
RenderX

in combating the general fatigue of the conditions. It was concluded that patient-reported outcomes could provide a new source of evidence about secondary uses for drugs and potentially identify targets for further study in RCTs.

In another PLM study, information reported online by the MS community was used to develop a survey for quantifying medication adherence, a known challenge particularly with MS [37]. Of the 36% of the PLM MS community that participated in the survey, 16% to 51% (depending on the treatment) of patients reported missing at least one dose of medication in the last 28 days. User-reported information like this could be used to develop more effective medication regimens based on user behavior by being more reflective of disease cycles and the daily rhythms of patients. Regarding perceptions of product safety, another study found that patient sentiment (per PLM forum discussion) remained positive for the MS drug Tysabri (natalizumab) even after it was linked to 3 cases of progressive multifocal leukoencephalopathy in 2008 [38].

Experience of Individuals Participating in Health Social Networks

In addition to the conduct of condition-related research, PLM examines the ongoing user experience of health social network participation. In one study, 19% of PLM community members responded to a survey, and when queried, overwhelmingly reported having had a positive experience with health social networking. Members used the site to learn about symptoms, understand treatments and their side effects, and make decisions about treatments (for example to start or stop treatments or change a dosage). Members also reported increased comfort in sharing personal health information [39].

Another study reports on the benefits of obtaining information about disease peers in health social networks. Benefits include the ability for patients to know how well they are doing in comparison to others and if they are receiving the most successful treatments [40]. Other studies discussed some of the next steps for improving the quality of information derived from health social networks, for example, having appropriate means of interpreting unstructured information, managing churning community populations, and confirming the accuracy of self-reported data. An effort should be made to determine whether health social network participation improves real-world outcomes, and to identify new tools that could further empower patients in managing their health [38]. One such tool would be expanding the functionality of health social network platforms to facilitate patient-organized studies like the lithium study [36].

23andMe Genome Association Studies

23andMe is the largest personal genotyping community, and as of June 2011 had over 100,000 genome service subscribers. A handful of research studies have been published in peer-reviewed journals such as PLoS Genetics and PLoS One. Over 75% of the 23andMe community has indicated a willingness to participate in research studies organized by the company [41,42]. One study was the largest case-control genome-wide association examination of Parkinson's disease conducted on a single collection of individuals (3426 cases and 29,624 controls). The study replicated 20 previously discovered genetic associations and discovered 2 new ones (rs6812193 near lysosome protein-related SCARB2, and rs11868035 near sterol regulation-related SREBF1/RAI1) [43].

Another study addressed the problem of collecting phenotypic data for large cohorts. 23andMe community members were asked to complete questionnaires, and 20,000 individuals reported data on 50 medical phenotypes. One hundred and eighty previously reported associations (curated by the National Human Genome Research Institute) were replicated for conditions such as type 2 diabetes, prostate cancer, cholesterol levels, and multiple sclerosis. These were, however, only 75% of expected associations [44], underlining the challenges of applied genetics [45] and suggesting the potential value of large-cohort follow-on studies.

An earlier study validated self-reported data in health social networks, focusing on non-disease conditions. Existing genetic associations were replicated for hair color, eye color, and freckling, and novel associations were found for hair morphology, freckling, smell detection, and sneeze reflex [46]. In addition to targeted studies, 23andMe has a community research effort, 23andWe, with ongoing open-enrollment via their website for a variety of conditions such as Parkinson's disease, sarcoma, and myeloproliferative neoplasms [47].

Participant-Organized Studies: Quantified Self, Genomera, and DIYgenomics

Self-experimentation and participant-organized studies may arise naturally through health social networks like the PLM lithium study, and also through communities that have been created expressly for the purpose of conducting experiments in individuals and groups. One such example is the Quantified Self community, a collaboration of users and toolmakers who share an interest in personalized knowledge through self-tracking [48]. The initial meeting of the group was on September 10, 2008 in San Francisco, California with 28 attendees. Just 3 years later, as of January 2012, 5524 members were listed in 42 worldwide meetup groups [22]. Numerous self-tracking projects have been shared at 'Show and Tell' meetings and approximately 20 posters were presented at the group's inaugural conference held in Silicon Valley in May 2011 [49]. Another self-tracking community is being convened at an Association for the Advancement of Artificial Intelligence meeting entitled Self-tracking and Collective Intelligence for Personal Wellness, in March 2012 [50], with the conceptual framing of citizen scientists comprising a new form of intelligence, 'community computing.'

Quantified self-experimentation has produced at least two peer-reviewed journal articles that provide examples of a robust and limitation-cognizant framework for self-experimentation in the areas of sleep, mood, health, and weight [51,52]. Specifically, an individual was able to reduce early awakening by avoiding breakfast and spending more time during the day standing, to improve mood by seeing faces in the morning, and to lose weight by drinking sugar water [51].

For a design school thesis project that was published online but not peer-reviewed, another quantified self-tracker measured several aspects of daily life and presented data visualizations

XSL•FO
RenderX

of a year of food consumption [53]. Most quantified self-projects to date have focused on experimentation in n = 1 studies, but group studies are also emerging. One example is the Butter Mind study, which was conducted with the advice of a scientist but not independently reviewed. The results were presented in a blog entry [54]. The randomized experiment had 45 individuals, took place from October 23 to November 12, 2010 and found that eating 2 ounces (56.7 grams) of butter per day resulted in improved arithmetic speed. There were limitations, including no clear articulation of method, a small sample size with limited statistical power, and results that did not control for IQ or education levels. Another crowdsourced group study, the Blueberry Study, has been running since 1999 with hundreds of participants investigating a potential link between blueberry consumption and enhanced mental performance. In 2011, study organizers reported that a 1% improvement in memory performance (as measured by online word recall exercises) occurred within a 1-year period. Results appear to be unreviewed and are reported in conference posters and online [55].

Group studies are also being conducted by DIYgenomics. The organization is attempting to realize preventive medicine by organizing studies according to the generalized hypothesis that one or more genetic polymorphisms may lead to out-of-bounds phenotypic biomarker levels, and that these may be ameliorated through personalized intervention. The methodology and results of a pilot study were published in the *Journal of Participatory Medicine* [56]. In the pilot study, conducted from June to December 2010, a crowdsourced cohort examined the potential role of methylenetetrahydrofolate reductase (MTHFR) polymorphisms in vitamin B deficiency and homocysteine levels, and tested a series of supplement interventions. The study found that 57% (n = 4) of the healthy cohort members already had higher-than-recommended homocysteine levels at baseline, and that personalized vitamin supplementation strategies quickly helped to bring these levels back into recommended ranges, particularly for those that were vegan or vegetarian and had one or more genetic polymorphisms. The best intervention for 5 individuals was the regular B vitamin, and for the 2 remaining individuals was the active form of B-9 (folate). The study was unique in that participants were also investigators, acting in collaboration with each other to determine all aspects of the study including protocol design and results interpretation. In this case, participants wished to be, and were identified publicly by name. Advice on the study protocol was gained from 2 independent experts in the field. The study is ongoing, with open enrollment; there are 24 participants as of January 2012 [57].

DIYgenomics currently has 6 other studies in open enrollment, covering a range of conditions including vitamin deficiency, aging, mental performance, and epistemology. One study concerns memory filtering and is in collaboration with the University of Geneva [58].

Study Operation Platforms

The Butter Mind study and the DIYgenomics studies were run on the Genomera personal health collaboration platform. Genomera is conceptually an ‘eBay for health science experiments,’ where any community member (professional researchers and citizen scientists alike) may post a study in an area of interest and attempt to crowdsource participants. As of January 2012, there were 20 studies listed on the site, with enrolled participants ranging from 10 to 60 per study, and over 300 community members volunteering to participate in crowdsourced studies by providing genotypic and phenotypic information. Individuals may participate at different levels with accompanying security protections, for example as a community member, study discussion participant, study data participant, or study organizer. Althea Health is a similar platform for the operation of crowdsourced longitudinal health research studies [26].

Self-Tracking Tools

In addition to Internet-based platforms for the automated operation of crowdsourced health research studies, self-tracking tools and their validation and calibration are essential for accurate data collection. The Quantified Self website lists over 400 such tools [59]. Zeo, the provider of a low-cost sleep tracking wireless system, commissioned a study with 29 subjects that validated data collection with their device as compared to traditional sleep laboratory measurements with polysomnography and actigraphy [60]. As widespread low-cost access to automated data collection tools grows, the number of individuals self-tracking and monitoring their health behavior could increase substantially. Continuously collected data from wireless sensors, accelerometers, gyroscopes, and pressure-sensitive textiles could be transmitted via smartphone or home WiFi networks and interpreted into personalized recommendations via the Internet with machine-learning algorithms [61]. Self-tracking data may be useful both to individuals for health self-management, and in clinical trials to convey a richer and less artificial picture of real-life activities.

Discussion

Principal Results

Different kinds of crowdsourced health research studies have been conducted. PatientsLikeMe and 23andMe are the leading operators of crowdsourced health research studies and have published results in peer-reviewed journals. Research findings have been in the areas of improving the characterization and measurement of disease, investigating aspects of prescription drug use (off-label use, medication adherence, and patient sentiment), exploring health social network user experience, and establishing disease and trait-based genetic associations. Quantified Self, Genomera, and DIYgenomics are the largest communities of participant-organized health research studies.

Results have been published in peer-reviewed journals, but more often in unreviewed gray literature. Self-experimentation studies have focused on optimizing physical and mental performance, improving alertness, mood, and weight loss, visualizing food consumption, and validating a consumer sleep-tracking device. Collaborative group studies have targeted mental performance, vitamin deficiency, and aging.

XSL•FO
RenderX

Limitations of Crowdsourced Health Research Studies and Their Critiques

Two dimensions of limitations are considered here. First, limitations in the evidence base (study methods, study design, regulation, and oversight), and second, limitations in critiques made of the field (degree of novel findings, citizen science as a pseudo-science, and overstating of impact). Current practitioner responses and potential future solutions to these limitations will be discussed.

Methodological Shortcomings: Self-Reported Data

There are limitations in the methods currently used by researchers in crowdsourced health research studies. Much of the available information is self-reported, and it cannot be verified whether the participant actually has the condition, engaged in the intervention(s), and/or reported accurate outcome data. In addition, disease patients may not be sufficiently reliable to diagnose and report on their own conditions [62]. Study organizers have managed these challenges by conducting in-house calculations to see how results would differ if some of the controls were really cases and vice versa [62], collecting (but not verifying) attending physician information [30], pointing out that it would be time-consuming and without ostensible benefit to participants to falsify data [30], and asking study participants to submit externally-validated data (such as blood test results via PDF forms) [56]. Encouragingly, 1 study found that crowdsourced data was at least as good or better than traditionally collected samples [63]. In the future, statistical analysis and automated data checks could be developed to confirm prescription activity with diagnosing physicians and otherwise validate data, perhaps similar to anomaly detection, credit-scoring, and fraud detection algorithms.

Study Design Shortcomings: Protocol, Self-Selection Bias, and Funding

Limitations are also apparent in study design employed in crowdsourced health research studies in the areas of protocol, self-selection bias, and funding. Crowdsourced health research studies do not always follow the rigorous protocols of randomized blinded controlled studies. A variety of alternative designs are the norm in crowdsourced health research; these designs enable costs to remain relatively low and increase feasibility of conducting studies. Designs used include observational studies, crossover studies, and adaptive studies. Some studies are without blinding and/or do not include a placebo arm. Concerns have been raised that differences may be observed when participants are subjects who knowingly collect and report their own data. Therefore, such biases may be particularly pronounced in participant-organized studies; especially where protocols are unclear.

Another protocol limitation has been that, thus far, the only form of study conducted by professional researchers in crowdsourced cohorts has been retrospective, non-interventional user questionnaires. There is, therefore, an opportunity for professional researchers to pursue intervention-based studies in crowdsourced cohorts.

Within crowdsourced studies there is the potential for self-selection bias. Crowdsourced study members are like-minded participants that are perhaps not representative of the target population [62]. This can result in cohort populations that are too homogenous or too heterogeneous, and cohorts that have high intra-individual variance, small sample sizes, and results that are not statistically significant. Self-selection bias could be improved both through alternative study design protocols, for example in the case of genetic studies using a complementary genome-wide association study (GWAS) approach to validate results [62], and through funded collaborations with patient advocacy groups to help recruit larger, more representative cohorts [56].

A criticism has arisen that crowdsourced health research study findings may not be fully accepted if studies are industry-financed; this critique is also made of more traditional studies. The greater transparency available in crowdsourced health research studies could be an asset in the validation of study results as any interested independent party could view study results (both positive and negative) publicly. Cost is a barrier to widespread participation in crowdsourced studies, so standard models for funding that do not influence the integrity of study results need to be established. Overall crowdsourced health research studies could be viewed as complementary to RCTs, offering a fresh perspective and allowing different types of research questions to be asked.

Regulation and Oversight

A limitation of crowdsourced health research studies has been that they do not always conform to generally accepted industry practices of research conduct. Recommendations have been made regarding institutional review board approval, consenting processes, data use policies, and communications to potential participants [64,65]. The process for obtaining informed consent should follow standard legal requirements. For example, information provided to participants should be non-technical and easy to understand, and should make clear which data will be published and in what format (eg, de-identified, aggregated). Many crowdsourced health research studies have been attempting to follow these recommendations. However, other studies specifically point out the practical impossibility of traditional compliance mechanisms and have participants consent to their acknowledgement of this. For example, the Harvard Medical School's Personal Genome Project (PGP) has participants agree to a more open stance on privacy and data use: "the data that you provide as part of the PGP may be used … to identify you as a participant in otherwise confidential genetic research [66]."

Another research standard is that institutional review board (IRB) approval is required and should be obtained before studies begin. This is a potential limitation in crowdsourced studies as it may not allow for the natural adaptation that can occur in self-experimentation studies. Alternative models that provide the same functions of IRBs could evolve as crowdsourced health research studies become more prominent. The roles and responsibilities of IRBs could be disintermediated and fulfilled by separate parties. For example, independent oversight could be preserved through external expert review. Blanket IRB approval could allow broad adaptive investigative research in an area with overall safeguards and restrictions in place.

XSL•FO
RenderX

Financial liability could be grounded in group insurance policies for health collaboration communities [18].

'Novel Findings Do Not Necessarily Flow From Novel Crowdsourced Methodologies'

Crowdsourced health research study methods are novel in several ways. First, the research uses Internet-based technologies to contact large numbers of potential study participants. Second, data is often available publicly (or to the study community) such that anyone can search the longitudinally-tracked real-time information in pre-aggregated patient communities; this openness is rarely (if ever) seen in more traditional studies. Although, while crowdsourced research methodologies are novel, it does not necessarily follow that they always beget novel discovery. Some critics argue that the same findings might have occurred with traditional methods. However, crowdsourcing provides a cheaper and faster alternative. In addition, crowdsourced studies can potentially draw on a much larger and more committed base of potential participants. Crowdsourcing studies may be useful in many dimensions including developing novel methods, discovering novel findings, and replicating existing findings in larger groups with more permutations. The key point is that valid scientific findings can occur with crowdsourcing techniques.

'Citizen Science Is Not Real Science'

In self-experimentation and participant-organized studies citizen scientists may be engaging in science-related activity but their activity (according to formal definitions) might not be regarded as science. The established scientific steps of creating well-formed falsifiable hypotheses, collecting and analyzing data, and publishing peer-reviewed results may not be followed in every project (nor need be followed in every project). The motivations behind individual crowdsourced projects can be different, and projects vary in the quality of crowdsourced science. This variation extends from professional researchers conducting large-scale peer-reviewed studies to individuals engaging in self-experimentation projects for personal knowledge and benefit. While all levels of crowdsourced activity may be useful, some argue that the term *science* should not be applied to projects unless the whole scientific process is followed. One of the benefits of new models like crowdsourcing is enabling a much broader audience to participate in science-related activities. This could help to dispel elitism [67] where science is "a closed society organized into fiefdoms of highly trained specialists" where "only a few minds engage with any problem [68]." Early successes in citizen science have shown "the potential to alter the landscape of science in important ways, harnessing countless able brains to do work that was once the province of a few overwhelmed experts [68]."

'Overstating the Impact of Crowdsourced Health Research Studies'

The area of crowdsourced health research is charged with overstating the potential growth and impact of participatory health initiatives. Critics argue that not all individuals are interested in health; instead they perceive it as the responsibility of physicians. The interest of individuals could further be undermined by health privacy concerns that impact on crowdsourced health research studies. These barriers currently mean that few individuals engage in health action-taking unless it is easy, automated, and (possibly) accompanied by financial incentives.

'There Are More Pressing Public Health Challenges Requiring Attention'

Crowdsourced health research studies may seem like an unimportant detail in the overall public health landscape where there is more urgency of focus on the near-term challenges of budget shortfalls, rising health care costs, anticipated physician shortages, aging populations, and the exorbitant cost of bringing new drugs to market (currently estimated at $1.3 billion [69]). However, participatory health initiatives might be able to help in addressing these challenges. They facilitate the realization of a new sensibility of health self-management through crowdsourced projects that could lead to healthier and more engaged populations, and have enduring benefits for both individuals and public health systems.

Conclusions

Growth of Participatory Health

Participatory health initiatives (self-tracking devices, smartphone applications, online personal health records, health social networks, and crowdsourced health research studies) are growing quickly; growth is facilitated by Internet and social networking influences. Individuals are joining researcher-organized studies, and designing and operating studies of their own. It is becoming easier to experiment with the launch of self-monitoring gadgets and smartphone applications, decreasing costs of genomic sequencing, availability of low-cost direct-to-consumer blood tests for testing interventions, increased access to online bioinformatics tools for data interpretation, and the advent of local DIYbio (do-it-yourself biology) labs [67] with facilities for education and experimental projects. Crowdsourced health research studies are emerging as an important new means of investigation in a multi-tier ecosystem that could include self-experimentation, participant-organized crowdsourced studies, and researcher-organized crowdsourced studies that are a complement and precursor to traditional RCTs. Over time, there could be greater convergence between citizen scientists and the established research enterprise. There are exciting opportunities for researcher-organized study activity in health social networks to move beyond survey-based methods towards active intervention-testing.

The Bigger Context of Crowdsourcing and Participatory Health: Preventive Medicine

Crowdsourcing has cost and speed benefits; it may allow science to be conducted at scales of magnitude greater than before (thousands recruited in months versus years [43,70] and billions of data points per person [71]), potential novel discovery in the patterns of large data sets [72,73], and the possibility of near real-time testing and application of new medical findings. Larger cohorts and more granular data could enable investigation in a much more detailed range of parameter-stratified sub-cohorts. Crowdsourced participatory health research efforts are helping to expand the conceptual scope of medicine from the traditional

XSL•FO
RenderX

focus on disease cure to the personalized preventive medicine of the future.

Conflicts of Interest

The author is the founder of DIYgenomics, a non-for profit organization, and a unpaid advisor to Genomera.

References

1. National Audubon Society. 2011 Jan. Christmas Bird Count URL: http://birds.audubon.org/christmas-bird-count [accessed 2011-11-07] [WebCite Cache ID 631KPP0Cj]
2. Markoff J. New York Times. 2011 Jan 10. RNA Game Lets Players Help Find a Biological Prize URL: http://www.nytimes.com/2011/01/11/science/11rna.html?_r=4&ref=science [accessed 2012-01-01] [WebCite Cache ID 631KYAzuA]
3. SciStarter. URL: http://scistarter.com/ [accessed 2011-12-27] [WebCite Cache ID 64Ein4e2N]
4. Citizen Science Alliance. URL: http://www.citizensciencealliance.org/index.html [accessed 2011-12-30] [WebCite Cache ID 64K5i4IF9]
5. Merriam-Webster. Crowdsourcing URL: http://www.merriam-webster.com/dictionary/crowdsourcing [accessed 2011-12-28] [WebCite Cache ID 64H4oVXxF]
6. Surowiecki J. The wisdom of crowds: why the many are smarter than the few and how collective wisdom shapes business, economies, societies and nations. New York, NY: Doubleday; 2004.
7. Tapscott D, Williams AD. Wikinomics: how mass collaboration changes everything. New York, NY: Portfolio; 2006.
8. Hughes B, Joshi I, Wareham J. Health 2.0 and Medicine 2.0: tensions and controversies in the field. J Med Internet Res 2008;10(3):e23 [FREE Full text] [doi: 10.2196/jmir.1056] [Medline: 18682374]
9. Sarasohn-Kahn J. California HealthCare Foundation. 2008 Apr. The Wisdom of Patients: Health Care Meets Online Social Media URL: http://www.chcf.org/~/media/MEDIA%20LIBRARY%20Files/PDF/H/PDF%20HealthCareSocialMedia.pdf [accessed 2011-12-22] [WebCite Cache ID 648CKkc9h]
10. Frydman G. e-patients.net. 2010 Apr 02. A Patient-Centric Definition of Participatory Medicine URL: http://participatorymedicine.org/ [accessed 2011-12-30] [WebCite Cache ID 64K67F6I3]
11. Fox S. Pew Research Center's Internet and American Life Project. 2011 May 12. The social life of health information 2011 URL: http://www.pewinternet.org/Reports/2011/Social-Life-of-Health-Info.aspx [accessed 2011-11-07] [WebCite Cache ID 631Kqymr6]
12. Swan M. Emerging patient-driven health care models: an examination of health social networks, consumer personalized medicine and quantified self-tracking. Int J Environ Res Public Health 2009 Feb;6(2):492-525. [doi: 10.3390/ijerph6020492] [Medline: 19440396]
13. Shirky C. Here comes everybody: the power of organizing without organizations. New York, NY: Penguin Press; 2008.
14. Bradbury D. The Guardian. 2011 Nov 08. US healthcare tries to go viral with social networks URL: http://www.guardian.co.uk/healthcare-network/2011/nov/08/us-healthcare-viral-social-networks [accessed 2011-12-22] [WebCite Cache ID 648Ds5lNs]
15. Burke A. Forbes. 2011 Oct 26. Crowdsourcing Scientific Progress: How Crowdflower's Hordes Help Harvard Researchers Study TB URL: http://www.forbes.com/sites/techonomy/2011/10/26/crowdsourcing-scientific-progress-how-crowdflowers-hordes-help-harvard-researchers-study-tb/ [accessed 2011-12-22] [WebCite Cache ID 648Hgi7Kf]
16. Levina M. Googling your genes: personal genomics and the discourse of citizen bioscience in the network age. JCOM 2010 Mar 09;9(1) [FREE Full text]
17. Irwin A. Constructing the scientific citizen: science and democracy in the biosciences. Public Understand Sci 2001;10:1-18. [doi: 10.1088/0963-6625/10/1/301]
18. Swan, M. Scaling crowdsourced health studies: the emergence of a new form of contract research organization. Personalized Medicine 2012.
19. PatientsLikeMe. URL: http://www.patientslikeme.com/ [accessed 2011-12-30] [WebCite Cache ID 64K6ip8EI]
20. 23andMe. URL: https://www.23andme.com/ [accessed 2011-12-30] [WebCite Cache ID 64K6kzInb]
21. DIYgenomics. URL: http://www.diygenomics.org/ [accessed 2011-12-30] [WebCite Cache ID 64K6mhFO3]
22. Quantified Self. URL: http://quantifiedself.com/ [accessed 2011-12-30] [WebCite Cache ID 64K6p0LSu]
23. Medicine 2.0. URL: http://www.medicine20congress.org [accessed 2011-12-30] [WebCite Cache ID 64K7FFFxk]
24. HealthCamp. URL: http://barcamp.org/w/page/403145/HealthCamp [accessed 2011-12-25] [WebCite Cache ID 64D4aC2bq]
25. Genomera. URL: http://genomera.com/ [accessed 2011-12-30] [WebCite Cache ID 64K7Un8U9]
26. Althea Health. URL: http://www.altheahealth.com/csl/ [accessed 2011-12-30] [WebCite Cache ID 64K7WZkxz]
27. RARE Project. 2011 Nov 07. PatientsLikeMe and RARE Project Unite to Find and Connect One Million Rare Disease Patients. URL: http://www.rareproject.org/patients-like-me.php [accessed 2011-12-19] [WebCite Cache ID 642YtkdZh]
28. Heywood J. TED Partner Series Talks. Jamie Heywood: The big idea my brother inspired URL: http://www.ted.com/talks/jamie_heywood_the_big_idea_my_brother_inspired.html [accessed 2011-12-21] [WebCite Cache ID 646O6iC01]

XSL•FO
RenderX

29. Fornai F, Longone P, Cafaro L, Kastsiuchenka O, Ferrucci M, Manca ML, et al. Lithium delays progression of amyotrophic lateral sclerosis. Proc Natl Acad Sci USA 2008 Feb 12;105(6):2052-2057 [FREE Full text] [doi: 10.1073/pnas.0708022105] [Medline: 18250315]
30. Wicks P, Vaughan TE, Massagli MP, Heywood J. Accelerated clinical discovery using self-reported patient data collected online and a patient-matching algorithm. Nat Biotechnol 2011 May;29(5):411-414. [doi: 10.1038/nbt.1837] [Medline: 21516084]
31. Frost JH, Massagli MP, Wicks P, Heywood J. How the Social Web Supports patient experimentation with a new therapy: The demand for patient-controlled and patient-centered informatics. In: AMIA Annu Symp Proc. 2008 Presented at: AMIA Annual Symposium; November 6, 2008; Washington, DC.
32. Turner MR, Wicks P, Brownstein CA, Massagli MP, Toronjo M, Talbot K, et al. Concordance between site of onset and limb dominance in amyotrophic lateral sclerosis. J Neurol Neurosurg Psychiatry 2011 Aug;82(8):853-854. [doi: 10.1136/jnnp.2010.208413] [Medline: 20562391]
33. Wicks P, Massagli MP, Wolf C, Heywood J. Measuring function in advanced ALS: validation of ALSFRS-EX extension items. Eur J Neurol 2009 Mar;16(3):353-359. [doi: 10.1111/j.1468-1331.2008.02434.x] [Medline: 19364363]
34. Bedlack RS, Wicks P, Heywood J, Kasarskis E. Modifiable barriers to enrollment in American ALS research studies. Amyotroph Lateral Scler 2010 Dec;11(6):502-507. [doi: 10.3109/17482968.2010.484494] [Medline: 20446890]
35. Wicks P, MacPhee GJ. Pathological gambling amongst Parkinson's disease and ALS patients in an online community (PatientsLikeMe.com). Mov Disord 2009 May 15;24(7):1085-1088. [doi: 10.1002/mds.22528] [Medline: 19353722]
36. Frost J, Okun S, Vaughan T, Heywood J, Wicks P. Patient-reported outcomes as a source of evidence in off-label prescribing: analysis of data from PatientsLikeMe. J Med Internet Res 2011;13(1):e6 [FREE Full text] [doi: 10.2196/jmir.1643] [Medline: 21252034]
37. Wicks P, Massagli M, Kulkarni A, Dastani H. Use of an online community to develop patient-reported outcome instruments: the Multiple Sclerosis Treatment Adherence Questionnaire (MS-TAQ). J Med Internet Res 2011;13(1):e12 [FREE Full text] [doi: 10.2196/jmir.1687] [Medline: 21266318]
38. Brownstein CA, Brownstein JS. Williams DS 3rd, Wicks P, Heywood JA. The power of social networking in medicine. Nat Biotechnol 2009 Oct;27(10):888-890. [Medline: 19816437]
39. Wicks P, Massagli M, Frost J, Brownstein C, Okun S, Vaughan T, et al. Sharing health data for better outcomes on PatientsLikeMe. J Med Internet Res 2010;12(2):e19 [FREE Full text] [doi: 10.2196/jmir.1549] [Medline: 20542858]
40. Brownstein CA, Wicks P. The potential research impact of patient reported outcomes on osteogenesis imperfecta. Clin Orthop Relat Res 2010 Oct;468(10):2581-2585. [doi: 10.1007/s11999-010-1373-x] [Medline: 20458644]
41. 23andMe. 2011 May 15. 23andMe Database Surpasses 100,000 Users URL: https://www.23andme.com/about/press/23andme_database_100000k_users/ [accessed 2011-11-07] [WebCite Cache ID 631Kv3rNx]
42. Tung JY, Eriksson N, Kiefer AK. Characteristics of an Online Consumer Genetic Research Cohort. 2011 Presented at: The 12th International Congress of Human Genetics and the American Society of Human Genetics 61st Annual Meeting; October 11-15, 2011; Montreal, Canada URL: http://spittoon.23andme.com/wp-content/uploads/2011/10/ASHG2011poster-JYT.pdf
43. Do CB, Tung JY, Dorfman E, Kiefer AK, Drabant EM, Francke U, et al. Web-based genome-wide association study identifies two novel loci and a substantial genetic component for Parkinson's disease. PLoS Genet 2011 Jun;7(6):e1002141 [FREE Full text] [doi: 10.1371/journal.pgen.1002141] [Medline: 21738487]
44. Tung JY, Do CB, Hinds DA, Kiefer AK, Macpherson JM, Chowdry AB, et al. Efficient replication of over 180 genetic associations with self-reported medical data. PLoS One 2011;6(8):e23473 [FREE Full text] [doi: 10.1371/journal.pone.0023473] [Medline: 21858135]
45. Swan M. Multigenic condition risk assessment in direct-to-consumer genomic services. Genet Med 2010 May;12(5):279-288. [Medline: 20474084]
46. Eriksson N, Macpherson JM, Tung JY, Hon LS, Naughton B, Saxonov S, et al. Web-based, participant-driven studies yield novel genetic associations for common traits. PLoS Genet 2010 Jun;6(6):e1000993 [FREE Full text] [doi: 10.1371/journal.pgen.1000993] [Medline: 20585627]
47. 23andWe Research. URL: https://www.23andme.com/research/ [accessed 2011-12-27] [WebCite Cache ID 64EihH0y2]
48. Lennon, G. The geoffreylennon blog. 2011 May 17. 'The Quantified Self' and Personal Development URL: http://geoffreylennon.wordpress.com/2011/05/17/the-quantified-self-and-personal-development/ [accessed 2011-11-07] [WebCite Cache ID 631Labbqw]
49. Quantified Self. Quantified Self Posters. 2011 Presented at: Quantified Self Inaugural Conference; May 28-29, 2011; Mountain View, CA URL: http://diygenomics.pbworks.com/w/file/fetch/49108415/QSPosters.pdf
50. Association for the Advancement of Artificial Intelligence. 2012. Self-tracking and Collective Intelligence for Personal Wellness meeting March 26-28 URL: http://mednlp.jp/AAAI2012 [accessed 2012-01-01] [WebCite Cache ID 64EjiplJb]
51. Roberts S. The unreasonable effectiveness of my self-experimentation. Med Hypotheses 2010 Dec;75(6):482-489. [doi: 10.1016/j.mehy.2010.04.030] [Medline: 20580874]
52. Roberts S. Self-experimentation as a source of new ideas: ten examples about sleep, mood, health, and weight. Behav Brain Sci 2004 Apr;27(2):227-262. [Medline: 15595236]

XSL•FO
RenderX

53. Manning L. FlowingData. 2011 Jun 29. A year of food consumption visualized URL: http://flowingdata.com/2011/06/29/a-year-of-food-consumption-visualized/ [accessed 2011-11-07] [WebCite Cache ID 631LPR9o7]
54. Roberts S. The Quantified Self blog. 2011 Jan 30. Results of The Buttermind Experiment URL: http://quantifiedself.com/2011/01/results-of-the-buttermind-experiment/ [accessed 2011-11-07] [WebCite Cache ID 631LdPTzG]
55. Martin R, Burns D, Doiron D. 2011 Blueberry Health Study Report: Memory Scores Continue to Improve. Mechanisms of Aging: Emerging Concepts. 2011 Presented at: 40th Annual Meeting of the American Aging Association; June 3-6, 2011; Raleigh, North Carolina URL: http://www.blueberrystudy.com/AAApresentations/
56. Swan M, Hathaway K, Hogg C, McCauley R, Vollrath A. Citizen science genomics as a model for crowdsourced preventive medicine research. J Participat Med 2010 Dec 23;2:e20 [FREE Full text]
57. Swan M and McCauley R. Genomera. 2010 Dec 08. Vitamin B-9 and MTHFR variants URL: http://genomera.com/studies/vitamin-b-9-and-mthfr-variants [accessed 2011-11-07] [WebCite Cache ID 631LiGuQo]
58. Swan M and Hogg C. Genomera. 2011 Mar 13. Processing Reality: Impact of Dopamine Modulation on Memory Filtering URL: http://genomera.com/studies/processing-reality-impact-of-dopamine-modulation-on-memory-filtering [accessed 2011-12-30] [WebCite Cache ID 64KBuCYVj]
59. Quantified Self self-tracking tools. URL: http://quantifiedself.com/guide/ [accessed 2011-12-30] [WebCite Cache ID 64KC5bjuC]
60. Shambroom JR, Fábregas SE, Johnstone J. Validation of an automated wireless system to monitor sleep in healthy adults. J Sleep Res 2011 Aug 22. [doi: 10.1111/j.1365-2869.2011.00944.x] [Medline: 21859438]
61. Dobkin BH, Dorsch A. The Promise of mHealth: Daily Activity Monitoring and Outcome Assessments by Wearable Sensors. Neurorehabil Neural Repair 2011 Nov;25(9):788-798. [Medline: 21989632]
62. Talan J. Can a Web-Based Recruitment Tool for Genomic Analysis be Valid? Neurology Today 2011 Aug 18;11(16):38-40 [FREE Full text] [doi: 10.1097/01.NT.0000405140.28789.76]
63. Behrend TS, Sharek DJ, Meade AW, Wiebe EN. The viability of crowdsourcing for survey research. Behav Res Methods 2011;43(3):800-813. [Medline: 21437749]
64. Gibson G, Copenhaver GP. Consent and internet-enabled human genomics. PLoS Genet 2010;6(6):e1000965. [Medline: 20585615]
65. MacDonald C. Genetic Engineering and Biotechnology News. 2009 Oct 15. DTC Genomics & Leading-Edge Ethics URL: http://www.genengnews.com/gen-articles/dtc-genomics-leading-edge-ethics/3063/ [accessed 2011-11-15] [WebCite Cache ID 63DoT9dZx]
66. Informed Consent form from the Harvard Medical School's Personal Genome Project. URL: http://www.personalgenomes.org/consent/PGP_Consent_Approved03242009.pdf [accessed 2011-12-30] [WebCite Cache ID 64KCSa9r9]
67. Burke A. Forbes. 2011 Oct 24. Citizen Science Takes Off: Could Community Labs Hatch the Next Generation of Bio Innovators? URL: http://uk.news.yahoo.com/citizen-science-takes-off-could-community-labs-hatch-224038589.html [accessed 2011-12-22] [WebCite Cache ID 648Ls8baP]
68. Cook G. The Boston Globe. 2011 Nov 11. How crowdsourcing is changing science URL: http://www.bostonglobe.com/ideas/2011/11/11/how-crowdsourcing-changing-science/dWL4DGWMq2YonHKC8uOXZN/story.html [accessed 2011-12-22] [WebCite Cache ID 648LeWUsL]
69. Gavura S. Science-based Medicine. 2011 Apr 14. What does a new drug cost? URL: http://www.sciencebasedmedicine.org/index.php/what-does-a-new-drug-cost/ [accessed 2011-12-30] [WebCite Cache ID 64K2Qjqco]
70. Dufau S, Duñabeitia JA, Moret-Tatay C. Smart phone, smart science: how the use of smartphones can revolutionize research in cognitive science. PLoS One 2011;6(9):e24974. [Medline: 21980370]
71. Hood L. Lee Hood. Nat Biotechnol 2011 Mar;29(3):191. [Medline: 21390010]
72. Halevy A, Norvig P, Pereira F. The Unreasonable Effectiveness of Data. IEEE Intelligence Systems 2009;24:8-12 [FREE Full text] [doi: 10.1109/MIS.2009.36]
73. Kelly K. The Technium blog. 2008 Jun 28. The Google Way of Science URL: http://www.kk.org/thetechnium/archives/2008/06/the_google_way.php [accessed 2011-12-28] [WebCite Cache ID 64H4qd03L]
74. Frost JH, Massagli MP. Social uses of personal health information within PatientsLikeMe, an online patient community: what can happen when patients have access to one another's data. J Med Internet Res 2008;10(3):e15 [FREE Full text] [doi: 10.2196/jmir.1053] [Medline: 18504244]

Abbreviations

ALS: amyotrophic lateral sclerosis
DIYbio: do-it-yourself biology
GWAS: genome-wide association study
IRB: institutional review board
MS: multiple sclerosis
MTHFR: methylenetetrahydrofolate reductase
PLM: PatientsLikeMe

XSL•FO
RenderX

PGP: personal genome project
RCT: randomized controlled trial

Edited by B Bewick; submitted 07.11.11; peer-reviewed by P Wicks, T Pickard, U Francke; comments to author 02.12.11; revised version received 08.02.12; accepted 10.02.12; published 07.03.12.

Please cite as:
Swan M
Crowdsourced Health Research Studies: An Important Emerging Complement to Clinical Trials in the Public Health Research Ecosystem
J Med Internet Res 2012;14(2):e46
URL: http://www.jmir.org/2012/2/e46/
doi:10.2196/jmir.1988
PMID:22397809

©Melanie Swan. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 07.03.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Online Doctor Reviews: Do They Track Surgeon Volume, a Proxy for Quality of Care?

Jeffrey Segal[1], MD, JD; Michael Sacopulos[2], JD; Virgil Sheets[3], PhD; Irish Thurston[4]; Kendra Brooks[4]; Ryan Puccia[5]

[1]Medical Justice Services, Inc., Greensboro, NC, United States

[2]Sacopulos, Johnson, Sacopulos, Terre Haute, IN, United States

[3]Indiana State University, Department of Psychology, Terre Haute, IN, United States

[4]Nussbaum Entrepreneurial Center, Greensboro, NC, United States

[5]Case Western Reserve University, Cleveland, OH, United States

Corresponding Author:
Jeffrey Segal, MD, JD
Medical Justice Services, Inc.
PO Box 49669
Greensboro, NC, 27419
United States
Phone: 1 336 691 1286
Fax: 1 208 988 5897
Email: jsegal@medicaljustice.com

Abstract

Background: Increasingly, consumers are accessing the Internet seeking health information. Consumers are also using online doctor review websites to help select their physician. Such websites tally numerical ratings and comments from past patients. To our knowledge, no study has previously analyzed whether doctors with positive online reputations on doctor review websites actually deliver higher quality of care typically associated with better clinical outcomes and better safety records.

Objective: For a number of procedures, surgeons who perform more procedures have better clinical outcomes and safety records than those who perform fewer procedures. Our objective was to determine if surgeon volume, as a proxy for clinical outcomes and patient safety, correlates with online reputation.

Methods: We investigated the numerical ratings and comments on 9 online review websites for high- and low-volume surgeons for three procedures: lumbar surgery, total knee replacement, and bariatric surgery. High-volume surgeons were randomly selected from the group within the highest quartile of claims submitted for reimbursement using the procedures' relevant current procedural terminology (CPT) codes. Low-volume surgeons were randomly selected from the lowest quartile of submitted claims for the procedures' relevant CPT codes. Claims were collated within the Normative Health Information Database, covering multiple payers for more than 25 million insured patients.

Results: Numerical ratings were found for the majority of physicians in our sample (547/600, 91.2%) and comments were found for 385/600 (64.2%) of the physicians. We found that high-volume (HV) surgeons could be differentiated from low-volume (LV) surgeons independently by analyzing: (1) the total number of numerical ratings per website (HV: mean = 5.85; LV: mean = 4.87, $P<.001$); (2) the total number of text comments per website (HV: mean = 2.74; LV: mean = 2.30, $P=.05$); (3) the proportion of glowing praise/total comments about quality of care (HV: mean = 0.64; LV: mean = 0.51, $P=.002$); and (4) the proportion of scathing criticism/total comments about quality of care (HV: mean = 0.14; LV: mean = 0.23, $P= .005$). Even when these features were combined, the effect size, although significant, was still weak. The results revealed that one could accurately identify a physician's patient volume via discriminant and classification analysis 61.6% of the time. We also found that high-volume surgeons could not be differentiated from low-volume surgeons by analyzing (1) standardized z score numerical ratings (HV: mean = 0.07; LV: mean = 0, $P=.27$); (2) proportion of glowing praise/total comments about customer service (HV: mean = 0.24; LV: mean = 0.22, $P=.52$); and (3) proportion of scathing criticism/total comments about customer service (HV: mean = 0.19; LV: mean = 0.21, $P=.48$).

Conclusions: Online review websites provide a rich source of data that may be able to track quality of care, although the effect size is weak and not consistent for all review website metrics.

(J Med Internet Res 2012;14(2):e50) doi:10.2196/jmir.2005

XSL•FO
RenderX

KEYWORDS

Doctor review; rating websites; physician reviews; online reputation; clinical outcomes; selection of physicians; surgical volume; surgeon volume

Introduction

Every day a patient somewhere will ask: “Is Dr. X a good doctor?”

By itself, such a statement is meaningless. The patient is really asking if Dr. X is a good doctor for a particular end. For example, is Dr. X a good doctor to address a particular symptom or to perform a defined treatment?

As an analogy, the question is as unspecific as “Is this a good car?” Better questions are: “Is this a good car for the gas mileage?” or “Is this a good car for value?” or “Is this a good car for accelerating quickly?” Each question delivers a different answer.

Patients access the Internet seeking an answer to the question “Is Dr. X a good doctor?” but they are really asking if Dr. X is a good doctor for a particular end. Is Dr. X a good diagnostician? Or is he compassionate with excellent listening skills? Or is she a doctor who has treated over 1000 patients with Chiari malformation? A typical doctor review website rarely makes that type of distinction with sufficient clarity.

Our hypothesis is that isolated doctor review websites may not be good proxies for what patients truly care about—namely clinical outcomes and safety. Doctor review websites measure whether patients like their doctor. These websites also measure subjective responses. Does the doctor communicate well? Does the doctor listen? How did they experience a procedure? These measures are important as clinical outcomes depend upon the collaborative role a patient plays in terms of decision making and compliance. Such measures could be complemented by more objective communication measures such as a doctor’s ability to consistently transmit information about risks, benefits, and options (eg, of various treatments) to patients with a broad range of medical literacy. Other complementary objective metrics include clinical outcomes and safety. To the extent clear online metrics of an individual doctor’s outcomes or safety record exist [1], they are not currently collated by the popular doctor review websites.

The medical literature supports the idea that for some surgical procedures, surgeon volume correlates with clinical outcomes [2-11]. In other words, for specific procedures, high-volume (HV) surgeons have better results than low-volume (LV) surgeons. It is unclear why this is the case: perhaps practice makes perfect—or the more successful doctors get more referrals. But, online information about a surgeon’s volume is also hard to find—if available at all.

The question we posed was whether posts on online doctor review websites, in aggregate, correlate with surgeon volume, as a proxy for quality, for three distinct procedures. We targeted surgical procedures where this correlation has been previously suggested: lumbar surgery [12], total knee replacement [13-14], and bariatric surgery [15-18]. In other words, are high-volume surgeons, in aggregate, more likely to have positive posts (and fewer negative posts) than low-volume surgeons, in aggregate? In doing so, we hope to better understand whether high-volume doctors (who have better clinical track records overall) collectively have better online reputations.

Methods

Physicians

Surgeons who perform lumbar surgery, total knee replacement, and bariatric surgery were selected for study because there are data supporting a correlation between surgeon volume and clinical outcome/patient safety for each of these procedures. Further, these procedures are more likely to be considered “elective” and affect a younger demographic than vascular or oncologic procedures (for which there are also data correlating surgeon volume and clinical outcome/patient safety). We believed that “younger” patients considering an “elective” procedure would be more likely to access an online review website to help guide their decision on surgeon selection.

Current procedural terminology (CPT) codes for bariatric surgery, lumbar surgery, and total knee replacement, were identified and selected (Table 1). Although there are other codes used to label these three surgeries, the codes presented in Table 1 identify the vast majority of the patients who have had bariatric surgery, lumbar surgery, or total knee replacement.

XSL•FO
RenderX

Table 1. Procedure codes and selection criteria for bariatric surgery, lumbar surgery, and total knee replacement.

Procedure	Code	Description
Bariatric surgery[a]	43644	LP GSTR RSTRCIV PRC;GSTR BYPS & ROUX-EN Y
	43644	LAP GASTRIC BYPASS/ROUX-EN-Y
	43645	LP GSTR RSTRCIV PRC;GSTR BYPS&SM INTST R
	43645	LAP GASTR BYPASS INCL SMALL INTESTINE
	43770	LAP PLACE GASTR ADJ DEVICE
	43770	UNKNOWN PROCEDURE
	43770	LAPS GSTR RSTCV PX PLMT BAND
	43842	V-BAND GASTROPLASTY
	43842	GASTROPLASTY FOR OBESITY
	43843	GASTROPLASTY W/O V-BAND
	43843	GASTROPLASTY FOR OBESITY
	43846	GASTRIC BYPASS FOR OBESITY
	43846	GASTRIC BYPASS FOR OBESITY
	43846	GAST RESTRIC W/BYP; SHORT ROUX-EN-Y
	43847	GASTRIC BYPASS INCL SMALL INTESTINE
	43847	GASTRIC BYPASS FOR OBESITY
Lumbar spinal fusion[b]	22558	LUMBAR SPINE FUSION
	22612	LUMBAR SPINE FUSION
	22630	LUMBAR SPINE FUSION
	0309	OTH EXPL&DECOMPRS SPINAL CANAL
	0309	SPINAL CANAL EXPLOR NEC
	63030	LOW BACK DISK SURGERY
	63035	SPINAL DISK SURGERY ADDON
	63035	ADDED SPINAL DISK SURGERY
	63042	LAMINOTOMY, SINGLE LUMBAR
	63042	LOW BACK DISK SURGERY
	63044	HEMILAMINECTOMY W NERVE RT DEC
	63044	LAMINOTOMY, ADDL LUMBAR
	63047	REMOVAL OF SPINAL LAMINA
	63048	REMOVAL OF SPINAL LAMINA
	63048	REMOVE SPINAL LAMINA ADD-ON
	63056	DECOMPRESS SPINAL CORD
	63057	DECOMPRESS SPINE CORD ADD-ON
	63057	DECOMPRESS SPINAL CORD
	8108	POSTERIOR LUMBAR FUSION
	8108	LUMB LUMBOSAC FUS ANT COL POST TECH
Total knee replacement[c]	27445	REVISION OF KNEE JOINT
	27447	TOTAL KNEE ARTHROPLASTY
	27447	TOTAL KNEE REPLACEMENT
	8154	TOTAL KNEE REPLACEMENT

[a] CPT-4 procedure codes

XSL•FO
RenderX

[b] Mix of CPT-4 and International Classification of Diseases, 9th Revision (ICD-9) procedure codes

[c] Mix of CPT-4 and ICD-9 procedure codes

Physician names were obtained from OptumInsight's Normative Health Information database (NHI), a national database maintained by one of the largest aggregate insurance companies in the United States. NHI contains multi-payer, Health Insurance Portability and Accountability Act (HIPAA)-compliant transaction-level claims for more than 25 million insured patients. The Lewin Group searched the database and created a list of physicians who submitted bills at least once in 2009-2010 for the CPT codes listed for the three surgical procedures (Table 2).

Table 2. Number of unique physicians submitting a bill at least once to a Normative Health Insurance (NHI) carrier for relevant CPT/ICD9 procedure codes in 2009-2010[a].

Type of surgery	Number of physicians
Bariatric surgery	1992
Lumbar spinal fusion	10,195
Total knee replacement	13,628

[a] Database from January 1, 2010 to December 31, 2010

Our sample consisted of 600 physicians with practices in bariatric surgery (n = 200), lumbar surgery (n = 200), and total knee replacement (n = 200). From the quartile of physicians who submitted the most claims for reimbursement for each CPT/ICD9-coded target procedure, 100 physicians were randomly selected to represent "high-volume" physicians and 100 "low-volume" physicians were randomly selected from the lowest quartile of physicians (who submitted the fewest CPT/ICD9 procedure codes for reimbursement for the target procedure in 2009-2010). Low-volume surgeons submitted at least one CPT/ICD9 procedure code for the relevant procedure. The median numbers of relevant surgeries for each of the three categories performed by high- and low-volume surgeons in 2009-2010 submitting bills to a NHI carrier are reported in Table 3. The underlying supposition was that patients intending to have bariatric surgery, lumbar surgery, or total knee replacement would search the Internet for information about physicians who have the experience to perform such procedures (and submit a bill for reimbursement to an insurance company).

Table 3. Median number of surgical procedures performed by high- and low-volume surgeons[a].

Type of surgery	Median surgical procedures	
	High-volume surgeons	Low-volume surgeons
Bariatric surgery	16	3
Lumbar spinal fusion	40	6
Total knee replacement	13	3

[a] As determined by bills submitted to NHI carrier in database from January 1, 2010 to December 31, 2010.

Data Collection

The authors were blinded as to which doctors were high-volume surgeons and which were low-volume surgeons.

Physician evaluations in the form of numerical ratings and comments were collected from 9 different heavily trafficked websites: 1 review website limits its focus to doctors and lawyers (Avvo); 3 websites limit their focus to doctors (HealthGrades, RateMDs, and Vitals); and 5 websites review a broad array of businesses and services including doctors (Citysearch, InsiderPages, Yahoo! Local, Google Maps, and Yelp). Ranking of traffic in the United States by Alexa (www.alexa.com) for the websites is presented in Table 4. Alexa is a leading provider of global web metrics, such as traffic.

XSL•FO
RenderX

Table 4. Alexa traffic rank in the United States for selected review websites [19].

Type of website	Website name	URL	Alexa US traffic rank
Doctor-specific			
	Avvo[a]	www.avvo.com	1613
	HealthGrades	www.healthgrades.com	570
	RateMDs	www.ratemds.com	6320
	Vitals	www.vitals.com	2029
Broad review			
	Citysearch	www.citysearch.com	341
	InsiderPages	www.insiderpages.com	1430
	Yahoo! Local	www.local.yahoo.com	4
	Google Maps	www.maps.google.com	1
	Yelp	www.yelp.com	43

[a] Reviews lawyers also

A rating is a numerical metric defined by the patient's subjective impression. For example, on a scale of 1-5, how does the patient rate the doctor's overall quality, timeliness, ability to communicate, etc. Each website had different measures, but most asked at least one general question similar to: "Overall, how would you rate the doctor?"

We searched each website using the name and location of each physician in our sample. We recorded the number of ratings and the "overall" rating reported for each physician. On websites that allowed ratings on multiple dimensions (eg, communication, trust, punctuality, and time spent with patient), the averages of all numerical ratings were also recorded.

A comment is a free text description of the patient's subjective experience. For example, "Dr. X was very compassionate and listened to each and every one of my concerns."

We recorded the number of comments posted about each physician. One of three independent judges, also blinded to the volume of a physician's practice, reviewed each post and categorized it as containing glowing praise or scathing criticism and whether the glowing praise or scathing criticism addressed quality of care/safety or customer service. A single post could include comments about both quality of care and customer service. If so, it was included in both counts. Comments that were neither glowing nor scathing were recorded in the total number of posts, but not in the glowing/scathing tallies. A prototypical example of a glowing quality of care/safety comment is "Dr. X gave me back my life." In comparison, a scathing quality of care/safety comment is "Dr. X was a butcher." A prototypical example of a glowing customer service comment is "Dr. X returned my call late at night and gave me all the time I needed." In comparison, a scathing customer service comment is "Dr. X was dismissive, arrogant, and never listened." One of the websites, HealthGrades, does not allow posting of comments.

Since many consumers may not do an exhaustive search for physician information, we recorded whether a link to any of the study websites was among the first 20 retrieved in a Google search for each physician in the lumbar and total knee replacement samples. A Google search was performed on each doctor in each of three formats:

1. "Dr. First_Name Last_Name" + "City, State"

2. "First_Name Last_Name, D.O." + "City, State"

3. "Dr. First_Name Last_Name, M.D." + "City, State"

Separate analyses were performed using only data retrieved in this abbreviated search. The first 20 links correlate with the first 2 webpages retrieved in a typical search as the default setting for a Google search is 10 results per page. [20]

Once the data was captured from the online review websites, the spreadsheet was sent to the Lewin Group. They added a field indicating whether a doctor was high volume or low volume. All other physician-identifying information was subsequently stripped and the rows were shuffled. The database was then returned to the authors for analysis.

Analytic Approach

Do ratings and comments posted on physician review websites provide valid information regarding surgical volume, a proxy for clinical outcomes/safety? We answered this by comparing the information available on high- and low-volume physicians, controlling for surgical practice in a 2 × 3 analysis of variance. Our analysis also considered whether the differences between high- and low-volume physicians were consistent across bariatric, lumbar, and total knee replacement surgical practices.

Analyses were performed using the mean number of ratings per website (on which each physician was rated at least once). Additional analyses were performed for each physician's overall rating, averaged across websites. Analyses using physicians' overall ratings tracked averages that included ratings of specific physician characteristics (average of multidimensional numerical ratings) very closely (all $r > .85$), so only analyses using the overall rating are presented. The Vitals website uses a different rating scale (1-4) than the other websites (1-5); therefore, ratings from each website were standardized using a z test (converting each physician's score into a value expressed as the number of

XSL•FO
RenderX

standard deviations from the mean on each website). The *z* score, or standard score, allowed for averaging ratings across websites.

Analyses were performed using the average number of comments per physician on websites with at least one posted comment. Additional analyses were performed identifying the proportions of comments that were glowing and scathing broken down by whether they concerned the physicians' quality of care or customer service.

Results

First, we report the results of these analyses using all available data for each physician. Second, we report analyses restricted to data available in the first 20 links of a Google search for each physician in the lumbar surgery and total knee replacement samples. Finally, we present the results of an analysis that explores the incremental validity of using data from both ratings and posted comments to distinguish high- and low-volume physicians.

Table 5 presents the numbers of physicians in our sample with ratings and comments posted on each of the study websites.

Table 5. Numbers of surgeons with ratings and comments posted on a study website.

	Surgeons with ratings (N = 547)				Surgeons with comments (N = 385)			
Website	Bariatric (n = 170)	Lumbar (n = 182)	Knee (n = 195)	Total	Bariatric (n = 101)	Lumbar (n = 147)	Knee (n = 137)	Total
Vitals	101	134	137	372	68	107	98	273
HealthGrades	129	161	165	455				
RateMDs	44	91	77	212	40	87	74	201
InsiderPages	100	141	151	392	7	9	13	29
Avvo	1	2	3	6	1	2	3	6
Yahoo! Local	11	17	20	48	10	17	19	46
Google Maps	9	16	6	31	1	14	5	20
Citysearch	2	5	3	10	2	2	1	5
Yelp	3	1	4	8	3	1	4	8
Total	400	568	566	1534	132	239	217	588

All Available Data

Numerical ratings were found for the majority (547/600, 91.2%) of the physicians in our sample; comments were found for 385 (64.2%) of the physicians. The average physician had ratings on 3 of the 9 websites (range: 1-7) and comments on 1 website (range: 1-5). Preliminary analysis noted the correlation between rank orders of physicians' total number of ratings aggregated across all websites and total number of ratings per website was $r = .86$, ($P < .001$). Additional preliminary analyses revealed that high-volume physicians had more total ratings across all websites and ratings on more websites than did low-volume physicians. Our analyses focus on average number of ratings per website on which a physician is rated—based on an assumption that a typical consumer may not do an exhaustive review of all available ratings on many websites but be satisfied upon finding one website with information on his or her physician.

Table 6 presents results of analyses of all available physician data. High-volume physicians had significantly more ratings per website compared to low-volume physicians for every type of practice ($P < .001$) and there was no evidence that this effect differed among physician groups ($P = .15$). However, the standardized numerical ratings assigned to high-volume physicians were not significantly different from those assigned to low-volume physicians ($P = .27$), nor was this null finding different across physician groups ($P = .48$). Table 6 also shows that high-volume physicians had more comments per website than did low-volume physicians for each type of practice ($P = .05$). Again, there was no evidence this differed among physician groups ($P = .74$).

Table 7 shows that only comments related to quality of care seem to distinguish high- and low-volume physicians; high-volume physicians had a significantly greater proportion of glowing comments ($P = .002$) and a significantly lower proportion of scathing comments regarding quality of care than low-volume physicians ($P = .005$). Again, we observe these patterns for each surgical practice and our analyses offer no basis for inferring that it's more true for one group than another ($P = .70$ for glowing; $P = .41$ for scathing). We also observed that there were far more glowing than scathing comments overall, even for low-volume physicians. In general, we observed that high-volume physicians tend to have almost 64% glowing comments (versus 51% for low-volume physicians) regarding quality of care. Proportion of glowing/scathing comments related to customer service did not differentiate between high- versus low-volume physicians overall ($P = .52$ for glowing; $P = .48$ for scathing) nor was there evidence that this null finding differed across physician groups ($P = .92$ for glowing; $P = .20$ for scathing).

XSL•FO
RenderX

Table 6. Analysis of ratings and comments for high- and low-volume surgeons.

	Surgeon volumes								Analysis of variance					
	All		Bariatric		Lumbar		Knee		Volume[a]		Procedure[b]		Interaction[c]	
	HV	LV	HV	LV	HV	LV	HV	LV	*F*	*P*	*F*	*P*	*F*	*P*
Surgeons with ratings														
N=	547		170		182		195		*F 1,541*		*F 2,541*		*F 2,541*	
Mean ratings/ website[d] (SD)	5.85 (3.92)	4.57 (3.29)	4.40 (3.22)	3.70 (2.53)	7.49 (4.29)	5.39 (3.97)	5.60 (3.58)	4.63 (3.02)	18.33	<.001	20.73	<.001	1.88	.15
Overall rating score[e]	0.07 (0.74)	-0.00 (0.84)	0.35 (0.68)	0.19 (0.90)	-0.14 (0.75)	-0.10 (0.85)	0.03 (0.69)	-0.07 (0.77)	1.21	.27	11.98	<.001	0.74	.48
Surgeons with comments														
N=	385		101		147		137		*F 1,379*		*F 2,379*		*F 2,379*	
Mean comments/ website[d] (SD)	2.74 (1.95)	2.30 (2.05)	2.03 (1.30)	1.78 (1.36)	3.07 (2.00)	2.74 (2.44)	2.87 (2.15)	2.25 (2.01)	3.82	.05	7.72	.001	0.30	.74

[a] Comparing high- versus low-volume surgeons

[b] Comparing bariatric, lumbar, and knee surgeons

[c] Comparing high- versus low-volume surgeons across surgeon categories

[d] Only includes individual websites on which doctor had at least one rating/comment

[e] *z* score

XSL•FO
RenderX

Table 7. Analysis of scathing and glowing comments for high- and low-volume surgeons.

	Surgeon types								Analysis of variance					
	All (N = 385)		Bariatric (n = 101)		Lumbar (n =147)		Knee (n = 137)		Volume[a]		Procedure[b]		Interaction[c]	
	HV	LV	HV	LV	HV	LV	HV	LV	*F 1,379*	*P*	*F 2,379*	*P*	*F2379*	*P*
Quality of care comments														
Glowing mean (SD)	1.76 (1.56)	1.25 (1.46)	1.09 (0.98)	0.73 (0.64)	2.06 (1.50)	1.55 (1.50)	1.89 (1.81)	1.35 (1.76)	9.43	.002	11.59	<.001	0.11	.89
Glowing % (SD)	0.64 (0.35)	0.51 (0.38)	0.53 (0.38)	0.44 (0.41)	0.70 (0.30)	0.55 (0.34)	0.64 (0.36)	0.53 (0.40)	9.87	.002	4.57	.01	0.36	.70
Scathing mean (SD)	0.35 (0.65)	0.44 (0.57)	0.26 (0.49)	0.34 (0.57)	0.40 (0.79)	0.57 (0.61)	0.35 (0.59)	0.38 (0.53)	1.98	.16	2.80	.06	0.42	.66
Scathing % (SD)	0.14 (0.26)	0.23 (0.34)	0.15 (0.30)	0.19 (0.35)	0.12 (0.22)	0.27 (0.33)	0.15 (0.27)	0.23 (0.35)	8.01	.005	0.28	.76	0.90	.41
Customer service comments														
Glowing mean (SD)	0.65 (0.90)	0.52 (0.89)	0.23 (0.41)	0.17 (0.42)	0.60 (0.72)	0.57 (1.02)	1.00 (1.16)	0.74 (0.93)	1.65	.20	17.83	<.001	0.74	.48
Glowing % (SD)	0.24 (0.30)	0.22 (0.32)	0.11 (0.23)	0.09 (0.26)	0.22 (0.27)	0.22 (0.31)	0.36 (0.33)	0.32 (0.35)	0.41	.52	18.93	<.001	0.09	.92
Scathing mean (SD)	0.58 (0.87)	0.49 (0.79)	0.32 (0.60)	0.18 (0.42)	0.73 (0.93)	0.67 (0.93)	0.60 (0.92)	0.56 (0.80)	0.97	.32	9.29	<.001	0.12	.89
Scathing % (SD)	0.19 (0.27)	0.21 (0.32)	0.14 (0.28)	0.08 (0.21)	0.22 (0.27)	0.26 (0.32)	0.19 (0.26)	0.26 (0.36)	0.49	.48	6.78	.001	1.60	.20

[a] Comparing high- versus low-volume surgeons

[b] Comparing bariatric, lumbar, and knee surgeons

[c] Comparing high- versus low-volume surgeons across surgeon categories

First 20 Links

We conducted a reanalysis of the physician data restricted to review websites within the first 20 links returned by a Google search of a physician's name (Table 8). These searches returned links to some or all of our sample doctor review websites enabling access to the majority (896/1134, 79%) of webpages where doctors had at least one rating and of the webpages where doctors had at least one comment (347/456, 76%). This analysis was restricted to lumbar and total knee replacement samples. We excluded bariatric surgery from this subanalysis because the number of reviews and comments accessible via the first 20 links for that category was inadequate to draw meaningful conclusions. The analyses in Table 9 parallel those reported in Table 7 using the full available data.

Again, we find that high-volume physicians had greater numbers of ratings and comments per linked website than did low-volume physicians. The numerical ratings given to high- and low-volume physicians did not differ. And high-volume physicians had greater proportions of glowing (and lower proportions of scathing) comments about quality of care than did low-volume physicians. There were no differences in proportions of comments concerning customer service.

XSL•FO
RenderX

Table 8. Analysis of ratings and comments for high- and low-volume surgeons on first 20 websites (excluding bariatric surgery).

	Surgeon volumes						Analysis of variance					
	All (N = 374)		Lumbar (n = 181)		Knee (n = 193)		Volume[a]		Procedure[b]		Interaction[c]	
	HV	LV	HV	LV	HV	LV	*F 1,370*	*P*	*F 1,370*	*P*	*F 1,370*	*P*
Ratings												
Mean ratings/ website[d] (SD)	6.76 (4.18)	5.47 (4.55)	7.70 (4.39)	6.08 (5.24)	5.85 (3.76)	4.93 (3.78)	8.21	.004	11.30	.001	0.62	.43
Overall rating score[e] (SD)	-0.01 (0.78)	0.02 (0.83)	-0.08 (0.80)	0.01 (0.85)	0.05 (0.76)	0.04 (0.81)	0.22	.64	0.96	.33	0.38	.54
Comments												
	Surgeon volumes						Analysis of variance					
	All (N = 266)[a]		Lumbar (n = 138)		Knee (n = 128)		Volume[a]		Procedure[b]		Interaction[c]	
	HV	LV	HV	LV	HV	LV	*F 1,262*	*P*	*F 1,262*	*P*	*F 1,262*	*P*
Mean comments/ website[d] (SD)	3.16 (2.36)	2.51 (2.32)	3.24 (2.24)	2.71 (2.60)	3.06 (2.51)	2.32 (2.03)	4.78	.03	0.98	.32	0.13	.72

[a] Comparing high- versus low-volume surgeons

[b] Comparing lumbar and knee surgeons

[c] Comparing high- versus low-volume surgeons across surgeon categories

[d] Only includes individual websites on which doctor had at least one rating/comment

[e] *z* score

XSL•FO
RenderX

Table 9. Analysis of scathing and glowing comments for high- and low-volume surgeons on first 20 websites (excluding bariatric surgeons).

	Surgeon volumes						Analysis of variance					
	All (N = 266)		Lumbar (n = 138)		Knee (n = 126)		Volume[a]		Procedure[b]		Interaction[c]	
	HV	LV	HV	LV	HV	LV	*F 1,262*	*P*	*F 1,262*	*P*	*F 1,262*	*P*
Quality of care comments												
Glowing mean (SD)	2.06 (1.74)	1.44 (1.72)	2.13 (1.59)	1.52 (1.67)	1.98 (1.92)	1.36 (1.77)	8.11	.005	0.51	.48	0.00	.99
Glowing % (SD)	0.68 (0.33)	0.53 (0.40)	0.71 (0.30)	0.55 (0.38)	0.65 (0.36)	0.52 (0.42)	10.76	.001	0.78	.38	0.12	.73
Scathing mean (SD)	0.43 (0.88)	0.44 (0.60)	0.45 (0.87)	0.52 (0.62)	0.39 (0.89)	0.37 (0.57)	0.04	.84	1.24	.27	0.22	.64
Scathing % (SD)	0.12 (0.23)	0.22 (0.34)	0.12 (0.22)	0.25 (0.35)	0.12 (0.24)	0.19 (0.33)	7.34	.007	0.76	.39	0.74	.39
Customer service comments												
Glowing mean (SD)	0.80 (0.99)	0.73 (1.05)	0.60 (0.81)	0.59 (1.09)	1.03 (1.13)	0.87 (1.00)	0.48	.49	8.13	.005	0.397	.53
Glowing % (SD)	0.29 (0.32)	0.31 (0.36)	0.22 (0.29)	0.23 (0.32)	0.38 (0.34)	0.38 (0.39)	0.01	.94	13.93	<.001	0.04	.85
Scathing mean (SD)	0.71 (1.07)	0.61 (0.90)	0.81 (1.04)	0.69 (0.98)	0.60 (1.10)	0.53 (0.82)	0.61	.44	2.24	.14	0.03	.86
Scathing % (SD)	0.19 (0.26)	0.24 (0.33)	0.22 (0.27)	0.26 (0.32)	0.16 (0.24)	0.23 (0.35)	2.13	.15	1.38	.24	0.16	.69

[a] Comparing high- versus low-volume surgeons

[b] Comparing lumbar and knee surgeons

[c] Comparing high- versus low-volume surgeons across surgeon categories

Additional Analyses

The preceding analyses suggest that high- and low-volume surgeons could be identified based on the (1) number of ratings; (2) number of comments; (3) proportion of glowing comments about quality of care; and (4) proportion of scathing comments about quality of care. Next, we attempted to establish the practical usefulness of these various pieces of information for distinguishing high- and low-volume physicians. The (discriminant) analysis develops a function that maximally distinguishes study groups from each other. Function coefficients (see Table 10) are the weights that support this discrimination; higher absolute weights indicate greater contribution of the variable to differentiating groups from each other. As illustrated in the table, discriminant analysis suggests that ratings per website, and proportion of glowing comments about quality of care are the two most differentiating pieces of information (highest absolute weights), followed by proportion of scathing comments about quality of care. The number of comments per website, while providing some information when examined alone, provides little additive information (beyond the other measures).

As a follow-up, we also performed a classification analysis wherein physicians' surgical volume (high or low) was "predicted" by the number of ratings and comments they received as well as the proportion of glowing and scathing comments about quality of care (using the discriminant function). The results revealed that one could accurately identify a physicians' surgical volume 61.6% of the time. An examination of the resulting discriminant function revealed that the number of ratings per website and proportion of glowing postings seemed most central to the discrimination, followed by proportion of scathing comments. Number of comments was largely redundant to these other measures.

XSL•FO
RenderX

Table 10. Discriminant function analysis results.

	Standardized function coefficients
Ratings per website	0.57
Comments per website	0.08
Proportion glowing (quality of care)	0.46
Proportion scathing (quality of care)	-0.35
Discriminant function is significant (= 21.4, $P < .001$)	

Discussion

Our study found there is evidence that online doctor review websites can be used to identify high-volume surgeons performing targeted procedures—a proxy which correlates with higher quality care. Patients naturally want to identify, and be treated by, the best practitioners. And they seek such information online. The importance of the Internet in determining patients' health care choices in the United States should not be underestimated. A recent study by The Pew Internet and American Life Project noted that 59% of adults have looked online for information on 15 health topics such as a specific disease or treatment [21]. And they are looking for information about health care providers too; 12% of adults have consulted online rankings or reviews of doctors or other providers.

Online review websites track patient sentiment. Recent advances even allow for automating the classification of patient comments by sentiment. Xia et al [22] described a multistep sentiment classifier for patient opinion mining that, in principle, could analyze large collections of data, online or otherwise, to assign sentiment scores to patient reviews. While patient sentiment is helpful, to our knowledge, our study is the first to tackle the connection between patient reviews, patient sentiment, and a proxy for clinical outcomes.

Defining quality in healthcare is difficult. From a patient's perspective, soft measures (eg, communication skills and ability to listen) are important for issues such as decision making and compliance—issues which impact outcomes. More objectively, quality often distils to patient safety and clinical outcomes. Such metrics include morbidity and mortality rates, length of stay in hospital, blood loss, time to return to work, and the like. This detailed information tracking of individual practitioners is not readily available online for patients to analyze.

The medical literature suggests that, for a number of surgical procedures, the volume of cases performed annually by an individual surgeon correlates with patient safety and clinical outcome metrics. In other words, for specific procedures, high-volume surgeons have better results than low-volume surgeons do.

We targeted three surgical procedures where this correlation has been shown previously: lumbar surgery [12], total knee replacement [13-14], and bariatric surgery [15-18]. To our knowledge, our analysis is the first to tackle the question of whether online reviews can identify the more successful surgeons using a proxy for clinical outcomes and safety. We posed the following hypothetical question: Do quantity and character of posts on online doctor review websites, in aggregate, correlate with surgeon volume, as a proxy for quality, for these three distinct procedures?

Our findings provide evidence that the following data aggregated from 9 doctor review websites can distinguish high-volume from low-volume surgeons: total number of numerical reviews; total number of text comments; proportion of glowing positive comments; and proportion of scathing negative comments. Analysis of the actual numerical ratings did not distinguish between high- and low-volume surgeons. The same conclusions were noted when limited to doctor review websites from the first 20 links of a Google search for the doctor's name.

While our analysis provides evidence that data from doctor review websites can help consumers identify higher quality doctors, the effect size is weak. From the patient's perspective, a far better way to determine whether a surgeon performs a high volume of procedures is to ask the doctor. Or the doctor could preemptively provide such information on the various review websites.

One surprising result was while the total number of reviews correlated with surgeon volume, the actual rating value did not. Also, it is unclear why the total number of reviews and comments are associated with surgeon volume. Perhaps high-volume surgeons are more comfortable with their skills/results and are more likely to ask their patients for feedback—internally or on the Internet. In any event, such observations deserve further study.

Our analyses also supported a finding previously reported by others [23]; namely, on online review websites, the single metric (overall rating) correlated highly with more granular, multidimensional numerical ratings. In our analyses, this correlation was between overall rating and the average of all multidimensional ratings (all $r > .85$). Accordingly, analyzing patient responses to the question "Overall, how would you rate this doctor?" predicts positive and negative sentiment from more detailed questions.

Even with these findings, it is still an open question whether consumers should rely heavily on the websites partly because the websites have limited data. Among the 600 doctors, on websites where the doctor was rated, the average doctor had between 4 and 6 ratings and between 2 and 3 comments. As the websites accumulate more data, our conclusions may change.

Our study identified at least one rating for 91% of doctors in our sample. This contrasts with the study by Lagu et al [24] where 70% of their physician sample did not have a single

XSL•FO
RenderX

review on any of the 33 websites they looked at. This study captured data limited to Boston generalists and undefined subspecialists in the spring of 2009. Our study captured data for specific categories of surgeons across the country in the summer of 2011. The experience a patient has with a surgeon is arguably different from the experience one has with a generalist or many types of subspecialists. The surgical experience is typically a "once-off." The experience with a generalist and many types of subspecialists is typically longer term. Patients may be more inclined to post ratings and comments based on a single (more emotionally charged) experience with a surgeon compared with a routine long-term experience with a generalist. But, the threshold of a doctor converting from no reviews on any website to at least one review on a website is low. The average doctor sees over 1000 patients per year. If just one patient takes the effort to post a review, that threshold is crossed. As our data was gathered two years after that of Lagu et al, this suggests that although the number of online reviews per doctor is still limited, the trend is for more reviews for more doctors.

Our study was limited to a sample of targeted surgical procedures. Within that dataset, there may be high-volume surgeons who have poor clinical outcomes/patient safety records. And there may be low-volume surgeons with excellent clinical outcomes/patient safety records. Our study only attempted to track a proxy for clinical quality—surgical volume—and not clinical quality itself. Also, our sample makes no conclusions about surgeons who perform procedures other than those analyzed or any conclusions about non-surgical practitioners.

Another limitation is that the NHI database used to identify low- and high-volume surgeons, while extensive, only covered CPT/ICD9 procedure codes submitted to private insurance carriers. The NHI database does not reflect data submitted to Medicare. In surveying the literature correlating surgeon volume with quality of care, we intentionally selected three surgical procedures that were more likely than others to be performed on a younger demographic, hoping to minimize whatever effect the absence of Medicare data might have on our analysis.

One further limitation is that our classification of comments into the categories of quality of care and customer service as glowing praise or scathing criticism required human judgment, making it susceptible to potential inter-reviewer variance. While it is unlikely different reviewers would classify words such as "butcher" and "life saver" differently, new technologies [22] may help automate the review process for greater consistency.

Online doctor review websites provide a growing collection of data for consumers to use. These websites provide fertile ground for future studies on whether its data can help patients reliably differentiate doctors who provide better clinical outcomes and patient safety.

In summary, online review websites provide a rich source of data that may be able to track quality of care, though the effect size is weak and not consistent for all review website metrics.

Acknowledgments

The authors of this article wish to acknowledge and thank Medical Justice Services, Inc for providing financial support for this research.

Conflicts of Interest

Jeffery Segal, MD, JD, is an owner and founder of Medical Justice Services Inc, a firm that assists healthcare providers with, among other issues, their online reputation.
Michael J. Sacopulos, JD, is a practicing attorney who serves as counsel to Medical Justice Services Inc.

References

1. Pennsylvania Health Care Cost Containment Council. Cardiac surgery in Pennsylvania 2008-2009 URL: http://www.phc4.org/reports/cabg/09/download.htm [accessed 2012-03-27] [WebCite Cache ID 66TljgaZn]
2. Birkmeyer JD, Stukel TA, Siewers AE, Goodney PP, Wennberg DE, Lucas FL. Surgeon volume and operative mortality in the United States. N Engl J Med 2003 Nov 27;349(22):2117-2127 [FREE Full text] [doi: 10.1056/NEJMsa035205] [Medline: 14645640]
3. Rodgers M, Jobe BA, O'Rourke RW, Sheppard B, Diggs B, Hunter JG. Case volume as a predictor of inpatient mortality after esophagectomy. Arch Surg 2007 Sep;142(9):829-839 [FREE Full text] [doi: 10.1001/archsurg.142.9.829] [Medline: 17875837]
4. Wright JD, Lewin SN, Deutsch I, Burke WM, Sun X, Herzog TJ. Effect of surgical volume on morbidity and mortality of abdominal hysterectomy for endometrial cancer. Obstet Gynecol 2011 May;117(5):1051-1059. [doi: 10.1097/AOG.0b013e31821647a0] [Medline: 21508742]
5. Browne JA, Pietrobon R, Olson SA. Hip fracture outcomes: does surgeon or hospital volume really matter? J Trauma 2009 Mar;66(3):809-814. [doi: 10.1097/TA.0b013e31816166bb] [Medline: 19276758]
6. Killeen SD, Andrews EJ, Redmond HP, Fulton GJ. Provider volume and outcomes for abdominal aortic aneurysm repair, carotid endarterectomy, and lower extremity revascularization procedures. J Vasc Surg 2007 Mar;45(3):615-626. [doi: 10.1016/j.jvs.2006.11.019] [Medline: 17321352]

XSL•FO
RenderX

7. Karanicolas PJ, Dubois L, Colquhoun PH, Swallow CJ, Walter SD, Guyatt GH. The more the better?: the impact of surgeon and hospital volume on in-hospital mortality following colorectal resection. Ann Surg 2009 Jun;249(6):954-959. [doi: 10.1097/SLA.0b013e3181a77bcd] [Medline: 19474684]
8. Eppsteiner RW, Csikesz NG, McPhee JT, Tseng JF, Shah SA. Surgeon volume impacts hospital mortality for pancreatic resection. Ann Surg 2009 Apr;249(4):635-640. [doi: 10.1097/SLA.0b013e31819ed958] [Medline: 19300225]
9. Nazarian SM, Yenokyan G, Thompson RE, Griswold ME, Chang DC, Perler BA. Statistical modeling of the volume-outcome effect for carotid endarterectomy for 10 years of a statewide database. J Vasc Surg 2008 Aug;48(2):343-350. [doi: 10.1016/j.jvs.2008.03.033] [Medline: 18644481]
10. Lin CC, Lin HC. Effects of surgeon and hospital volume on 5-year survival rates following oral cancer resections: the experience of an Asian country. Surgery 2008 Mar;143(3):343-351. [doi: 10.1016/j.surg.2007.09.033] [Medline: 18291255]
11. McPhee JT, Robinson WP, Eslami MH, Arous EJ, Messina LM, Schanzer A. Surgeon case volume, not institution case volume, is the primary determinant of in-hospital mortality after elective open abdominal aortic aneurysm repair. J Vasc Surg 2011 Mar;53(3):591-599. [doi: 10.1016/j.jvs.2010.09.063] [Medline: 21144692]
12. Farjoodi P, Skolasky RL, Riley LH. The effects of hospital and surgeon volume on postoperative complications after lumbar spine surgery. Spine (Phila Pa 1976) 2011 Nov 15;36(24):2069-2075. [doi: 10.1097/BRS.0b013e318202ac56] [Medline: 21343869]
13. Hervey SL, Purves HR, Guller U, Toth AP, Vail TP, Pietrobon R. Provider volume of total knee arthroplasties and patient outcomes in the HCUP-Nationwide Inpatient Sample. J Bone Joint Surg Am 2003 Sep;85-A(9):1775-1783. [Medline: 12954837]
14. Katz JN, Barrett J, Mahomed NN, Baron JA, Wright RJ, Losina E. Association between hospital and surgeon procedure volume and the outcomes of total knee replacement. J Bone Joint Surg Am 2004 Sep;86-A(9):1909-1916. [Medline: 15342752]
15. Smith MD, Patterson E, Wahed AS, Belle SH, Bessler M, Courcoulas AP, et al. Relationship between surgeon volume and adverse outcomes after RYGB in Longitudinal Assessment of Bariatric Surgery (LABS) study. Surg Obes Relat Dis 2010 Mar 4;6(2):118-125. [doi: 10.1016/j.soard.2009.09.009] [Medline: 19969507]
16. Kelles SM, Barreto SM, Guerra HL. Mortality and hospital stay after bariatric surgery in 2,167 patients: Influence of the surgeon expertise. Obes Surg 2009 Sep;19(9):1228-1235. [doi: 10.1007/s11695-009-9894-7] [Medline: 19562422]
17. Weller WE, Hannan EL. Relationship between provider volume and postoperative complications for bariatric procedures in New York State. J Am Coll Surg 2006 May;202(5):753-761. [doi: 10.1016/j.jamcollsurg.2006.02.002] [Medline: 16648015]
18. Nallamothu BK, Gurm HS, Ting HH, Goodney PP, Rogers MA, Curtis JP, et al. Operator experience and carotid stenting outcomes in Medicare beneficiaries. JAMA 2011 Sep 28;306(12):1338-1343. [doi: 10.1001/jama.2011.1357] [Medline: 21954477]
19. Alexa the Web Information Company. URL: http://www.alexa.com/ [accessed 2012-03-27] [WebCite Cache ID 66TkyTIm9]
20. Google Guide. Customizing your results: Preferences URL: http://www.googleguide.com/preferences.html [accessed 2012-03-27] [WebCite Cache ID 66TlGlpWz]
21. Fox S. "I don't know, but I can try to find out" is the default setting for people with health questions. In: The Social Life of Health Information, 2011. Washington, DC: Pew Internet & American Life Project; May 12, 2011.
22. Xia L, Gentile AL, Munro J, Iria J. Improving patient opinion mining through multi-step classification. In: Text, Speech and Dialogue. Berlin: Springer Verlag; 2009:70-76.
23. Kadry B, Chu L, Gammas D, Macario A. Analysis of 4999 online physician ratings indicates that most patients give physicians a favorable rating. J Med Internet Res 2011;13(4):e95 [FREE Full text] [doi: 10.2196/jmir.1960] [Medline: 22088924]
24. Lagu T, Hannon NS, Rothberg MB, Lindenauer PK. Patients' evaluations of health care providers in the era of social networking: an analysis of physician-rating websites. J Gen Intern Med 2010 Sep;25(9):942-946. [doi: 10.1007/s11606-010-1383-0] [Medline: 20464523]

Abbreviations

CPT: current procedural terminology
HV: high volume
ICD9: International Classification of Diseases, 9th Revision
LV: low volume
NHI: Normative Health Information
HIPAA: Health Insurance Portability and Accountability Act

XSL•FO
RenderX

Edited by G Eysenbach; submitted 19.11.11; peer-reviewed by D Strech, G Gao, L Goeuriot; comments to author 07.12.11; revised version received 05.02.12; accepted 09.03.12; published 10.04.12.

Please cite as:
Segal J, Sacopulos M, Sheets V, Thurston I, Brooks K, Puccia R
Online Doctor Reviews: Do They Track Surgeon Volume, a Proxy for Quality of Care?
J Med Internet Res 2012;14(2):e50
URL: http://www.jmir.org/2012/2/e50/
doi:10.2196/jmir.2005
PMID:22491423

©Jeffrey Segal, Michael Sacopulos, Virgil Sheets, Irish Thurston, Kendra Brooks, Ryan Puccia. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 10.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Internet-Based HIV and Sexually Transmitted Infection Testing in British Columbia, Canada: Opinions and Expectations of Prospective Clients

Travis Salway Hottes[1], MSc; Janine Farrell[2], BA; Mark Bondyra[1], BFA; Devon Haag[1], MSc; Jean Shoveller[3], PhD; Mark Gilbert[1,3], MHSc, MD

[1]BC Centre for Disease Control, Vancouver, BC, Canada

[2]Faculty of Health Sciences, Simon Fraser University, Burnaby, BC, Canada

[3]School of Population and Public Health, University of British Columbia, Vancouver, BC, Canada

Corresponding Author:
Mark Gilbert, MHSc, MD
BC Centre for Disease Control
655 West 12th Avenue
Vancouver, BC, V5Z4R4
Canada
Phone: 1 604 707 5615
Fax: 1 604 707 5604
Email: mark.gilbert@bccdc.ca

Abstract

Background: The feasibility and acceptability of Internet-based sexually transmitted infection (STI) testing have been demonstrated; however, few programs have included testing for human immunodeficiency virus (HIV). In British Columbia, Canada, a new initiative will offer online access to chlamydia, gonorrhea, syphilis, and HIV testing, integrated with existing clinic-based services. We presented the model to gay men and other men who have sex with men (MSM) and existing clinic clients through a series of focus groups.

Objective: To identify perceived benefits, concerns, and expectations of a new model for Internet-based STI and HIV testing among potential end users.

Methods: Participants were recruited through email invitations, online classifieds, and flyers in STI clinics. A structured interview guide was used. Focus groups were audio recorded, and an observer took detailed field notes. Analysts then listened to audio recordings to validate field notes. Data were coded and analyzed using a scissor-and-sort technique.

Results: In total, 39 people participated in six focus groups. Most were MSM, and all were active Internet users and experienced with STI/HIV testing. Perceived benefits of Internet-based STI testing included anonymity, convenience, and client-centered control. Salient concerns were reluctance to provide personal information online, distrust of security of data provided online, and the need for comprehensive pretest information and support for those receiving positive results, particularly for HIV. Suggestions emerged for mitigation of these concerns: provide up-front and detailed information about the model, ask only the minimal information required for testing, give positive results only by phone or in person, and ensure that those testing positive are referred for counseling and support. End users expected Internet testing to offer continuous online service delivery, from booking appointments, to transmitting information to the laboratory, to getting prescriptions. Most participants said they would use the service or recommend it to others. Those who indicated they would be unlikely to use it generally either lived near an STI clinic or routinely saw a family doctor with whom they were comfortable testing. Participants expected that the service would provide the greatest benefit to individuals who do not already have access to sensitive sexual health services, are reluctant to test due to stigma, or want to take immediate action (eg, because of a recent potential STI/HIV exposure).

Conclusions: Internet-based STI/HIV testing has the potential to reduce barriers to testing, as a complement to existing clinic-based services. Trust in the new online service, however, is a prerequisite to client uptake and may be engendered by transparency of information about the model, and by accounting for concerns related to confidentiality, data usage, and provision of positive (especially HIV) results. Ongoing evaluation of this new model will be essential to its success and to the confidence of its users.

XSL•FO
RenderX

(J Med Internet Res 2012;14(2):e41) doi:10.2196/jmir.1948

KEYWORDS

HIV; human immunodeficiency virus; sexually transmitted diseases

Introduction

Several jurisdictions have implemented Internet-based sexually transmitted infection (STI) testing programs, with good uptake and reach into untested populations [1-11]. This approach is consistent with broader efforts to complement existing face-to-face sexual health services with online interventions [12]. Various models for publicly funded Internet-based STI testing have been explored. Most initially engage clients through a website. Specimen collection may then be facilitated either by mail, in which case samples are self-collected at home [5,11], or by providing a requisition that can be presented at designated specimen collection sites or laboratories [7,8]. Some programs continue to deliver results by telephone or face to face [1,4]; however, the feasibility and acceptability of online result delivery, particularly for chlamydia and gonorrhea, has been demonstrated [6,10,13]. The majority of online testing services implemented to date are broad, population screening interventions for chlamydia, predominantly targeting youth [4,10,11,14-16]. Notably, few programs have incorporated testing for human immunodeficiency virus (HIV), and few have targeted gay men and other men who have sex with men (MSM) [7,8].

In British Columbia, Canada, a new program is under development at the BC Centre for Disease Control (BCCDC) to provide online access to chlamydia, gonorrhea, syphilis, and HIV testing, through a model integrated with existing clinic-based services. This program will initially be offered in a pilot phase to clients attending two urban STI clinics—where approximately 10,000 clients are screened annually—and additionally to MSM in Vancouver. After evaluating the results of the pilot phase, this service is intended to expand to other parts of the province, with further targeted promotion to groups that experience high rates of STI and HIV. The goals are to increase test uptake and frequency and to ease demand on clinic-based testing services. The current model invites prospective users to visit a secure website where they will create an account, review pretest information, answer a series of questions (related to, for example, symptoms, recent exposure to STI/HIV, recent sexual behaviors, and history of STI diagnosis), and then print a laboratory requisition. Clients will present to designated specimen collection sites to give blood and urine samples; in the Vancouver area, these sites offer greater flexibility in hours and locations than existing STI clinics. Those who test positive will be contacted by a nurse, who will deliver results by phone or in person, consistent with current clinical practice at the BCCDC. Negative results will be viewable online via the same secure website. Prior to using the service, clients will review an overview of the testing process, including methods for results delivery, on the website. The service will be free of cost for all clients, though cost recovery mechanisms (eg, through the provincial public medical service billing system) will be explored as the service expands.

The importance of formative evaluation to provide end-user input at early stages in the development of novel eHealth interventions is well established [17-19]. Research related to the development of Internet-based preventive care management systems in sexual health as well as other domains (eg, diabetes, arthritis) has illustrated the need first to identify the right group of users for a new online intervention, then to ensure that features of the new service are well tailored to the intended user group and mindful of their most significant concerns—for example, confidentiality in the case of sexual health [5,20,21]. While the acceptability of some Internet-based STI testing models has been demonstrated elsewhere [5,6], we anticipated concerns that may be unique to the British Columbia setting (eg, within the context of a publicly funded health care system) and model, which includes multiple infections—notably HIV—and is integrated with clinic-based services. Anonymous HIV testing is not available in British Columbia, though to afford additional protection of privacy, clients seeking HIV testing have the option to suppress their name and address when a positive result is reported to public health; some STI clinics in the province furthermore allow clients to test using pseudonyms [22]. With respect to delivery of results, clients of the Provincial STI Clinic at BCCDC are contacted by a nurse if any result is positive but may otherwise telephone the clinic to receive their test results. Awareness and utilization of these existing testing options may influence expectations of the online testing service.

Recent in-depth interviews with youth 15–24 years of age in British Columbia have suggested that this population appreciates online sexual health services for the convenience and privacy they afford; however, youth had low tolerance for technologies perceived to be outdated, such as the requirement to print a laboratory requisition form [23]. The current study expands on these findings through formative research with adult MSM and STI clinic clients in Vancouver. We conducted a series of focus groups to gauge initial reactions to the British Columbia Internet-based STI/HIV testing model, identify components of the model that require modification, and describe end users' overall perception of and intention to use the service. Based on other studies and formative work with community-based organizations in British Columbia, we sought to understand particular concerns related to confidentiality and provision of results, as well as ways to create and maintain trust in the service.

Methods

Participants

Focus group attendees were MSM and clients already accessing in-clinic STI testing services (ie, members of target populations to be included in the pilot phase of the British Columbia Internet testing service). MSM were recruited into one of three focus groups through online classifieds and gay news site advertising (6/20, 30%), community agency email lists (5/20, 25%), posters

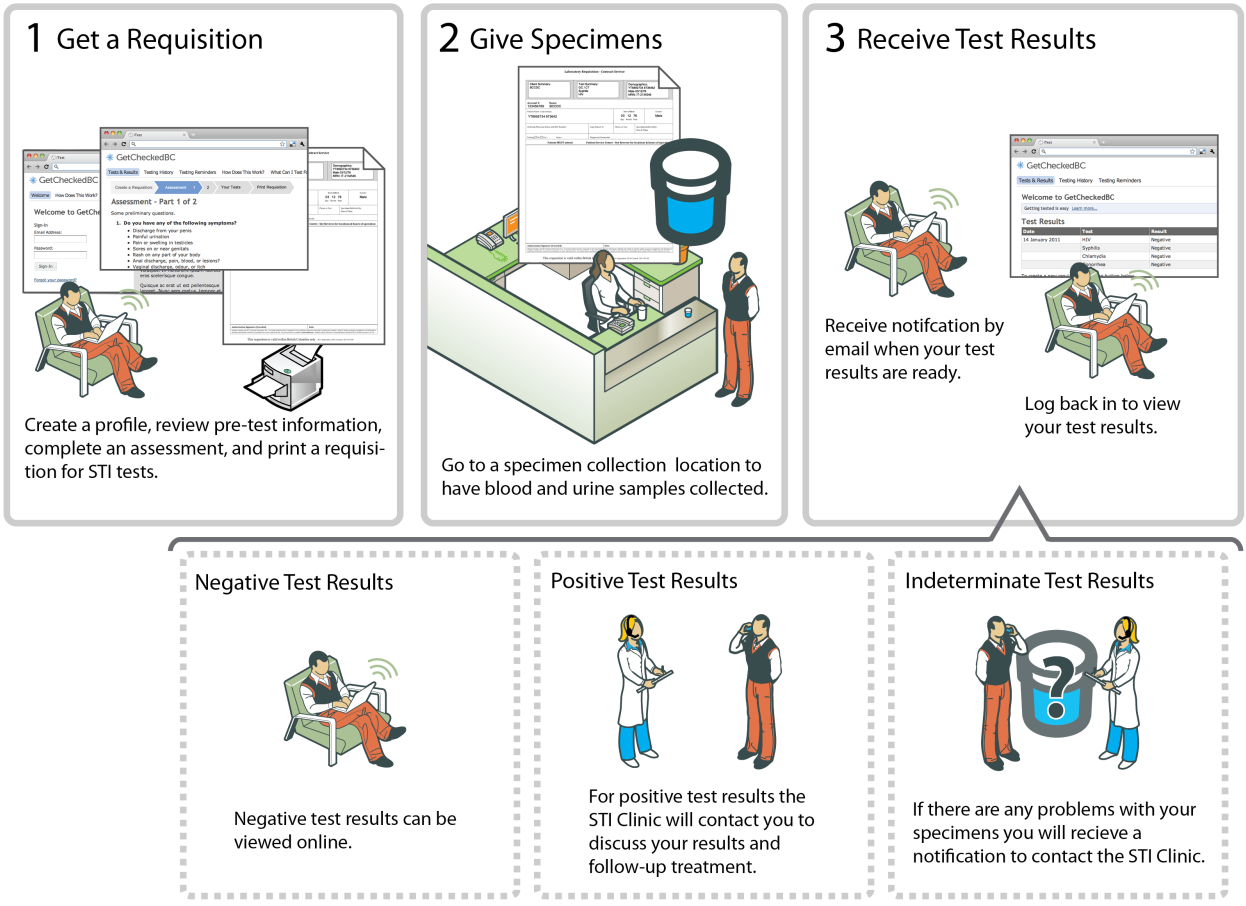
XSL•FO
RenderX

at gay community organizations and businesses (4/20, 20%), and word of mouth (5/20, 25%). Clinic clients were recruited into a further three focus groups through in-clinic flyers (2/19, 11%), emails to clients who had previously consented to be contacted for research (14/19, 74%), and word of mouth (3/19, 16%). All participants were 19 years of age or older, resided in the greater Vancouver area, and gave written informed consent. This study was approved by the Research Ethics Board of the University of British Columbia.

Procedures

Focus groups were audio recorded and lasted 1.5 to 2 hours; they were conducted at the BCCDC in private meeting rooms with one moderator and one observer who took detailed field notes. Upon arriving participants completed a brief, anonymous questionnaire. Prior to discussion participants were reminded to respect the confidentiality of their peers, and participants were never asked to share their name in front of the group. At the start of each focus group, participants discussed their Internet use and past experiences with accessing STI and HIV testing. They were then given a brief (<5 minutes) description of the model (Figure 1), after which the moderator answered clarifying questions. A structured interview guide was used to address the following domains throughout the remaining discussion: willingness to provide personal information online, ways to engender trust in the service, comfort with different ways of delivering results, interest in specific features, appeal of the service, and willingness to use the service. Participants received a $25 cash honorarium.

Figure 1. Proposed British Columbia Internet-based sexually transmitted infection (STI)/human immunodeficiency virus testing model, as presented to focus group participants.



Analysis

An analyst first reviewed the audio recordings and field notes from each focus group to ensure that every statement was captured; this analyst was distinct from the observer who took notes for that particular group. A consensus-based coding scheme was initially developed based on a literature review and subsequently modified to reflect new concepts that emerged throughout the analysis period. Two team members independently reviewed field notes to apply codes from the scheme. They then jointly used a scissor-and-sort technique to analyze the data: printed and coded field notes were cut so that individual statements could be sorted and re-sorted to explore common themes [24]. Analysis was iterative, covering all codes from the scheme and ultimately giving analysts a sense of frequency or extensiveness of each theme. Analysts returned to audio recordings to transcribe quotations of illustrative comments. Except where noted, results reported here include themes identified across two or more focus groups. Results also include descriptions of connections across concepts based on salient themes that we identified as the analysis progressed.

XSL•FO
RenderX

Results

Participant Characteristics

A total of 39 people participated in six focus groups (4–9 participants each) between February 25 and May 5, 2011. Most were men (32, 82%) who identified as gay (19, 49% of total sample), bisexual (4, 10%), or two-spirit (2, 5%). A total of 28 (72%) reported having postsecondary education. All participants had experience with HIV or STI testing, and nearly all were active Internet users: most reported being online 15–40 hours per week, and some described themselves as "[an] Internet addict" and "permanently wired in." None of the participants were familiar with the British Columbia Internet-based STI/HIV testing initiative prior to attending, and few had heard of Internet-based testing services offered elsewhere. Table 1 describes additional participant characteristics.

Table 1. Sociodemographic characteristics, testing behaviors, and access to relevant technology among focus group participants (N = 39).[a]

Variable	n	%
Age range (years)		
20–29	10	26%
30–39	5	13%
40–49	14	36%
≥50	10	26%
Gender		
Male	32	82%
Two-spirit	3	8%
Female	4	10%
Country of birth		
Canada	34	87%
Sexual orientation		
Gay	19	49%
Bisexual	4	10%
Two-spirit	2	5%
Straight	12	31%
Unknown	2	5%
Highest level of education completed		
Elementary school	1	3%
High school	10	26%
University	23	59%
Graduate school	5	13%
Testing history		
Ever tested for HIV[b]	38	97%
Ever tested for STI[c] (other than HIV)	36	92%
Tested for HIV or STI in past year	29	74%
Access to technology		
Private Internet-connected computer	39	100%
Printer that can be used to print personal information	31	79%

[a] Based on self-report through anonymous questionnaire.

[b] Human immunodeficiency virus.

[c] Sexually transmitted infection.

XSL•FO
RenderX

Current Barriers to In-Clinic Testing

Participants articulated numerous barriers to in-clinic STI/HIV testing (Table 2). The most common were embarrassment and stigma. Embarrassment was often described as discomfort with talking to a clinician about sex, sexuality, or STI and HIV tests. Stigma was a broader, more complex issue that permeated most topics of discussion and was raised in every focus group. Stigma was described in terms of perceived judgment, not only from the provider but also from those who might see them or know they were going to get tested. While most participants had recently accessed testing themselves, they recounted past experience or knowledge of friends' experiences in expressing how broader social stigma leads to avoidance of testing. As one middle-aged man explained, "I've been in situations with the clinic before where you get this judgment and this fear factor built up and you just don't want to talk to them anymore and you end up just not going back." Others discussed frustration with in-person testing, citing long wait times—both to get an appointment and to be seen after arriving at the clinic—and difficulty returning to the clinic for results. Finally, limited access to competent or sensitive sexual health services was another barrier discussed. This may include not having a family doctor or dissatisfaction with a family doctor; for example, some expressed concern that their doctor may not know the right tests to offer. One participant told of a family doctor who was reluctant, even uncomfortable, to offer an HIV test: "I went to my family doctor and told him I wanted an HIV test and he was like 'why?, you're not gay,' and um obviously, well, yah I am and I do...I had to go to a hospital to go get tested." Participants were also mindful of those who live in rural areas or far from the city center, who may not have access to nonjudgmental or gay/lesbian/bisexual/transgender-friendly STI clinics as an alternative to going to see a family doctor.

Perceived Benefits of Internet Testing

In this context, Internet-based testing was thought to offer the potential to circumvent some of these existing barriers through anonymity, access, convenience, and control (Table 2). Participants repeatedly described anonymity, or the "faceless experience," as perhaps the greatest promise of the Internet in relation to sexual health services. By ordering tests online, participants felt that they would avert some of the aforementioned worries about someone seeing them walk into an STI clinic:

> *This is definitely a service I would use, not only for the convenience factor but I mean, no matter how old we are, it's still an embarrassing issue for a lot of people. Like he was saying, there's the STI clinic, and so what I do is look around and see what traffic is on the road...because it's embarrassing for me.*

The facelessness of the Internet may further facilitate clients' comfort with providing personal information. As one young woman observed:

> *I'd be definitely more comfortable doing it [answering questions about sexual behaviors] online because I think people have a tendency to underestimate when in person, because I think as you said the fear, or it's embarrassing when you're asked how many sexual partners you've had, people will tend to go on the low end, you know, it's just human nature, so I'd rather do it online probably.*

The ability to access Internet testing any time of the day or night was also emphasized as a key benefit. In light of the problems some individuals had with getting to the clinic during business hours to retrieve results, online access to test results offers a striking advantage. One clinic client explained that "being able to get a negative test result by logging in and saying oh there it is, really provides a lot of convenience...the easier you make it to get a negative test result, the more people will be tempted to use the service." A 20-something-year-old gay man highlighted the client-centered control of Internet-based services as a major appeal:

> *I can't speak for all people, but certainly for a lot of people in my generation, well our generation, certainly, it's just um easier. You get to, it's the email thing, your results are ready, you check it, and then you can call someone...I prefer it because...it sort of gives me agency over my own health care in a way, like, in the sense that here's the information, I can do with it what I choose, rather than relying on some doctor or some nurse that I may not know to sort of decide how they're going to do it and sort of be in that emotional space, you know. I can then decide how I approach it.*

Using the Internet to offer testing was furthermore thought to be beneficial for *both* the client and the provider, in that it will standardize the service clients receive—taking away some of the variability encountered when seeking in-clinic testing—while allowing providers to focus their time on delivering results, treatment, and follow-up, with the potential to also reduce costs.

Table 2. Barriers to in-clinic sexually transmitted infection and human immunodeficiency virus testing, and corresponding benefits of Internet-based testing, as expressed by participants.

Existing barriers to testing	Perceived benefits of Internet-based testing
Embarrassment of talking to a clinician about sexual health concerns; and stigma or perceived judgment associated with seeking testing	Anonymity or faceless experience of ordering tests online
Long wait times at the clinic	Immediate access to website
Difficulty getting to sexually transmitted infection clinic during business hours	24-hour availability of Internet; extended/flexible hours of specimen collection (laboratory) sites
Dissatisfaction with/lack of family doctor	Standardized service, controlled by the client

XSL•FO
RenderX

Building Trust

When participants were presented with the Internet testing model (Figure 1), many initially expressed some hesitation or confusion (Table 3). While some of the previously mentioned anonymity-related concerns may be mitigated by an online platform, new misgivings about the provision of personal information were heightened with the use of the Internet:

> *I think dealing with people's fears around this is a critical component of it. And anonymity is going to be kind of a position people will start from, and then they'll sort of move to a point of being more comfortable.*

For some this reluctance to provide personal information was traced to fears about security; one participant explained that "I would say, first of all, you know, I wouldn't be comfortable putting any personal information into a website like this where I know someone could hack into it or something." Others wanted to know what the service provider would be doing with their information, where it would be stored, and why it was being collected. In response, however, participants offered suggestions to allay these concerns about sharing personal information, as illustrated by the following quotes and further outlined in Table 3.

> *If you're going to use an email address to register, you may want to say something like go to Gmail or Hotmail and create a new, anonymous email account that you only use for this, if you want to have more privacy, if you don't feel comfortable using your own personal email account.*

> *For people who obviously want to do this confidentially...I'm assuming people are going to be using it because they don't want people to see them going to a clinic...when you refresh the page, and someone comes by and someone is being snoopy, 'why were you on that website?,' you know kind of thing, I don't know if there's computer technology for back browsing or to clear the cache so when you leave that site there's no way to tell them you were on that site.*

A few participants expressed concern that someone might maliciously enter another person's name or email address when creating an account. Participants consequently suggested that email addresses be verified by sending a confirmation email and requiring a response before activating the account. Most participants were ultimately willing to give information required for STI/HIV testing but not more than is absolutely necessary. They also expected to be told why they were being asked for each piece of information, repeatedly suggesting that a description of the use and purpose of all data collected be clearly described for prospective clients up front, in advance of registering for the service.

Other concerns with the model related to lived or perceived experiences with positive test results, particularly for HIV; these concerns were more prevalent in the focus groups with gay men and other MSM. A few participants worried that testing online would mean that clients would not receive all of the pretest information they thought they needed:

> *How do you know somebody has actually read all the information? I click agree to the conditions, right, like when you order software or whatever. Nobody reads all those things, but you have to click it to get through.*

There was also frequent concern for what it would be like to get a positive result using the Internet testing service, and participants were eager to suggest extra measures to protect those receiving positive results. One person suggested that all clients be required to receive all four tests (ie, chlamydia, gonorrhea, syphilis, and HIV) so that if they are notified that a result is positive they wouldn't know for certain that it was their HIV result. This suggestion was liked by some participants as a way to reduce anxiety for testers but disliked by others because it was regarded as contrary to the otherwise client-centered nature of the model. To remedy this, many participants suggested providing positive HIV results in person or by phone only, and providing Web links to other care and support, including community-based peer services and counseling:

> *I think one of the things that could be offered through Internet resources is uh immediate access for people who are getting devastating results. Where do you go next? What do you do? In the first 48 hours you need critical care for these people.*

Participants also talked about the anxiety experienced while waiting for a test result and worried that such anxiety could be exacerbated when testing online; thus, many participants urged that resources and referrals be provided at the time of testing (via the website or laboratory requisition form), as well as at the time of diagnosis.

When asked how trust in the service might be gained, participants noted the importance of professionalism and of adhering to standardized guidelines. As outlined above, transparency of information and practices is key. Three participants, across multiple focus groups, inquired about whether evaluation or research would be done to ensure the service is meeting its goals and is acceptable to users. Additionally, the legitimacy of the organization sponsoring the program was noted to be relevant in gaining trust in the new service (eg, BCCDC as a government organization).

XSL•FO
RenderX

Table 3. Concerns with Internet-based sexually transmitted infection/human immunodeficiency virus (HIV) testing and corresponding strategies for mitigation expressed by participants.

Concern	Suggestions for mitigation
Reluctance to provide personal information online	• Ask only for information required for testing • Explain rationale for other data collected • Validate email address when creating a new account
Distrust of security of data provided online	• Describe security measures of website up front • Explain additional measures client can take (eg, private browsing, clear cache/history)
Ensuring comprehensive pretest counseling	• Remind clients of the option of coming to a clinic for face-to-face pretest discussions • Include detailed pretest information on the website
Support for those waiting for results and receiving positive results, particularly for HIV	• Do not provide any positive results online • Provide links to referrals, including counseling and support services in community, at time of testing (via website)

Expectations of the Service

In general, most participants expected that the Internet testing service would offer features similar to other commonly used Web-based services and in particular would provide continuous online service delivery. This included a strong interest in booking in-clinic appointments and getting prescriptions for STI treatments online. When presented with the model, several people noted the requirement to print a laboratory form and suggested that the requisition data instead be sent electronically, either to the client's smart phone or directly to the laboratory itself:

> *What if you were provided with a verification code, say to my iPhone, to my email address, that I could just take to [the lab], show them the code, and they would have the information in their system?...it could go direct to their forms.*

Nearly all participants were interested in receiving result notifications (ie, messages indicating that results are ready) and testing reminders, either by email or by text message, though many emphasized that clients should be able to control when and how such notifications are sent, bearing in mind the potential for breaches in confidentiality, through email especially. Repeatedly participants stated that they would like to have options with regard to nearly every aspect of using the service, and in particular when receiving communications:

> *[Regarding how would you like to be notified of results] I'd rather it just be like, either or, check online, and maybe click something if you prefer to be notified by phone...but certainly there should be the option as well for people who just want to be notified over the Internet, on their own terms.*

Participants also believed that standards of service for online testing should be similar to those in the clinic, and where they differ (eg, for particular STI tests not being offered online), clients expect to be given referrals to other places for testing. Likewise, when asked what questions they would expect to be asked before testing online, participants responded that they would expect to see the same questions they would be asked in a clinic. As one participant explained:

> *I'd say with regard to the risk assessment though there would be no reason to have it any different than the questions they ask you when you come in here [STI clinic], you know like how many partners, the whole thing they go through.*

In response, another participant noted that "when you give answers here [at the BCCDC] they type them into a computer database anyway."

Barriers to Use of Online Testing Service

Across focus group discussions, a few noteworthy barriers to use of the Internet testing service were elicited. These limitations predominantly reflected concerns over levels of technical or English-language literacy. Although 79% of participants reported access to a printer where they could print confidential information, many raised the lack of a personal printer and the expense and hassle of obtaining ink and printer paper as barriers to using this service. A middle-aged heterosexual male participant elicited agreement from several others in his focus group when he described a typical situation:

> *My only printer is at work. [moderator: What would it be like to print a requisition like this at work?] It's easy, but I mean, mine's a group printer. There's eight of us using one printer, and if I'm not up and at that printer, they're going to look at it and ask, 'what the hell is this?'*

When asked whether this would ultimately dissuade them from using the service, most acknowledged that it would not, though it would likely be perceived by some as an annoyance. Beyond the concerns with printing, others noted varying levels of comfort with computers and with the Internet as potential barriers. Focus group attendees furthermore highlighted limited English-language skills, among both native and nonnative speakers, suggesting that instructions and information on the site be written in a style mindful of those with more basic levels of language literacy and health literacy.

Uptake

Most participants said they would use the Internet testing service or recommend it to others. Those who indicated they would be unlikely to use it generally lived near an STI clinic and therefore had convenient access to testing, or routinely saw a family

XSL•FO
RenderX

doctor with whom they were comfortable testing (eg, HIV-positive individuals who were regularly receiving screening and other care and treatment services through a primary care provider). Some also suggested that Internet testing may not be well suited for people such as first-time testers, who may have heightened anxiety or questions that are best handled face to face.

Participants expected that the service would provide the greatest benefit to individuals who do not have access to sensitive sexual health services (for example, those living outside the city center or in rural or remote areas), are reluctant to test due to stigma (eg, youth or non-gay-identified MSM), want to start the process of testing immediately (eg, those who had a recent possible exposure to an STI/HIV), or may simply forget or put off going for routine testing. As one participant expressed, "I'm someone who procrastinates a bit, and this would remind me to get going, get tested every...however often."

Discussion

This study of gay, bisexual, and two-spirit men and STI clinic clients in Vancouver, Canada revealed generally high levels of enthusiasm for Internet-based STI/HIV testing. Focus group attendees started from a point of reluctance toward the Internet testing concept, raising concerns related to confidentiality, data usage, and provision of positive (especially HIV) results, but gradually moved to a point of confidence and comfort after seeing that these concerns were accounted for in the present model. Trust in the service is thus a prerequisite to client uptake and may be engendered through transparency of information about the model, by providing positive test results preferably in person (in the case of HIV) or by phone, and by ensuring that provisions are in place to link those testing positive or waiting for results with referrals for care, including counseling and community-based support services. Notably, for each of the most prevalent concerns elicited, participants themselves identified a mitigation strategy (Table 3). Other suggestions generated from this study—for example, inclusion of online prescriptions—may not be feasible for the pilot phase of the service but are useful in long-term strategic planning for program expansion.

The proposed Internet-based service was described by potential users through a discussion of tensions and trade-offs. Losing the face-to-face interaction of traditional clinic settings was welcomed when it meant a gain in anonymity but was questioned in terms of the ability to provide support for those receiving positive test results. Generally, clients expected that the online service would take care of them, offering the quality of care equivalent to that provided in a clinic; however, they wanted to see justification for all questions asked of clients via the website and resisted the collection of extraneous personal data. Likewise, some participants expressed a desire for paternalistic features (eg, requiring all clients to test for all four infections), while others demanded a more client-centered model where they could test and receive results in a way of their choosing. These trade-offs suggest that Internet testing for STI and HIV requires careful balancing to respect divergent viewpoints. Ultimately this service cannot accommodate *all* client preferences, though we may heed these requests by providing options where possible. For example, while clients will not be able to choose to receive positive results online, they may be able to opt in or out of email notifications concerning negative results.

Our findings were generally consistent with those of others who have assessed the acceptability of online STI screening services [5,6,23]. Concerns over confidentiality and data usage are common in relation to sexual health services [25-27] and perhaps not surprising given the stigma and shame associated with STI and HIV, as articulated by our participants themselves. Privacy- and health data-related concerns have been heightened in recent years in British Columbia, in response to an initiative to both centralize and expand access to electronic medical records in the province [28], as well as increasing criminal cases for HIV nondisclosure [29]. As found in qualitative studies of British Columbia youth [23], the adults sampled in our study expressed an expectation that online services be totally online and balked at the requirement to print a form to use the service. Unlike most other Internet testing models that have been described in published research, ours includes the option to test for HIV. Participants in our focus groups praised the increased accessibility to HIV testing afforded by this model but also raised concerns with the experience of testing for HIV in a new setting, particularly one that does not include a face-to-face consultation. A disproportionate amount of the anxiety around provision of results was centered on the HIV test, especially among gay and bisexual men and other MSM. This was a noteworthy concern but not an irreconcilable one, and various strategies for mitigation were elicited, as already noted.

Soliciting input from end users through formative research is recommended at early stages of development of novel, Internet-based health services [17,18], though there are compelling challenges to achieving this in the setting of understaffed and underfunded small governmental projects. Our study demonstrates how such qualitative research can nonetheless provide valuable results through the use of efficient methods such as field notes (in lieu of full data transcription) and scissor-and-sort analysis techniques. Such methods preclude detailed analysis of themes that may be pursued in traditional qualitative research but allow for rapid cycles of recruitment, interview or focus group conduct, analysis, and interpretation, the rehearsal of which is essential to the success of programs like ours. We have thereby been able to incorporate the key findings highlighted above—and in particular the mitigation strategies outlined in Table 3—into the British Columbia Internet testing model in real time.

The participants in this study were largely Internet-savvy, highly educated, urban gay men who were already experienced with testing. Thus, our findings are helpful in tailoring this intervention for the more limited pilot phase but may not be generalizable to other groups—notably those that are not currently testing for STI/HIV, a population that will be of keen interest during the provincial expansion of the program and that may have particular concerns when first testing through an online platform. Participants themselves noted that Internet testing likely holds the greatest benefit for those living outside the city center, who have limited access to sensitive sexual

XSL•FO
RenderX

health services. Further focus groups with traditionally underserved and marginalized populations are planned and will aid in the development and scale-up of this service.

As illustrated by the data presented here, Internet-based STI/HIV testing is a potentially powerful complement to existing clinic-based services. Despite the rapid growth in online testing programs globally, these services remain unfamiliar to most target users in British Columbia. In light of its differences from traditional testing services, fully understanding the needs and expectations of prospective clients is imperative, as is providing them with clear, up-front information about the new model, along with justification for its particular functions and features. Much of the research on Internet testing has explored feasibility and acceptability [30]; more data are now needed to determine its effectiveness in relation to other outcomes such as frequency of testing, uptake among those not already testing, and uptake among those most at risk of infection.

Acknowledgments

The authors are grateful to all participants who enthusiastically contributed to focus group discussions. We also wish to thank Wendy Davis and the Youth Sexual Health Team at the University of British Columbia for their help in preparing for focus groups, as well as the members of our Community Consultation Working Group for their insightful input at various stages of developing the British Columbia Internet testing model: Elgin Lim (Positive Living BC), Heidi Morgan (AIDS Vancouver), Janet Madsen (Positive Women's Network BC), Michael Reid (YouthCO AIDS Society), Monica Freudenreich (AIDS Vancouver), Robin Parry (QMUNITY), Stephanie Martin (McCreary Centre Society), and Wayne Robert (Health Initiative for Men). This research was funded in part by the Canadian Institutes of Health Research.

Conflicts of Interest

None declared.

References

1. Chai SJ, Aumakhan B, Barnes M, Jett-Goheen M, Quinn N, Agreda P, et al. Internet-based screening for sexually transmitted infections to reach nonclinic populations in the community: risk factors for infection in men. Sex Transm Dis 2010 Dec;37(12):756-763. [doi: 10.1097/OLQ.0b013e3181e3d771] [Medline: 20644498]
2. Gaydos CA, Barnes M, Aumakhan B, Quinn N, Agreda P, Whittle P, et al. Can e-technology through the Internet be used as a new tool to address the Chlamydia trachomatis epidemic by home sampling and vaginal swabs? Sex Transm Dis 2009 Sep;36(9):577-580. [doi: 10.1097/OLQ.0b013e3181a7482f] [Medline: 19543145]
3. Gaydos CA, Barnes M, Aumakhan B, Quinn N, Wright C, Agreda P, et al. Chlamydia trachomatis age-specific prevalence in women who used an internet-based self-screening program compared to women who were screened in family planning clinics. Sex Transm Dis 2011 Feb;38(2):74-78. [doi: 10.1097/OLQ.0b013e3182039d7f] [Medline: 21173720]
4. Gaydos CA, Dwyer K, Barnes M, Rizzo-Price PA, Wood BJ, Flemming T, et al. Internet-based screening for Chlamydia trachomatis to reach non-clinic populations with mailed self-administered vaginal swabs. Sex Transm Dis 2006 Jul;33(7):451-457. [doi: 10.1097/01.olq.0000200497.14326.fb] [Medline: 16652069]
5. Gaydos CA, Rizzo-Price PA, Barnes M, Dwyer K, Wood BJ, Hogan MT. The use of focus groups to design an internet-based program for chlamydia screening with self-administered vaginal swabs: what women want. Sex Health 2006 Dec;3(4):209-215. [Medline: 17112429]
6. Greenland KE, Op de Coul EL, van Bergen JE, Brouwers EE, Fennema HJ, Götz HM, et al. Acceptability of the internet-based Chlamydia screening implementation in the Netherlands and insights into nonresponse. Sex Transm Dis 2011 Jun;38(6):467-474. [doi: 10.1097/OLQ.0b013e318204546e] [Medline: 21217416]
7. Koekenbier RH, Davidovich U, van Leent EJ, Thiesbrummel HF, Fennema HS. Online-mediated syphilis testing: feasibility, efficacy, and usage. Sex Transm Dis 2008 Aug;35(8):764-769. [doi: 10.1097/OLQ.0b013e31816fcb0a] [Medline: 18496472]
8. Levine DK, Scott KC, Klausner JD. Online syphilis testing--confidential and convenient. Sex Transm Dis 2005 Feb;32(2):139-141. [Medline: 15668622]
9. Novak DP, Edman AC, Jonsson M, Karlsson RB. The internet, a simple and convenient tool in Chlamydia trachomatis screening of young people. Euro Surveill 2003 Sep;8(9):171-176 [FREE Full text] [Medline: 14512638]
10. Novak DP, Karlsson RB. Simplifying chlamydia testing: an innovative Chlamydia trachomatis testing approach using the internet and a home sampling strategy: population based study. Sex Transm Infect 2006 Apr;82(2):142-7; discussion 152. [doi: 10.1136/sti.2005.016832] [Medline: 16581742]
11. van Bergen JE, Fennema JS, van den Broek IV, Brouwers EE, de Feijter EM, Hoebe CJ, et al. Rationale, design, and results of the first screening round of a comprehensive, register-based, Chlamydia screening implementation programme in the Netherlands. BMC Infect Dis 2010;10:293 [FREE Full text] [doi: 10.1186/1471-2334-10-293] [Medline: 20925966]
12. McFarlane M, Bull SS. Use of the Internet in STD/HIV prevention. In: Aral SO, Douglas JM, editors. Aral SO, Douglas JM, editors. Behavioral Interventions for Prevention and Control of Sexually Transmitted Diseases. New York, NY: Springer US; 2007:214-231.

XSL•FO
RenderX

13. Ling SB, Richardson DB, Mettenbrink CJ, Westergaard BC, Sapp-Jones TD, Crane LA, et al. Evaluating a Web-Based Test Results System at an Urban STI Clinic. Sex Transm Dis 2010 Mar 9. [doi: 10.1097/OLQ.0b013e3181d3d037] [Medline: 20220562]
14. Don't Think Know.: Los Angeles County Sexually Transmitted Disease Program; 2011. About the Test URL: https://www.dontthinkknow.org/get-a-home-test-kit/about-the-test.html [accessed 2011-07-22] [WebCite Cache ID 60NZ1yhJj]
15. Quickie Chlamydia Test.: UK National Health Service; 2011. URL: http://www.fancyaquickie.org.uk/ [accessed 2011-07-22] [WebCite Cache ID 60NZOvmB3]
16. Get Tested Why Not.: Ottawa Public Health Department; 2011 Jul 21. About the Test URL: http://www.gettestedwhynot.ca [WebCite Cache ID 60NZahmxl]
17. Catwell L, Sheikh A. Evaluating eHealth interventions: the need for continuous systemic evaluation. PLoS Med 2009 Aug;6(8):e1000126 [FREE Full text] [doi: 10.1371/journal.pmed.1000126] [Medline: 19688038]
18. Lilford RJ, Foster J, Pringle M. Evaluating eHealth: how to make evaluation more methodologically robust. PLoS Med 2009 Nov;6(11):e1000186 [FREE Full text] [doi: 10.1371/journal.pmed.1000186] [Medline: 19956674]
19. Ross JD, Copas A, Stephenson J, Fellows L, Gilleran G. Optimizing information technology to improve sexual health-care delivery: public and patient preferences. Int J STD AIDS 2007 Jul;18(7):440-445. [doi: 10.1258/095646207781147210] [Medline: 17623499]
20. Nijland N, van Gemert-Pijnen JE, Kelders SM, Brandenburg BJ, Seydel ER. Factors influencing the use of a Web-based application for supporting the self-care of patients with type 2 diabetes: a longitudinal study. J Med Internet Res 2011;13(3):e71 [FREE Full text] [doi: 10.2196/jmir.1603] [Medline: 21959968]
21. Stinson J, McGrath P, Hodnett E, Feldman B, Duffy C, Huber A, et al. Usability testing of an online self-management program for adolescents with juvenile idiopathic arthritis. J Med Internet Res 2010;12(3):e30 [FREE Full text] [doi: 10.2196/jmir.1349] [Medline: 20675293]
22. HIV/AIDS Epi Updates. Ottawa, ON: Public Health Agency of Canada; 2010 Jul. HIV Testing and Surveillance Systems in Canada URL: http://www.phac-aspc.gc.ca/aids-sida/publication/epi/2010/pdf/EN_Chapter3_Web.pdf [accessed 2012-02-22] [WebCite Cache ID 65eYspJWM]
23. Shoveller J, Knight R, Davis W, Gilbert M, Ogilvie G. Online sexual health services: examining youth's perspectives. Can J Public Health 2012;103(1):14-18. [Medline: 22338322]
24. Stewart DW, Shamdasani PN, Rook DW. Focus Groups: Theory and Practice. 2nd edition. Thousand Oaks, CA: SAGE Publications; 2007:109-133.
25. Gold RS, Karantzas G. Thought processes associated with reluctance in gay men to be tested for HIV. Int J STD AIDS 2008 Nov;19(11):775-779. [doi: 10.1258/ijsa.2008.008228] [Medline: 18931273]
26. Hitchings S, Allotey J, Pittrof R. What do patients want most from sexual health services? Int J STD AIDS 2009 Oct;20(10):719-722. [doi: 10.1258/ijsa.2009.009133] [Medline: 19815918]
27. Shoveller J, Johnson J, Rosenberg M, Greaves L, Patrick DM, Oliffe JL, et al. Youth's experiences with STI testing in four communities in British Columbia, Canada. Sex Transm Infect 2009 Sep;85(5):397-401. [doi: 10.1136/sti.2008.035568] [Medline: 19508967]
28. Johnson G. Georgia Straight. Vancouver, BC: Vancouver Free Press Publishing Corp.; 2011 May 18. Electronic Health Records Raise Privacy Concerns URL: http://www.straight.com/article-393216/vancouver/ehrs-raise-privacy-concerns [accessed 2012-02-22] [WebCite Cache ID 65eZNawgG]
29. Criminal Law and HIV Non-disclosure in Canada: Questions and Answers (Document Number 1921). Toronto, ON: Canadian HIV/AIDS Legal Network; 2011 Aug 01. URL: http://www.aidslaw.ca/publications/publicationsdocEN.php?ref=1222 [accessed 2012-02-22] [WebCite Cache ID 65eZVxEeN]
30. Rietmeijer CA, Shamos SJ. HIV and sexually transmitted infection prevention online: current state and future prospects. Sex Res Social Policy 2007;4(2):65-73. [doi: 10.1525/srsp.2007.4.2.65]

Abbreviations

BCCDC: British Columbia Centre for Disease Control
HIV: human immunodeficiency virus
MSM: men who have sex with men
STI: sexually transmitted infection

XSL•FO
RenderX

Edited by G Eysenbach; submitted 28.09.11; peer-reviewed by C Fairley, K Horvath, D McDonnell, S Patolia, J West; comments to author 01.11.11; revised version received 18.01.12; accepted 21.01.12; published 06.03.12.

Please cite as:
Hottes TS, Farrell J, Bondyra M, Haag D, Shoveller J, Gilbert M
Internet-Based HIV and Sexually Transmitted Infection Testing in British Columbia, Canada: Opinions and Expectations of Prospective Clients
J Med Internet Res 2012;14(2):e41
URL: http://www.jmir.org/2012/2/e41/
doi:10.2196/jmir.1948
PMID:22394997

©Travis Salway Hottes, Janine Farrell, Mark Bondyra, Devon Haag, Jean Shoveller, Mark Gilbert. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 06.03.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Validation of an Informant-Reported Web-Based Data Collection to Assess Dementia Symptoms

Kenneth Rockwood[1,2], MD, FRCPC; An Zeng[1], PhD; Chris Leibman[3], MS, PharmD; Lisa Mucha[4], PhD; Arnold Mitnitski[1,2], PhD

[1]DGI Clinical Inc, Halifax, NS, Canada

[2]Department of Medicine, Dalhousie University, Halifax, NS, Canada

[3]Janssen Alzheimer Immunotherapy R&D, LLC, South San Francisco, CA, United States

[4]Pfizer Inc, Collegeville, PA, United States

Corresponding Author:
Kenneth Rockwood, MD, FRCPC
DGI Clinical Inc
1344 Summer Street
Suite 208
Halifax, NS, B3H 0A8
Canada
Phone: 1 902 421 5710 ext 5
Fax: 1 902 421 2733
Email: KRockwood@dgiclinical.com

Abstract

Background: The Web offers unprecedented access to the experience of people with dementia and their care partners, but data gathered online need to be validated to be useful.

Objective: To test the construct validity of an informant Web-based data collection to assess dementia symptoms in relation to the 15-point Dependence Scale (DS).

Methods: In an online survey posted on the DementiaGuide website, care partners of people with dementia built individualized profiles from the 60-item SymptomGuide and completed a questionnaire, which included the DS and a staging tool.

Results: In the 250 profilees (155, 62% women, mean age 77 years), increasing dependence was associated with a greater chance of institutionalization. For example, no one at the lowest levels of dependence (DS score < 5, n = 33) was in long-term care, compared with half (13/25) of the profilees at the highest levels of dependence (DS score > 12) being in institutions (χ^2_4 = 27.9, $P < .001$). The Web-based DS was correlated with the number of symptoms: higher DS scores were associated with a higher stage of dementia ($F > 50$, $P < .001$).

Conclusion: In an online survey, the Web-based DS showed good construct validity, potentially demonstrating how the Web can be used to learn more about dementia progression and how it relates to symptoms experienced by patients across the course of dementing illnesses. Even so, caution is needed to assure the validity of data collected online.

(J Med Internet Res 2012;14(2):e42) doi:10.2196/jmir.1941

KEYWORDS

Dementia; online survey; symptoms; Dependence Scale; staging; cognitive impairment not dementia; mild cognitive impairment; validation; World Wide Web

Introduction

Dementia is a progressive disorder that affects memory, thinking, language, judgment, and behavior. This high dimensionality challenges measurement of the myriad effects of progressive neurocognitive illnesses. Our group has aimed to understand dementia by focusing on a few symptoms of greatest importance to each patient [1]. This focus on how patients experience dementia is achieved through an individualized approach, in which each patient–care partner dyad focuses on just a few symptoms (typically 3–6) of most importance to them. Individualization is feasible in clinical trials. It offers a means of evaluating medications by how well

XSL•FO
RenderX

they work on dementia symptoms, and not just on how much they improve scores on standardized tests [2,3].

A more common—and complementary—way to reduce dimensionality in dementia and achieve some sort of quantitative understanding of a patient's overall disease course is by means of staging the dementia. This can be done from semi-individualized clinical interviews, or by focusing on functional disability as a means of understanding the impact of dementia. Instruments such as the Functional Assessment Staging Tool describe impairment in self-care needs and instrumental activities; such disability is highly correlated with the other 10 axes (including memory, orientation, language, praxis, and behavior) of the Brief Cognitive Rating Scale [4]. Staging of dementia severity also typically reflects increasing dependence on others—not just for disability, but also because impaired judgment can pose risks. As a complement to classic staging instruments, the Dependence Scale (DS) was developed to measure the amount of care required by dementia patients [5]. Longitudinal studies of change in DS scores have demonstrated its validity and reliability in reflecting increased impairment with dementia progression [6].

Dependence is also well understood by those who care for people with dementia, making it a potentially useful construct in surveys. Such surveys offer some important potential in helping to bridge the gap between the lived experience of dementia and its measurement in clinical research, especially clinical trials, where the issue of clinical relevance can be fraught [2,7]. The popularity of the World Wide Web enables patients and their caregivers to conveniently access the Internet, and many do, especially adults caring for aging parents [8]. A 2011 survey found that 59% of American adults reported looking for health information online; this included 88% of self-reported caregivers. Overall, 17% of all Internet users reported looking online for information about memory loss, dementia, or Alzheimer disease [9]. Even so, how to make best use of this access remains unclear. If it unifies understanding of disease progression, the concept of progressive dependence might help translate from the clinical endpoints employed in trials to better understand the clinical meaningfulness of what historically appear to be small changes in neuropsychological test scores. To do so, it is important to be able to evaluate the information provided by respondents online. Here, our primary aim was to test the construct validity of Web-based symptom profiles. We compared these profiles with a responder-completed assessment of a patient's level of dementia using the DS and an informant-reported staging tool. In particular, we expected to see more symptoms at higher levels of dependence, and to see more symptoms in those in institutions than otherwise. In addition, we examined patterns among the symptoms that patients targeted and their DS score, expecting to see more behavioral symptoms and functional dependence symptoms with increasing levels of the DS.

Methods

Setting

This is an online survey of visitors to the DementiaGuide website [10]. That site's SymptomGuide is a Web-based tool for persons with dementia and their caregivers to identify the symptoms they are exhibiting and track how the symptoms change over time [1]. The 60 dementia symptoms in the online symptom library (Multimedia Appendix 1) and the corresponding hundreds of plain-language descriptors are easily understood by families and caregivers, who for the most part are the chief users of the site. For each symptom, information is available about its definition and descriptions, the typical stage of dementia at which it occurs, and common management strategies. These are accessed by clicking on tabs visible on each symptom, a tab providing standard advice from a physician about the typical challenges and course related to that problem, and another tab ("What's happening in the Brain?") that describes the pathophysiology in lay terms.

In an open survey, participants were sampled from website visitors who visited the site long enough to view its symptom library. Participants who completed the survey were offered a free subscription to the website for their participation. An announcement of the survey was posted on the DementiaGuide homepage and sent to registered site users via email. There was no other advertising for the survey.

Measures

Visitors (caregivers) to the DementiaGuide website [10] were invited to complete a 3-part care survey. The survey was developed from existing measures, as follows. First, we asked basic information related to caregivers and the person they care for, such as age, gender, type of dementia, and living arrangements. The second part listed the 13 questions of the DS [5,6] to assess the level of care. The DS questions were exactly as they appeared in the print version of the questionnaire. The final part provided specific information about the 60 symptoms, from which people noted which symptoms were present in the person for whom they cared, and so provided an individualized symptoms profile. In addition, they staged dementia qualitatively, using the grades very mild, mild, moderate, severe, and very severe (Multimedia Appendix 2). After completing the symptom profiles, caregivers assayed the stage of the person whom they were profiling using these descriptors.

In addition to cognitive symptoms (eg, impaired recent and remote memory, expressive language, naming, understanding, attention, and orientation to time and place) SymptomGuide symptoms included disability in instrumental and personal activities of daily living (ADLs), and behavioral and psychological symptoms of dementia (BPSD). SymptomGuide tracks other common symptoms, typically related to a general construct of function, which often go unmeasured in clinical trials (eg, looking after grandchildren, operating appliances, hobbies, leisure activities, planning, and social engagement). Note that, in contrast to typical use of the SymptomGuide, where only those symptoms targeted for treatment are selected as part of a patient profile, here we asked users to note any symptoms that were problems in relation to the person for whom they cared.

The DS was described in 1994 [5]. It is based on the notion that patient dependence and the need for supervision is a means of unifying disease progression from the cognitive, functional, and behavioral standpoints [5,11,12]. It is scored by an algorithm

XSL•FO
RenderX

that counts responses to 13 questions about patient dependence and need for care and supervision. The DS score ranges from 0 to 15, with higher scores indicating a higher care burden. It has been cross-validated in several clinical settings [6,13-16], including in a prospective longitudinal study [5]. The DS's interrater reliability was high (intraclass correlation coefficient = .90) as was the internal consistency (eg, Cronbach alpha of .66–.93, depending on the subscales). Although it has not been validated in an online environment, its apparent ease of use, as well as its measurement properties, makes it an attractive way to provide a standardized description of people with dementia who might be the object of dementia surveys. All 13 items on the DS questionnaire [5,6] could be represented by similar symptoms in the SymptomGuide.

The survey was displayed over 3 screen pages. Completeness checks were done for each individual page, with unanswered questions highlighted for the participant, with completion prompted before going to the next page or submitting the survey. Respondents could hit the back browser button if they wished to edit a previous response page. The Internet protocol address of study participants was captured, and duplicates were filtered in the analysis, with only data from the first completed survey used. No cookies were used. A timestamp was captured after the first page was completed, but no time cut-off was used. Survey functionality was tested on a development site before moving to the live site.

Analysis

Given a 95% completion rate (below), we analyzed only completed questionnaires. Validity was assessed chiefly by construct validation as follows. As the DS represents increasing dependence, we compared it against the proportion of people institutionalized by DS group; the hypothesis was that as the DS increased, so did the chance of being in assisted living or in institutional long-term care. DS scores were plotted against the severity reported on the SymptomGuide, operationalized as the number of symptoms endorsed. (Again, we expected a positive relationship.) The data distribution was first inspected for linearity; if linear, a regression analysis was performed; otherwise analysis of variance (ANOVA) was used to measure group mean differences.

To compare DS scores by user-rated grades of severity, we constructed a box-and-whiskers plot. A Spearman rank-order correlation was used to assess the values of the DS in relation to the 5 severity levels. We conducted separate ANOVAs for increasing dependence in instrumental and personal ADLs and in BPSD.

To analyze the relationships between the DS score and dementia stages identified by the participants as very mild, mild, moderate, severe, and very severe (based on symptom profiles and function, Multimedia Appendix 2), we calculated the distributions of people by the DS for each severity group. The numbers of profilees at a given DS score were cross-tabulated with the stage of dementia that was assigned by each profilee's caregiver. These distributions were smoothed using a moving average and indicate the probabilities for an individual with a given DS score to belong to any given severity group. We calculated empirically derived crossovers of overlapping distributions from the ratios of probabilities (likelihoods) to define cut points for each DS severity interval. ANOVA was conducted to assess associations between the DS scores and the stages of dementia.

Ethics

All respondents to the survey consented by checking their agreement to the terms and conditions of DementiaGuide, which includes their consent to the use of anonymized data. No personal information was collected that could identify the survey participant. All responses are stored on a secure server.

Results

From January 27, 2010 to August 24, 2010, of 514 unique visitors who viewed the symptom library, 264 started the questionnaire and 250 respondents completed the online survey (completion rate 94.7%; net response rate 48.6%). All were care partners, completing information about symptoms in patients (profilees). Of the 250 care partner respondents, most were women (203, 81.2%), 208 (83.2%) and were less than 65 years old, usually with adult children (125, 50.0%) or spouses (71, 28%). Most care partners lived in the same household (115, 46.0%) or saw the person with dementia at least 5 days a week (46, 18%) although 18 (7%) saw the person less than weekly. Most care partners came from the United States (113, 45.2%), Canada (82, 33%), or the United Kingdom (22, 9%). The mean age of the patients being profiled was 77.1 years (SD 11.1) and 155 (62%) were women. Most (198, 79.2%) were community dwelling, with the remainder (52, 21%) in assisted living or nursing home care. DS scores ranged from 0 to 14, with a mode of 8.

With respect to patient residence (community versus institution), none of the 33 people profiled at the lowest levels of dependence (DS score < 5) lived in a long-term care facility, whereas of the 25 profilees at the highest level of dependence (DS score > 12) 13 (52%) were resident in a long-term care facility ($\chi^2_4 = 27.9$, $P < .001$).

Profilees who experienced more symptoms tended to be more dependent in general (Figure 1). The number of the SymptomGuide symptoms and the DS score were highly correlated ($r = .73$, $P < .001$). Likewise, as the DS score increased, so did the number of instrumental and personal ADL symptoms and the number of BPSD ($F_4 = 76$, $F_4 = 54$, and $F_4 = 14$, $P < .001$; Figure 2). Note that the personal ADL and BPSD types of symptoms were especially uncommon at DS scores <5. The mean number of targeted instrumental ADL symptoms increased from 1 at DS scores < 2 to 8 at DS scores > 10.

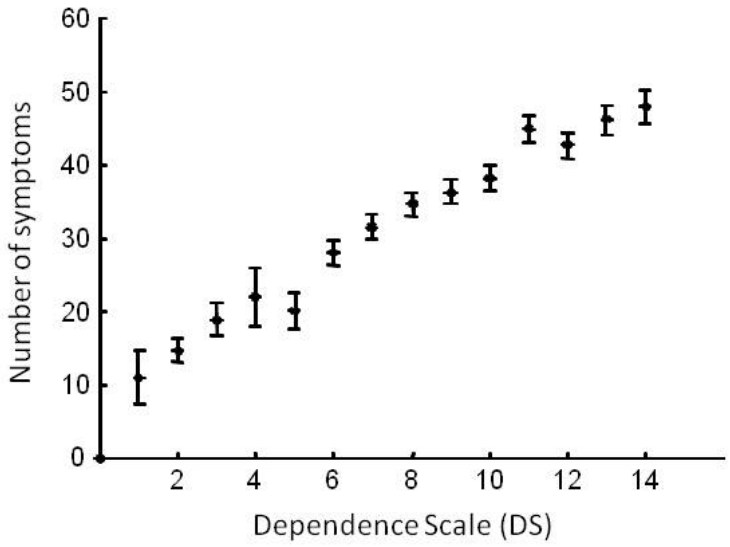
The DS score also increased as the user-based severity staging score increased ($r = .85$, $P < .001$; Figure 3). ANOVA confirmed a significant difference in the association of the DS score by severity groups ($F_4 = 148$, $P < .001$; Figure 3).

We discerned 5 empirically derived cut points at ≤5, ≤8, ≤11, ≤13, and >13; the modes increased with increasing values of the DS (Figure 4) as did the median values (ie, ≤5, median proportion value of the DS; ≤8; ≤11; ≤13; >13). We chose the cut points by using the crossovers between the neighboring

XSL•FO
RenderX

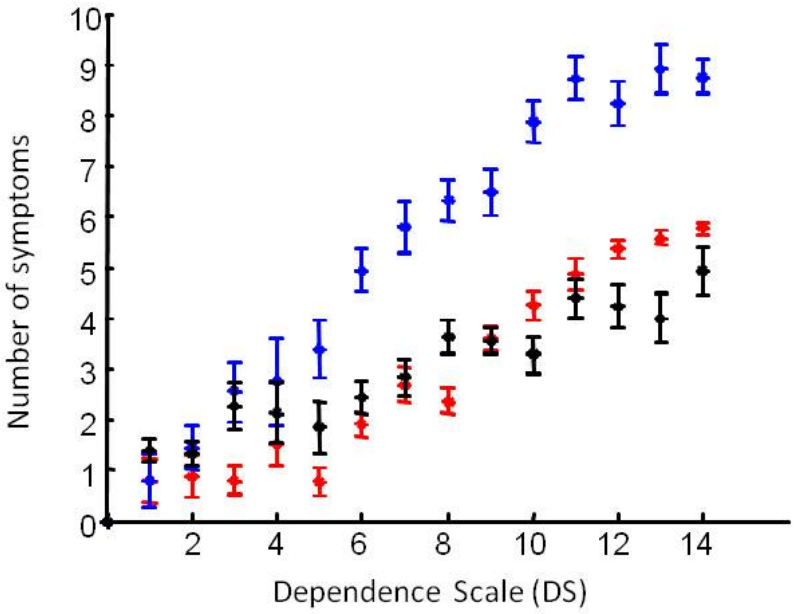
distributions as indicated in the legend of Figure 4. The distributions are not normal (at least on the extremes, the medians are deviate from the means); the crossover's location, however, indicates that on the right from the crossover, the probability of the right distribution is higher than that on the left. It could be said that the cut points were chosen in accordance with the maximum likelihood of belonging to one or the other group. Note that when the DS score was <2, profilees were almost all in the stage of very mild dementia. When the DS score was between 2 and 8, most profilees were in the mild dementia stage. Profilees identified as having moderate dementia had a DS score varying from 6 to 12. When the DS score was >10, the profilees were predominantly at the severe or very severe stage of dementia, and no one remained in the mild stage.

Figure 1. Mean number of dementia symptoms as a function of the Dependence Scale score. Circles show the means and bars show the standard errors.



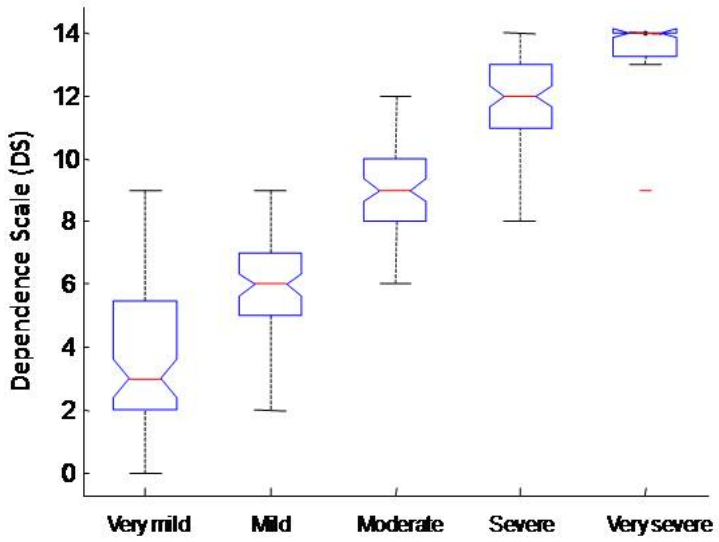
XSL•FO
RenderX

Figure 2. Mean number of dementia symptoms: instrumental activities of daily living (blue), activities of daily living (red), and behavioral and psychological symptoms (black). Given that only 5 people had a Dependance Scale score of 0 or 1, these states are combined here.



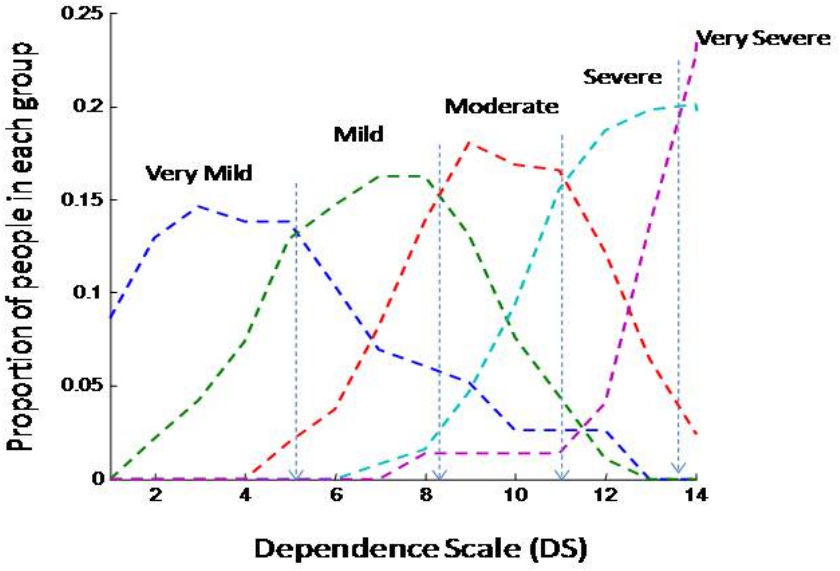
XSL•FO
RenderX

Figure 3. Dependence Scale score by grade of severity as a box-and-whiskers plot. The boxes show medians (red lines), edges at the quartiles Q1 and Q3; the whiskers show the boundary for the outliers.



XSL•FO
RenderX

Figure 4. Probability distribution of the Dependence Scale score by dementia stage. Arrows indicate crossovers between the neighboring distributions and thus represent the the cut points to distinguish between the stages.



Discussion

This study used an online survey of dementia caregivers and compared how they scored the DS with how they completed a checklist of 60 dementia symptoms and how they staged dementia severity. Most respondents came from the United States, Canada, and the United Kingdom and were women profiling people with dementia, chiefly parents and spouses. Several analyses (correlation of the DS score with the total number of symptoms and those specific to functional dependency and BPSD; comparison of proportions of patients receiving institutional care by DS grade; and comparison with a staging instrument) suggest construct validity in online use of the DS.

Our data must be interpreted with caution. Consistency of like measures is an important aspect of construct validity. Even so, it does not guarantee that the profiles portrayed here are what an independent observer would find. This potential weakness is shared with other self-report data and not just those collected online. On the other hand, to the extent that care partner reports tap an aspect of dementia profiles that are comparatively understudied, this may be a necessary trade-off to gather more data on the views of caregivers and what is important to them. For example, many people who use the website set goals in relation to repetitive questioning, as they did in clinical trials in which this option was available to them [17-19]. Even so, this problem receives almost no attention in the current clinical trial environment. What is more, informant-based reports have a long history in understanding dementia staging in epidemiological surveys, leading to a call for their use in electronic formats [20]. Building on this experience with self-report in standardized instruments, the World Wide Web offers a means for care partners to draw attention to what is important to them, as a way of sensitizing researchers about the lived experience of dementia. At the same time, it must be remembered that the Web tends to be used less by older people, people with lower socioeconomic status, and those with lower levels of education, who are less likely to participate in Web-based medical programs [21]. In addition, a comparatively high proportion (21%) of the people described here were in assisted living or nursing homes, with correspondingly higher levels of dependence. Given such considerations, we underscore that this cannot be seen as a representative survey, which is why we have been careful not to make any such claim. Still, it is interesting to note that our respondents, in being women, usually spouses or adult daughters, living with or near the person with dementia, are not in these ways dissimilar to typical dementia caregivers in Western countries [22].

In addition, this approach is relatively new, so it is not clear where the magnitude of the correlations—which are moderate to high by traditional standards—fits in the online environment. We also cannot be sure that the respondents were describing

XSL•FO
RenderX

real cases, although this would be true also for postal or telephone surveys, so that the same cautions as exist with these better-accepted forms of data collection would need to apply here. For example, we cannot make prevalence estimates, although it remains possible to study associations between variables.

Our data potentially contribute to understanding how the Web might be used to gather information about dementia. At present, the Internet is being used in several contexts in dementia. For example, it is used to elicit opinions about issues related to Alzheimer disease (such as the merit in screening for it) [23] and to collect data about the burden of care [24,25]. The Internet is also being used to deliver care interventions [26-28] and to provide educational programs to formal care providers [29]. Note too that, while several of the interventions or surveys are targeted to particular groups, more widespread uses include the identification of people who might be at an increased risk of dementia [30]. Recently, too, the Web has been used as a means of doing experiments, such as testing whether people who took up cognitive training in the form of video games showed improved cognitive functioning on tests related to the items practiced in the games [31]. Such potential obliges designers to maximize the usability of their sites, and in particular to clearly identify the source of their information [32].

The information here is also more than just correlation. For example, the mismatch between DS scores and caregiver impressions of staging in relation to a DS score of 9,where 70% (23/33) were given a moderate stage by the caregiver, 6% (2/33) severe, 3% (1/33) very severe, 9% (3/33)very mild, and 12% (4/33) mild, illustrates a potential problem with the DS. In getting data on the views, if not of patients themselves, then of people involved with them on a frequent basis, who were asked to consider which symptoms they displayed, we are helping to meet a gap in understanding. From a time when people with dementia were not considered able to contribute to descriptions of the syndrome because of the nature of their illness, it became clear that their perspective was particularly important to understanding how people with dementia cope [33].

That this perspective is important is clear if we consider that, although the literature on the lived experience of dementia is rich [34,35] it has had comparatively little direct impact in the clinical trials literature on the meaningfulness of dementia treatment [36]. The perspective of individuals on how they cope has a clear impact on the response to psychosocial therapy [37]. This has led to calls for a better understanding of how both pharmacological and nonpharmacological treatments might have an impact in ways that are evident to patients and their care partners [38,39]. This will be especially important in the longer trials needed to evaluate the impact of potentially disease-modifying therapies, as these cover a span in which patients' perceptions of quality of life can change [1,40]. How symptoms change over time from the perspective of care partners is an important concern that is motivating additional inquires by our group.

Acknowledgments

DGI is supported by the National Research Council of Canada Industrial Research Assistance Program (NRC-IRAP), the Atlantic Canada Opportunities Agency (ACOA), and Innovacorp.

Conflicts of Interest

KR, AZ, and AM are employees of DGI Clinical, of which KR was founder (the company was called DementiaGuide Inc.) and has a proprietary interest. LM is an employee of Pfizer, CL is an employee of JAI, and JAI provided funding for this study.

Multimedia Appendix 1

List of 60 symptoms.

[PDF File (Adobe PDF File), 34KB - jmir_v14i2e42_app1.pdf]

Multimedia Appendix 2

Operationalizing dementia staging in the online questionnaire.

[PDF File (Adobe PDF File), 38KB - jmir_v14i2e42_app2.pdf]

References

1. Rockwood K. An individualized approach to tracking and treating Alzheimer's disease. Clin Pharmacol Ther 2010 Oct;88(4):446-449. [doi: 10.1038/clpt.2010.68] [Medline: 20856240]
2. Rockwood K. Should we listen to people affected by dementia? CNS Neurosci Ther 2011 Feb;17(1):1-3. [doi: 10.1111/j.1755-5949.2010.00205.x] [Medline: 21235731]
3. Rockwood K, Fay S, Song X, MacKnight C, Gorman M, Video-Imaging Synthesis of Treating Alzheimer's Disease (VISTA) Investigators. Attainment of treatment goals by people with Alzheimer's disease receiving galantamine: a randomized controlled trial. CMAJ 2006 Apr 11;174(8):1099-1105 [FREE Full text] [doi: 10.1503/cmaj.051432] [Medline: 16554498]

XSL•FO
RenderX

4. Reisberg B, Ferris SH. Brief Cognitive Rating Scale (BCRS). Psychopharmacol Bull 1988;24(4):629-636. [Medline: 3249764]
5. Stern Y, Albert SM, Sano M, Richards M, Miller L, Folstein M, et al. Assessing patient dependence in Alzheimer's disease. J Gerontol 1994 Sep;49(5):M216-M222. [Medline: 8056940]
6. Brickman AM, Riba A, Bell K, Marder K, Albert M, Brandt J, et al. Longitudinal assessment of patient dependence in Alzheimer disease. Arch Neurol 2002 Aug;59(8):1304-1308. [Medline: 12164728]
7. Georges J, Jansen S, Jackson J, Meyrieux A, Sadowska A, Selmes M. Alzheimer's disease in real life--the dementia carer's survey. Int J Geriatr Psychiatry 2008 May;23(5):546-551. [doi: 10.1002/gps.1984] [Medline: 18232054]
8. Kernisan LP, Sudore RL, Knight SJ. Information-seeking at a caregiving website: a qualitative analysis. J Med Internet Res 2010;12(3):e31 [FREE Full text] [doi: 10.2196/jmir.1548] [Medline: 20675292]
9. Fox S. Health topics: 80% of Internet users look for health information online. Washington, DC: Pew Internet & American Life Project; 2011 Feb 01. URL: http://www.pewinternet.org/~/media/Files/Reports/2011/PIP_HealthTopics.pdf [accessed 2012-02-09] [WebCite Cache ID 65KK2piHB]
10. Anonymous. DementiaGuide Inc. 2011 Sep 14. DementiaGuide home page URL: http://www.dementiaguide.com/ [accessed 2012-02-09] [WebCite Cache ID 65KK65GrD]
11. Zhu CW, Leibman C, Townsend R, McLaughlin T, Scarmeas N, Albert M, et al. Bridging from clinical endpoints to estimates of treatment value for external decision makers. J Nutr Health Aging 2009 Mar;13(3):256-259. [Medline: 19262963]
12. Frank L, Howard K, Jones R, Lacey L, Leibman C, Lleo A, et al. A qualitative assessment of the concept of dependence in Alzheimer's disease. Am J Alzheimers Dis Other Demen 2010 May;25(3):239-247. [doi: 10.1177/1533317509356690] [Medline: 20147602]
13. Sarazin M, Stern Y, Berr C, Riba A, Albert M, Brandt J, et al. Neuropsychological predictors of dependency in patients with Alzheimer disease. Neurology 2005 Mar 22;64(6):1027-1031. [doi: 10.1212/01.WNL.0000154529.53488.30] [Medline: 15781821]
14. Scherer RK, Scarmeas N, Brandt J, Blacker D, Albert MS, Stern Y. The relation of patient dependence to home health aide use in Alzheimer's disease. J Gerontol A Biol Sci Med Sci 2008 Sep;63(9):1005-1009. [Medline: 18840808]
15. Zhu CW, Leibman C, McLaughlin T, Scarmeas N, Albert M, Brandt J, et al. The effects of patient function and dependence on costs of care in Alzheimer's disease. J Am Geriatr Soc 2008 Aug;56(8):1497-1503. [doi: 10.1111/j.1532-5415.2008.01798.x] [Medline: 18662215]
16. McLaughlin T, Buxton M, Mittendorf T, Redekop W, Mucha L, Darba J, et al. Assessment of potential measures in models of progression in Alzheimer disease. Neurology 2010 Oct 5;75(14):1256-1262. [doi: 10.1212/WNL.0b013e3181f6133d] [Medline: 20921511]
17. Asp E, Cloutier F, Fay S, Cook C, Robertson ML, Fisk J, et al. Verbal repetition in patients with Alzheimer's disease who receive donepezil. Int J Geriatr Psychiatry 2006 May;21(5):426-431. [doi: 10.1002/gps.1486] [Medline: 16676290]
18. Rockwood K, Fay S, Jarrett P, Asp E. Effect of galantamine on verbal repetition in AD: a secondary analysis of the VISTA trial. Neurology 2007 Apr 3;68(14):1116-1121. [doi: 10.1212/01.wnl.0000258661.61577.b7] [Medline: 17404193]
19. Rockwood K, Black S, Bedard MA, Tran T, Lussier I, TOPS Study Investigators. Specific symptomatic changes following donepezil treatment of Alzheimer's disease: a multi-centre, primary care, open-label study. Int J Geriatr Psychiatry 2007 Apr;22(4):312-319. [doi: 10.1002/gps.1675] [Medline: 17006874]
20. Cherbuin N, Anstey KJ, Lipnicki DM. Screening for dementia: a review of self- and informant-assessment instruments. Int Psychogeriatr 2008 Jun;20(3):431-458. [doi: 10.1017/S104161020800673X] [Medline: 18289452]
21. Green BB, Anderson ML, Ralston JD, Catz S, Fishman PA, Cook AJ. Patient ability and willingness to participate in a web-based intervention to improve hypertension control. J Med Internet Res 2011;13(1):e1 [FREE Full text] [doi: 10.2196/jmir.1625] [Medline: 21371993]
22. Dupuis SL, Epp T, Smale B. Murray Alzheimer Research and Education Program, University of Waterloo. 2004. Caregivers of Persons with Dementia: Roles, Experiences, Supports and Coping: A Literature Review URL: http://marep.uwaterloo.ca/PDF/InTheirOwnVoices-LiteratureReview.pdf [accessed 2012-02-09] [WebCite Cache ID 65KKBIlt9]
23. Bond J, Graham N, Padovani A, Mackell J, Knox S, Atkinson J. Screening for cognitive impairment, Alzheimer's disease and other dementias: opinions of European caregivers, payors, physicians and the general public. J Nutr Health Aging 2010 Aug;14(7):558-562. [Medline: 20818471]
24. Black SE, Gauthier S, Dalziel W, Keren R, Correia J, Hew H, et al. Canadian Alzheimer's disease caregiver survey: baby-boomer caregivers and burden of care. Int J Geriatr Psychiatry 2010 Aug;25(8):807-813. [doi: 10.1002/gps.2421] [Medline: 20029824]
25. Chow TW, Pio FJ, Rockwood K. An international needs assessment of caregivers for frontotemporal dementia. Can J Neurol Sci 2011 Sep;38(5):753-757. [Medline: 21856580]
26. Chiu T, Marziali E, Colantonio A, Carswell A, Gruneir M, Tang M, et al. Internet-based caregiver support for Chinese Canadians taking care of a family member with Alzheimer disease and related dementia. Can J Aging 2009 Dec;28(4):323-336. [doi: 10.1017/S0714980809990158] [Medline: 19925698]
27. Lewis ML, Hobday JV, Hepburn KW. Internet-based program for dementia caregivers. Am J Alzheimers Dis Other Demen 2010 Dec;25(8):674-679. [doi: 10.1177/1533317510385812] [Medline: 21131674]

XSL•FO
RenderX

28. van der Roest HG, Meiland FJ, Jonker C, Dröes RM. User evaluation of the DEMentia-specific Digital Interactive Social Chart (DEM-DISC). A pilot study among informal carers on its impact, user friendliness and, usefulness. Aging Ment Health 2010 May;14(4):461-470. [doi: 10.1080/13607860903311741] [Medline: 20455122]
29. Marziali E, Garcia LJ. Dementia caregivers' responses to 2 Internet-based intervention programs. Am J Alzheimers Dis Other Demen 2011 Feb;26(1):36-43. [doi: 10.1177/1533317510387586] [Medline: 21282276]
30. Hobday JV, Savik K, Gaugler JE. An internet-based multimedia education prototype to enhance late-stage dementia care: formative research results. Geriatr Nurs 2010;31(6):402-411. [doi: 10.1016/j.gerinurse.2010.06.001] [Medline: 20691503]
31. Owen AM, Hampshire A, Grahn JA, Stenton R, Dajani S, Burns AS, et al. Putting brain training to the test. Nature 2010 Jun 10;465(7299):775-778. [doi: 10.1038/nature09042] [Medline: 20407435]
32. Zulman DM, Kirch M, Zheng K, An LC. Trust in the internet as a health resource among older adults: analysis of data from a nationally representative survey. J Med Internet Res 2011;13(1):e19 [FREE Full text] [doi: 10.2196/jmir.1552] [Medline: 21324832]
33. Brandt J, Rogerson M. Preliminary findings from an internet-based dementia risk assessment. Alzheimers Dement 2011 Jul;7(4):e94-100. [doi: 10.1016/j.jalz.2010.08.229] [Medline: 21220214]
34. de Boer ME, Hertogh CM, Dröes RM, Riphagen II, Jonker C, Eefsting JA. Suffering from dementia - the patient's perspective: a review of the literature. Int Psychogeriatr 2007 Dec;19(6):1021-1039. [doi: 10.1017/S1041610207005765] [Medline: 17727738]
35. Steeman E, de Casterlé BD, Godderis J, Grypdonck M. Living with early-stage dementia: a review of qualitative studies. J Adv Nurs 2006 Jun;54(6):722-738. [doi: 10.1111/j.1365-2648.2006.03874.x] [Medline: 16796664]
36. Harman G, Clare L. Illness representations and lived experience in early-stage dementia. Qual Health Res 2006 Apr;16(4):484-502. [doi: 10.1177/1049732306286851] [Medline: 16513992]
37. O'Connor DW, Ames D, Gardner B, King M. Psychosocial treatments of behavior symptoms in dementia: a systematic review of reports meeting quality standards. Int Psychogeriatr 2009 Apr;21(2):225-240. [doi: 10.1017/S1041610208007588] [Medline: 18814806]
38. Kurz AF, Leucht S, Lautenschlager NT. The clinical significance of cognition-focused interventions for cognitively impaired older adults: a systematic review of randomized controlled trials. Int Psychogeriatr 2011 Jul 11:1-12. [doi: 10.1017/S1041610211001001] [Medline: 21740614]
39. Bouwens SF, van Heugten CM, Verhey FR. Review of goal attainment scaling as a useful outcome measure in psychogeriatric patients with cognitive disorders. Dement Geriatr Cogn Disord 2008;26(6):528-540. [doi: 10.1159/000178757] [Medline: 19052453]
40. Ettema TP, Dröes RM, de Lange J, Ooms ME, Mellenbergh GJ, Ribbe MW. The concept of quality of life in dementia in the different stages of the disease. Int Psychogeriatr 2005 Sep;17(3):353-370. [Medline: 16252370]

Abbreviations

ADL: activities of daily living
ANOVA: analysis of variance
BPSD: behavioral and psychological symptoms of dementia
DS: Dependence Scale

Edited by R Crutzen; submitted 20.09.11; peer-reviewed by Q Samus, A Jansen, J Saczynski; comments to author 10.11.11; revised version received 05.12.11; accepted 06.12.11; published 12.03.12.

Please cite as:
Rockwood K, Zeng A, Leibman C, Mucha L, Mitnitski A
Validation of an Informant-Reported Web-Based Data Collection to Assess Dementia Symptoms
J Med Internet Res 2012;14(2):e42
URL: http://www.jmir.org/2012/2/e42/
doi:10.2196/jmir.1941
PMID:22411293

©Kenneth Rockwood, An Zeng, Chris Leibman, Lisa Mucha, Arnold Mitnitski. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 12.03.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Online Schools and Children With Special Health and Educational Needs: Comparison With Performance in Traditional Schools

Lindsay A Thompson[1], MS, MD; Rick Ferdig[2], PhD; Erik Black[1], PhD

[1]Department of Pediatrics, University of Florida, Gainesville, FL, United States

[2]Research Center for Educational Technology, Kent State University, Kent, OH, United States

Corresponding Author:
Erik Black, PhD
Department of Pediatrics
University of Florida
1701 SW 16th Avenue, Building A
Gainesville, FL, 32608
United States
Phone: 1 352 334 1357
Fax: 1 352 334 1357
Email: ewblack@peds.ufl.edu

Abstract

Background: In the United States, primary and secondary online schools are institutions that deliver online curricula for children enrolled in kindergarten through 12th grade (K-12). These institutions commonly provide opportunities for online instruction in conjunction with local schools for students who may need remediation, have advanced needs, encounter unqualified local instructors, or experience scheduling conflicts. Internet-based online schooling may potentially help children from populations known to have educational and health disadvantages, such as those from certain racial or ethnic backgrounds, those of low socioeconomic status, and children with special health care needs (CSHCN).

Objective: To describe the basic and applied demographics of US online-school users and to compare student achievement in traditional versus online schooling environments.

Methods: We performed a brief parental survey in three states examining basic demographics and educational history of the child and parents, the child's health status as measured by the CSHCN Screener, and their experiences and educational achievement with online schools and class(es). Results were compared with state public-school demographics and statistical analyses controlled for state-specific independence.

Results: We analyzed responses from 1971 parents with a response rate of 14.7% (1971/13,384). Parents of online-school participants were more likely to report having a bachelor's degree or higher than were parents of students statewide in traditional schools, and more of their children were white and female. Most notably, the prevalence of CSHCN was high (476/1971, 24.6%) in online schooling. Children who were male, black, or had special health care needs reported significantly lower grades in both traditional and online schools. However, when we controlled for age, gender, race, and parental education, parents of CSHCN or black children reported significantly lower grades in online than in traditional schooling (adjusted odds ratio [aOR] 1.45, 95% confidence interval [CI] 1.29–1.62 for CSHCN, $P < .001$; aOR 2.73, 95% CI 2.11–3.53 for black children, $P < .001$.) In contrast, parents with a bachelor's degree or higher reported significantly higher online-school grades than traditional-school grades for their children (aOR 1.45, 95% CI 1.15–1.82, $P < .001$).

Conclusions: The demographics of children attending online schools do not mirror those of the state-specific school populations. CSHCN seem to opt into online schools at a higher rate. While parents report equivalent educational achievement in online and traditional classrooms, controlling for known achievement risks suggests that CSHCN and black children have lower performance in online than in traditional schools. Given the millions of students now in online schools, future studies must test whether direct assistance in online schools, such as taking individualized education plans into consideration, will narrow known disparities in educational success. Only then can online schools emerge as a true educational alternative for at-risk populations.

(J Med Internet Res 2012;14(3):e62) doi:10.2196/jmir.1947

XSL•FO
RenderX

KEYWORDS

Virtual schooling; schools; K-12; children with special health care needs; online learning; education, adolescent health services, special education

Introduction

Asking about educational attainment in the primary care setting is common, since educational success is a culmination of children's health and well-being. However, while much has been written, research and clinical interventions have not consistently narrowed educational disparities [1-6], mostly because there are few resources by which to quantitatively measure education as a health outcome. Educational outcomes for health are often relegated only to school days missed or appropriate grade level for age [7,8]. A relatively new educational innovation in the United States, kindergarten to 12th grade (K-12) online schooling, constitutes an online means by which children can maintain or further their educational progress. This Internet-based educational opportunity is ideally situated to providing an opportunity for improved educational and health outcomes and would allow for a centralized means to measure both health and educational progress.

The phenomenon of online schooling is not limited to the United States, although its definition and approach lack uniformity both internationally and across US states. For example, a variety of terms are used to describe online learning, including distance education, online schools, online learning, e-learning, and electronic learning. In general, however, the common understanding is that this type of learning simply takes place over the Internet [9]. Over a million US students participate, choosing online classes for a variety of reasons, including credit recovery, advanced preparation, schedule conflicts, home schooling supplementation, and the lack of local qualified instructors. Originating in the United States in 1995, state-funded online K-12 education now exists in 44 states [10,11]. Although school administrators, policy makers, parents, and students have questioned the effectiveness of K-12 online schooling compared with traditional, face-to-face schooling [12,13], numerous studies have documented evidence of their educational equivalence [14,15].

International efforts have developed similarly. In a recent survey of online education practices in 50 different countries, nearly 60% of respondents reported government funding for online programs at the primary and secondary school levels (5–18 years of age). Examples of growth and adoption include China's online-schooling initiative, which has expanded from 1 institution in 1996 to more than 200 online schools, with enrollments exceeding 600,000 students. In British Columbia, Canada, approximately 12% of the student population participates in some form of online learning [9]. While more-developed nations (Australia, China, Denmark, Mexico, Canada, and the United Kingdom, for example) have more-advanced programs, online programs are emerging or have emerged in Africa (Egypt), Asia (Indonesia, Malaysia, Singapore, and Uzbekistan), Europe (Belgium, Finland, France, Germany, and Italy), Eastern Europe (Slovenia, Albania, Romania, and Serbia), the Middle East (Turkey and Israel), and South America (Argentina, Peru, and Uruguay) [9].

Both nationally and internationally, online schools have adopted many different models for course delivery to primary and secondary education students. Some offer the opportunity for students to earn a diploma and take all of their coursework online. Others only supplement traditional face-to-face schools. Course format also varies; some institutions allow students to self-pace, meaning the student is required to complete a requisite amount of work to earn credit for the course. Whether the student is able to do so in 6 weeks or 6 months is entirely up to the student. Other institutions may offer a format that is more traditional, in which the student has a fixed time during each school day to work through curricular content. It remains unknown, however, how online schooling may serve children from populations known to have health and educational challenges, such as those from certain racial or ethnic backgrounds, those with socioeconomic disadvantages, and children with special health care needs (CSHCN) [12,13,16,17]. Nonetheless, the potential advantages of online schools are substantial, with self-pacing and class attendance from home or even a hospital bed.

Given these potential advantages and the current popularity of online schooling, the purpose of this study was to describe and quantify who uses online schools and why. Drawing from parental survey results from three states, this study aimed to clarify four goals: (1) to establish a knowledge of the basic demographics of online-school users, (2) to gain an understanding of the educational background and success of online-school students, (3) to determine whether there is a high prevalence of CSHCN enrolled in online schooling, and (4) to determine how children perform in online schooling compared with their prior experiences in traditional school. Online schools may potentially allow US students known to have both educational and health challenges, such as those from certain racial or ethnic backgrounds, those with socioeconomic disadvantages, and CSHCN, to better succeed.

Methods

Survey Participants

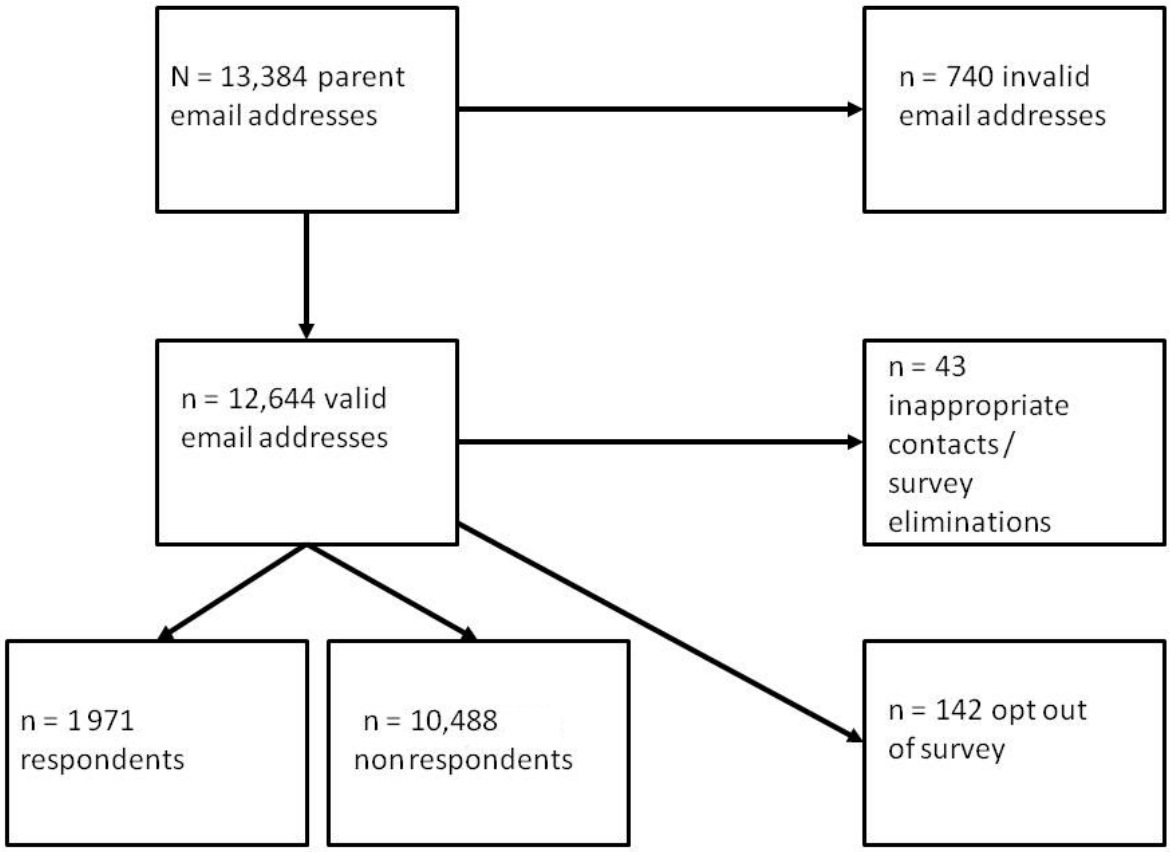
We performed an observational study in three of the states that have established state-led online-school programs, all of which are in the southeastern region of the United States. A multidisciplinary team from the University of Florida, Colleges of Education and Medicine, contacted parents via email, with three sequential invitations, to participate in a brief, online survey that could be accessed via an embedded link. The three participant states and their state-led online schools were invited to participate from the 21 state participants in the Virtual School Clearinghouse [18], "a collaborative research project sponsored by the AT&T Foundation" that provides state-led online schools "with data analysis tools and metrics vital for school improvement." Unlike cyber-charter schools or school district-oriented programs, state-led online schools are associated

XSL•FO
RenderX

with state departments of education, which provides some similarity in the scope and nature of their operations.

The three participating state-led online schools were required to supply email contact information for the parents of enrolled students. Using only these email addresses, this study achieved a response rate of 14.73% (1971/13,384) (state ranges 10.1%–20.3%). This response rate is in keeping with other parent-oriented email-based surveys, and, coupled with its lack of incentive for participation, is within an acceptable range for this population [19]. As Figure 1 illustrates, of the 13,384 individuals solicited, 740 had email addresses on record that were no longer in use or invalid. A small number (n = 142) chose to opt out of the survey using an embedded link within the email solicitation to remove their name and email address from the mailing list. There were 20 respondents who were contacted inappropriately (in a majority of cases these were a school counselor listed as a child's contact) and 2 who did not want to complete the survey online. Five more recipients had technical difficulties precluding their ability to fill out the survey. We excluded an additional 23 respondents, as they filled out the survey but stated that they were not the parent of the child or that their child had not yet taken an online course.

Figure 1. Progress of participants through the study.



Survey Design and Measures

All members of the study team contributed to the design and pilot testing of this survey for parents that would take about 5 minutes to complete. The survey was constructed with the following domains: basic demographics and educational history of the child, parental education, the CSHCN Screener [20], and the child's experiences and educational achievement with online class(es). We purposefully chose the CSHCN Screener to bridge medical and educational outcomes. Traditionally, educationally based screeners cite disabilities that reflect those conditions that will directly require adaptive learning tools, such as learning disabilities, emotional disturbances, or speech and language impairments [17]. The CSHCN Screener uses a comprehensive approach to health and is a well-validated and reliable tool aimed at discriminating those children who have an ongoing health need [21,22]. Although brief, the self-administered CSHCN Screener consists of five consequences-based questions that identify children with chronic or special health care needs [22]. These health consequences are summed into three nonexclusive definitional domains: dependency on prescription medications, service use above that considered usual or routine, and functional limitations [22]. As a reference, roughly 15% of the general public and 20.7% of those enrolled in Medicaid screen positive using this screener [23]. We conducted all univariate, bivariate, and multivariate analyses with Stata version 9.2 (StataCorp LP, College Station, TX, USA). The accepted level of significance was $P < .05$.

XSL•FO
RenderX

Results

Demographics of Participants in Online Schooling

This survey reports on 1971 parents of any students of online schools in three US states. Table 1 shows demographic comparisons of survey participants and available data from face-to-face public-school classrooms in each state. The students were overwhelmingly older adolescents (86.90%), ages 15–18 years. There was also a high prevalence of CSHCN (476/1971, 24.6% overall, range 21.0%–29.9%), which is significantly greater than in the general population (15.0%–15.4%; see also Table 2) [23]. Overall and within each state, online-school parents participating in this survey were more likely than parents of students statewide in traditional schools to report having a bachelor's degree or higher, and more of them reported that their child was female (1138/1971, 57.88%) or white (1397/1971, 70.88%). While there was variation by state, overall there were fewer black and Hispanic students and more children of other or mixed races and ethnicities than in traditional schools. Parents of online-school students rated their child's educational success as "very good" or "excellent" 62.9% (846/1971) of the time, yet there was a wide range by state (52.7%–70.0%). Importantly, there was no difference in the distribution of reported grades (recorded as A, B, C, D, or failing) between their child's online-school grade and their usual grades from traditional school.

Table 1. Demographics of students in online school and traditional school according to parental report.

Characteristic	Total	State 1		State 2		State 3	
	Online school population (n = 1971)	Online school population (n = 553)	Traditional school population	Online school population (n = 831)	Traditional school population	Online school population (n = 593)	Traditional school population
Gender							
Female, n (%)	1138 (57.88%)	312 (56.4%)	NA[a]	503 (61.2%)	NA	323 (54.6%)	NA
Age distribution (years), n (%)							
≤14	195 (9.9%)	40 (7%)	NA	114 (13.8%)	NA	41 (7%)	NA
15–18	1711 (86.90%)	473 (85.7%)	NA	704 (85.4%)	NA	534 (90.1%)	NA
19+	63 (3%)	39 (7%)	NA	6 (1%)	NA	18 (3%)	NA
Race/ethnicity, n (%)							
White	1397 (70.88%)	327 (59.1%)	46.5%[b]	607 (73.4%)	55.7%[b]	463 (78.1%)	53.9%[b]
Hispanic	50 (3%)	5 (1%)	1.7%[b]	34 (4%)	9.3%[b]	11 (2%)	4.6%[b]
Black	367 (18.6%)	188 (34.0%)	50.8%[b]	89 (11%)	28.3%[b]	90 (15%)	39.8%[b]
Other/mixed	157 (8.0%)	33 (6%)	1.0%[b]	95 (12%)	3.6%[b]	29 (5%)	1.7%[b]
Health, n (%)							
Child with a special health care need[c]	476 (24.6%)	116 (21.0%)	15.0%[d]	193 (23.2%)	15.4%[d]	173 (29.9%)	15.2%[d]
Parental education, n (%)							
Bachelor's degree or higher	967 (49.3%)	254 (46.0%)	25.6%[e]	440 (53.8%)	25.6%[e]	273 (53.8%)	22.6%[e]
Educational success in past 6 months, n (%)							
Very good/excellent	846 (62.9%)	607 (59.5%)	NA	555 (70.0%)	NA	291 (52.7%)	NA
Poor/fair/good	499 (37.1%)	215 (40.5%)	NA	238 (30.0%)	NA	261 (47.3%)	NA

[a] Not available.

[b] Data from Schooldatadirect.org, an online service of the State Education Data Center, an initiative of the Counsel of Chief State School Officers, funded by the Bill and Melinda Gates Foundation.

[c] Children with a special health care need were defined using the CSHCN Screener.2.

[d] Child and Adolescent Health Measurement Initiative. 2005/2006 National Survey of Children with Special Health Care Needs, Data Resource Center for Child and Adolescent Health website. Retrieved November 3, 2009 from www.cshcndata.org.

[e] Adults aged 25 years or older. Data from http://www.census.gov/population/www/socdemo/education/cps2006.html.

XSL•FO
RenderX

Table 2. Domains of the Children with Special Health Care Needs (CSHCN) Screener.

Domain	Total online school population (n = 1971)
Overall: having a special health care need[a]	476 (24.6%)
Definitional domains	
Dependency on prescription medications	400 (21.7%)
Service use above that considered usual or routine	211 (10.8%)
Functional limitations	119 (6.2%)

[a] The domains are not mutually exclusive categories, as a child identified by the CSHCN Screener can qualify on one or more definitional domains [16].

Parents reported diverse reasons why their children took online classes. The majority (377/497, 76.0%) took online classes because their school did not offer the class, they wanted to augment their education, or they had scheduling difficulties. Only 16% (78/497) took classes because of disciplinary concerns or credit recovery. Only a small portion (41/497, 8%) cited health or significant social concerns as the reason for taking online classes.

Educational Success in Online Compared With Traditional Schools

Matching a child's reported online-school grade with their usual grade in a traditional class was possible in 61.09% of all study participants (1204 parents report their child's grades, since not all had completed the course or could predict their child's grade). When comparing reported grades from traditional or online schools, certain populations consistently reported low performance. Boys, black children, and CSHCN had significantly lower grades (as demonstrated by nonoverlapping confidence intervals of grades compared with girls; white, Hispanic, and others; and healthy children, respectively; Table 3). Comparisons between traditional and online schools yielded no differences, even within subgroups. Online schools and traditional schools seem to have similar success rates within populations in straight, unadjusted comparisons.

Table 3. Parental report of grades[a] in traditional and online school by demographic characteristics.

Characteristic	Traditional school grade (n = 1386)		Online school grade (n = 1207)	
	Mean	95% CI[b]	Mean	95% CI
Female	3.37	3.32–3.41	3.34	3.28–3.41
Male[c]	2.93	2.87–3.01	3.08	2.99–3.17
Race/ethnicity				
White	3.24	3.19–3.29	3.30	3.23–3.36
Black[c]	2.84	2.74–2.94	2.82	2.70–2.96
Hispanic	3.33	3.09–3.57	3.31	2.99–3.63
Other/mixed	3.43	3.29–3.57	3.42	3.26–3.58
Children with special health care needs[c]	2.93	2.83–3.02	3.02	2.91–3.14
No special health care needs	3.27	3.22–3.31	3.30	3.24–3.35

[a] Grade point average equivalences: A = 4.0; B = 3.0; C = 2.0; D = 1.0.

[b] Confidence interval.

[c] Significantly different reported grades ($P < .0001$) between males and females, blacks and all others, and children with special health care needs and those without within traditional or online-school classes. No significant differences in this relationship are seen between traditional and online grades.

However, multivariate regression techniques that adjust for known educational performance factors further clarified these univariate trends to help decipher the question of whether children in high-risk groups performed better in online or in traditional classes. Controlling for age, gender, race, and parental education, CSHCN and black children were significantly *more* likely to have lower grades in online classes than their usual grades in traditional classrooms (adjusted odds ratio [aOR] 1.45, 95% confidence interval [CI] 1.29–1.62 for CSHCN, $P < .001$; aOR 2.73, 95% CI 2.11–3.53 for black children, $P < .001$). In contrast, children whose parents had a bachelor's degree or higher were more likely to perform better in online schools (aOR 1.45, 95% CI 1.15–1.82, $P < .001$).

Discussion

Child health care providers frequently encounter children who fall behind in their education because of health, behavioral, or

XSL•FO
RenderX

situational concerns that may inhibit their ability to learn in a traditional classroom setting [7,24]. Outside of individualized education programs or 504 plan adaptations [6], United States physicians are generally without tools to support families with struggling children. Online schooling offers a unique means with which to maintain educational progress in order to satisfy the myriad needs that children may have. This study, even using parent-reported grades, supports previous work demonstrating that online schools offer an equivalent educational experience. As such, providers might choose to recommend online schools, since they can provide an educational choice for medically or socially challenged children instead of traditional schools with strict rules such as attendance requirements [12,25,26]. This study confirms that significantly more students who have special health care needs are opting into this online educational opportunity. Importantly, however, while there are diverse students attending online schools, their demographics do not mirror those of the general population, an observation that requires attention from the administrators of online schools. Further, despite the potential of online schools to address specific needs, this study confirms through adjusted analyses that children at high risk for poor health and educational outcomes do not improve their poor educational performance in online schools.

Few studies have linked health and educational outcomes [27], likely due to the few means of measurement, as well as the different functional definitions of "at risk" that each discipline uses. Students who meet definitions for needing special education may or may not screen positive in the CSHCN Screener (as demonstrated in the distribution of positive findings in the screener; Table 2). This study highlights this research gap for health and education, and underscores the need to develop linked, efficiently defined, and codependent health and education outcomes, given that many social forces affect both health and education, such as poverty and family structure [24,28]. To achieve educational success, children must have sufficient health to learn, and, in the reverse, children with educational failures may well experience poorer health.

This study leads to the hypothesis that improvements in health outcomes may result from educational success, especially through novel educational opportunities and modalities like online schools. Few studies have examined the intertwined relationship between health and educational achievement, although the parallel sources of literature reveal the same populations having poor outcomes [24,27-30]. The most informative studies have prospectively followed medically complex birth cohorts (such as cancer survivors or prematurely born infants) and have monitored intellectual progress [3,31]. There are otherwise few opportunities to link medically oriented pediatric datasets, such as vital statistics, to those collected by the US Department of Education. Other studies use more readily available intermediate outcomes, such as the number of school days missed or school-related quality-of-life indicators, as reported through the PedsQL, to measure the impact of health on daily functioning [32]. These indicators, although important, lack any assessment of educational success itself. Future studies may seek to identify the crossover between the term *disability* as commonly used in education and a designation used in clinical settings such as "having a special health care need." Based on this large population of CSHCN who seek online schools and the equivalent education that online schooling can offer, online schools may carry the dual role of enhancing educational progress and improving health outcomes if designed to maximize opportunities for child with special needs.

This study confirms that, while online schools may provide equivalent education, it does not help at-risk populations. More comprehensive screening measures for children who participate in online-schooling courses may be necessary to confirm the presence of individuals with special health care needs. Indeed, success factors associated with online schooling built by Cavanaugh [33] and others and adapted by Black et al [34] suggest that a student's abilities and disabilities predict online-schooling success. However, in these studies and others, students' abilities and disabilities were conceptualized from a cognitive perspective rather than from a physical health perspective [17]. Predictive screening has been proposed by Roblyer et al [35] and supported by Black et al [34] as a means of identifying individuals who may need more academic attention. As yet, a valid and reliable tool for assessment has not been developed.

Not only do online schools maintain educational achievement gaps in certain populations known to have both poor health and educational outcomes [4,36], they may also cause further disparities in these populations. The multivariate regressions imply that these students perform significantly worse academically in online schools than white, healthy students. That these disparities persist in an online world where teachers may not know any physical characteristics of their students suggests that these disparities are complex and will not be remedied by simplistic solutions. Many online courses, similar to other forms of online content [37], are typically not built with accessibility standards in mind. In fact, few US K-12 online schools have protocols in place to accurately identify students with differing abilities [38]. Future research can, however, use these two divergent settings (online and traditional classrooms) to perform comparative-effectiveness research techniques to seek methods that may reduce health and educational disparities [39]. In addition, directly recruiting children from special populations (such as those with special heath care needs) into online schooling will provide the opportunity to measure whether, with direct assistance, they can gain higher educational progress. It is possible that designing courses that are compliant with the Americans with Disabilities Act guidelines will offer benefit to students with special health care needs. To this end, Repetto et al [16] offer several pedagogical strategies to assist individuals with specific needs in online courses, including being flexible with assignments and learning modalities; connecting content with real-world examples that would be salient to the student's specific context; mentoring; and offering professional development for online instructors. Health and education are linked, codependent outcomes. Studies of international comparisons of online-school systems or measures of online-school integration into traditional schools may provide additional methods to calculate the achievement of high-risk populations.

XSL•FO
RenderX

This study has several limitations that merit comment. First, our surveys experienced low response rates in each state. That said, Internet-based research is emerging as a powerful means to communicate with parents, and we believe this response rate is sufficient to provide a meaningful summary of their points of view, and we feel that any incentive for response may have its own inherent bias [19]. Second, the generalizability of the sample is unclear given the high proportion of highly educated parents. We do not know whether a non-Internet-based survey would attract a more representative sample of parents, although other forums such as parent–teacher meetings have a notoriously skewed sample of parents. Finally, the achievement data used in this study presented a limitation. We used parent-reported grade data, which is subject to recall and social desirability bias. In addition, we used course grades as a measure of student achievement. Course grades are a subjective, nonstandardized means of assessing student performance. Further, we did not stratify grade data based on course subject matter. Finally, the population of students who use online schools may actually be biased toward the higher-educated families, requiring these schools to better market their opportunities in all school settings.

Health care providers need to be aware of the technological and pedagogical advances during the past 10 years that have enabled primary and secondary students through state-accredited online schools the opportunities for “any time, any place, any pace” learning. Online schooling is an equivalent and novel means with which to maintain educational progress. However, it also provides an unmet opportunity to narrow the achievement gap for CSHCN and children in high-risk populations such as racial and ethnic minorities. As online-schooling programs become more prominent, accepted, and popular, it is imperative to adapt online instruction to populations known to experience less educational success, such as racial and ethnic minorities and those with special health care needs. Given the affordances of online schools and the potential to follow children in the long term with health conditions through school, the health, well-being, and long-term successes for children who are at high risk for poor educational and health outcomes may yet be improved.

Authors' Contributions

All authors contributed equally to the preparation of this manuscript.

Conflicts of Interest

None declared.

References

1. Yin HS, Johnson M, Mendelsohn AL, Abrams MA, Sanders LM, Dreyer BP. The health literacy of parents in the United States: a nationally representative study. Pediatrics 2009 Nov;124 Suppl 3:S289-S298 [FREE Full text] [doi: 10.1542/peds.2009-1162E] [Medline: 19861483]
2. DeWalt DA, Hink A. Health literacy and child health outcomes: a systematic review of the literature. Pediatrics 2009 Nov;124 Suppl 3:S265-S274 [FREE Full text] [doi: 10.1542/peds.2009-1162B] [Medline: 19861480]
3. Lancashire ER, Frobisher C, Reulen RC, Winter DL, Glaser A, Hawkins MM. Educational attainment among adult survivors of childhood cancer in Great Britain: a population-based cohort study. J Natl Cancer Inst 2010 Feb 24;102(4):254-270 [FREE Full text] [doi: 10.1093/jnci/djp498] [Medline: 20107164]
4. Taras H, Potts-Datema W. Chronic health conditions and student performance at school. J Sch Health 2005 Sep;75(7):255-266. [doi: 10.1111/j.1746-1561.2005.00034.x] [Medline: 16102088]
5. National Asthma Education and Prevention Program--School Subcommittee; National School Boards Association; American School Health Association; American Diabetes Association; American Academy of Pediatrics; Food Allergy and Anaphylaxis Network; Epilepsy Foundation. Students with chronic illnesses: guidance for families, schools, and students. J Sch Health 2003 Apr;73(4):131-132. [Medline: 12728609]
6. American Academy of Pediatrics, Committee on Children with Disabilities. The pediatrician's role in development and implementation of an Individual Education Plan (IEP) and/or an Individual Family Service Plan (IFSP). Pediatrics 1999 Jul;104(1 Pt 1):124-127. [Medline: 10390275]
7. Kelly DP, Aylward GP. Identifying school performance problems in the pediatric office. Pediatr Ann 2005 Apr;34(4):288-298. [Medline: 15871433]
8. Bravender T. School performance: the pediatrician's role. Clin Pediatr (Phila) 2008 Jul;47(6):535-545. [doi: 10.1177/0009922807313272] [Medline: 18566352]
9. Barbour M, Brown R, Waters LH, Hoey R, Hunt JL, Kennedy K, et al. Online and Blended Learning: A Survey of Policy and Practice of K-12 Schools Around the World. Vienna, VA: iNacol Press; 2011.
10. Greenway R, Vanourek G. The virtual revolution: understanding online schools. Educ Next 2006;6(2):34-41.
11. Watson J, Gemin B, Ryan J. Evergreen Consulting Associates. 2008 Nov. Keeping Pace With K-12 Online Learning: A Review of State-Level Policy and Practice URL: http://www.kpk12.com/cms/wp-content/uploads/KeepingPace_2008.pdf [accessed 2011-09-22] [WebCite Cache ID 61tNmsviD]

XSL•FO
RenderX

12. Cavanaugh C, Gillan KJ, Kromrey J, Hess M, Blomeyer R. Learning Point Associates. 2004 Oct. The Effects of Distance Education on K-12 Student Outcomes: A Meta-analysis URL: http://www.ncrel.org/tech/distance/k12distance.pdf [accessed 2011-09-22] [WebCite Cache ID 61tNgExjA]
13. Dickson WP. Toward a deeper understanding of student performance in virtual high school courses: using quantitative analyses and data visualization to inform decision making. In: Smith R, Clark T, Blomeyer RL, editors. A Synthesis of New Research in K-12 Online Learning. Naperville, IL: Learning Point Associates; 2005.
14. Russell TL. The No Significant Difference Phenomenon. Raleigh, NC: North Carolina State University; 1999.
15. Bernard RM, Abrami PC, Lou Y, Borokhovski E, Wade A, Wozney L, et al. How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. Rev Educ Res 2004;74(3):379-439. [doi: 10.3102/00346543074003379]
16. Repetto J, Cavanaugh C, Wayer N, Liu F. Virtual high schools: improving outcomes for students with disabilities. Q Rev Distance Learn 2010;11:91-104.
17. Müller E. Project Forum. 2010 Jul 15. Virtual K-12 Public School Programs and Students with Disabilities: Issues and Recommendations: A Policy Proceedings Document URL: http://www.projectforum.org [accessed 2011-09-22] [WebCite Cache ID 61tO4MjOE]
18. AT&T. 2009. Virtual School Clearinghouse URL: http://www.vsclearinghouse.com/ [accessed 2011-09-22] [WebCite Cache ID 61tO7nFph]
19. Manfreda KL, Bosnjak M, Berzelak J, Haas I, Vehovar V. Web surveys versus other survey modes: a meta-analysis comparing response rates. Int J Market Res 2008;50(1):79-104.
20. Bethell CD, Read D, Stein RE, Blumberg SJ, Wells N, Newacheck PW. Identifying children with special health care needs: development and evaluation of a short screening instrument. Ambul Pediatr 2002;2(1):38-48. [Medline: 11888437]
21. Child and Adolescent Health Measurement Initiative. Children with Special Health Care Needs URL: http://cahmi.org/pages/Sections.aspx?section=10 [accessed 2011-09-22] [WebCite Cache ID 61tOBbSwt]
22. Bethell CD, Read D, Blumberg SJ, Newacheck PW. What is the prevalence of children with special health care needs? Toward an understanding of variations in findings and methods across three national surveys. Matern Child Health J 2008 Jan;12(1):1-14. [doi: 10.1007/s10995-007-0220-5] [Medline: 17566855]
23. Carle AC, Blumberg SJ, Poblenz C. Internal psychometric properties of the Children with Special Health Care Needs Screener. Acad Pediatr 2011;11(2):128-135. [doi: 10.1016/j.acap.2009.11.006] [Medline: 20227936]
24. Sanders LM, Federico S, Klass P, Abrams MA, Dreyer B. Literacy and child health: a systematic review. Arch Pediatr Adolesc Med 2009 Feb;163(2):131-140 [FREE Full text] [doi: 10.1001/archpediatrics.2008.539] [Medline: 19188645]
25. Cavanaugh C. Effectiveness of cyber charter schools: a review of research on learnings. TechTrends 2009;53(4):28-31. [doi: 10.1007/s11528-009-0302-x]
26. Ferdig RE, DiPietro M, Papanastasiou E. Teaching and Learning in Collaborative Virtual High Schools. Naperville, IL: Learning Point Associates; 2005.
27. Forrest CB, Bevans KB, Riley AW, Crespo R, Louis TA. School outcomes of children with special health care needs. Pediatrics 2011 Aug;128(2):303-312. [doi: 10.1542/peds.2010-3347] [Medline: 21788226]
28. Byrd RS, Weitzman ML. Predictors of early grade retention among children in the United States. Pediatrics 1994 Mar;93(3):481-487. [Medline: 8115209]
29. Fiscella K, Kitzman H. Disparities in academic achievement and health: the intersection of child education and health policy. Pediatrics 2009 Mar;123(3):1073-1080 [FREE Full text] [doi: 10.1542/peds.2008-0533] [Medline: 19255042]
30. Haas SA, Fosse NE. Health and the educational attainment of adolescents: evidence from the NLSY97. J Health Soc Behav 2008 Jun;49(2):178-192. [Medline: 18649501]
31. Chyi LJ, Lee HC, Hintz SR, Gould JB, Sutcliffe TL. School outcomes of late preterm infants: special needs and challenges for infants born at 32 to 36 weeks gestation. J Pediatr 2008 Jul;153(1):25-31. [doi: 10.1016/j.jpeds.2008.01.027] [Medline: 18571530]
32. Wade TJ, Mansour ME, Line K, Huentelman T, Keller KN. Improvements in health-related quality of life among school-based health center users in elementary and middle school. Ambul Pediatr 2008;8(4):241-249. [doi: 10.1016/j.ambp.2008.02.004] [Medline: 18644546]
33. Cavanaugh C. Distance education success factors. In: Khosrow-Pour M, editor. Encyclopedia of Information Science and Technology. Hershey, PA: Information Science Publishing; 2004.
34. Black EW, Ferdig RE, DiPietro M. An overview of evaluative instrumentation for virtual high schools. Am J Distance Educ 2008;22(1):24-45. [doi: 10.1080/08923640701713422]
35. Roblyer MD, Davis L, Mills SC, Marshall J, Pape L. Toward practical procedures for predicting and promoting success in virtual school students. Am J Distance Educ 2008;22(2):90-109. [doi: 10.1080/08923640802039040]
36. Rose RM, Blomeyer RL. North American Council for Online Learning. 2007. Access and Equity in Online Classes and Virtual Schools URL: http://www.inacol.org/research/docs/NACOL_EquityAccess.pdf [accessed 2011-09-22] [WebCite Cache ID 61tMwFPUs]

XSL•FO
RenderX

37. Zeng X, Parmanto B. Web content accessibility of consumer health information web sites for people with disabilities: a cross sectional evaluation. J Med Internet Res 2004 Jun 21;6(2):e19 [FREE Full text] [doi: 10.2196/jmir.6.2.e19] [Medline: 15249268]
38. Black EW, Thompson LA, Ashkenazy N, Ferdig RE, Kisker T. As assessment of the health of virtual school participants and an innovative outreach program for chronically ill children. 2010 Presented at: Virtual School Symposium 2010; Nov 14-16, 2010; Glendale, AZ, USA.
39. Committee on Comparative Effectiveness Research Prioritization, Institute of Medicine. Initial National Priorities for Comparative Effectiveness Research. Washington, DC: National Academies Press; 2009.

Abbreviations

aOR: adjusted odds ratio
CI: confidence interval
CSHCN: children with special health care needs
K-12: kindergarten to 12th grade

Edited by G Eysenbach; submitted 27.09.11; peer-reviewed by C Cavanaugh, J Repetto; comments to author 12.01.12; revised version received 26.01.12; accepted 28.02.12; published 30.04.12.

Please cite as:
Thompson LA, Ferdig R, Black E
Online Schools and Children With Special Health and Educational Needs: Comparison With Performance in Traditional Schools
J Med Internet Res 2012;14(3):e62
URL: http://www.jmir.org/2012/3/e62/
doi:10.2196/jmir.1947
PMID:22547538

©Lindsay A Thompson, Rick Ferdig, Erik Black. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 30.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

How is an Electronic Screening and Brief Intervention Tool on Alcohol Use Received in a Student Population? A Qualitative and Quantitative Evaluation

Jessica Fraeyman[1]; Paul Van Royen[2], MD, PhD; Bart Vriesacker[1]; Leen De Mey[3]; Guido Van Hal[1], PhD

[1]Epidemiology and Social Medicine, Medical Sociology and Health Policy, Faculty of Medicine and Health Sciences, University of Antwerp, Wilrijk (Antwerp), Belgium

[2]Department of Primary and Interdisciplinary Care, Faculty of Medicine and Health Sciences, University of Antwerp, Wilrijk (Antwerp), Belgium

[3]Categorical Care CGG, Vagga vzw (Centre for Mental Health Care), Antwerp, Belgium

Corresponding Author:
Jessica Fraeyman
Epidemiology and Social Medicine, Medical Sociology and Health Policy
Faculty of Medicine and Health Sciences
University of Antwerp
Universiteitsplein 1
Wilrijk (Antwerp), 2610
Belgium
Phone: 32 32652855
Fax: 32 32652875
Email: jessica.fraeyman@ua.ac.be

Abstract

Background: A previous study among Antwerp college and university students showed that more male (10.2%–11.1%) than female (1.8%–6.2%) students are at risk for problematic alcohol use. The current literature shows promising results in terms of feasibility and effectiveness for the use of brief electronic interventions to address this health problem in college and university students. We evaluated this type of intervention and cite existing literature on the topic.

Objective: To develop a website, www.eentjeteveel.be, to motivate college and university students with problematic alcohol use to reduce alcohol consumption and increase their willingness to seek help.

Method: The website contained a questionnaire (Alcohol Use Disorders Identification Test [AUDIT]) for students to test their alcohol use. According to their answers, the students immediately received personalized feedback (personal AUDIT score and additional information on risks associated with alcohol use) and a suggestion for further action. Afterward, students could send an email to a student counselor for questions, guidance, or advice. To obtain in-depth qualitative information on the opinions and experiences of students, we held 5 focus group discussions. The topics were publicity, experiences, impressions, and effects of the website. We analyzed the quantitative results of the online test in SPSS 15.0.

Results: More than 3500 students visited www.eentjeteveel.be; over half were men (55.0%). A total of 34 students participated in the focus group discussions. The mixture of quantitative and qualitative methods to evaluate the intervention allowed a thorough analysis and provided complementary results. The intervention was well received by the student population. However, some minor aspects should be reconsidered, such as website publicity and providing students with options that were added after intermediate evaluation. The intervention increased the motivation of students to think about their alcohol use but could not stimulate them to change their behavior. The website attracted relatively more male than female students and more students in the high-risk group than in the low-risk group. The high-risk group was more inclined to seek advice or guidance (23/400, 6%; $\chi^2_{2 = 32.4,}$ $P < .001$) than the low-risk group (34/1714, 2%; $\chi^2_{2 = 32.4,}$ $P < .001$).

Conclusions: We gained unique insight into students' experiences, opinions, and perceptions with regard to the intervention. The results show that the intervention was positively received in the population, and the willingness to seek help was increased. However, real behavior change needs further research. The results of this study can assist health providers and researchers in better understanding college and university students' perceptions of eHealth initiatives.

(J Med Internet Res 2012;14(2):e56) doi:10.2196/jmir.1869

XSL•FO
RenderX

KEYWORDS

Alcohol; students; intervention

Introduction

The Internet is an ever-present and increasingly important aspect of modern society. Therefore, online interventions are becoming a more important way of approaching young people on health issues. Young people see the Internet as an acceptable and credible source of health information. College and university students are often reluctant to participate in face-to-face motivational counseling on their alcohol use. Students at high risk for problematic alcohol use are rarely interested in attending individual treatment or group programs [1] and prefer self-help interventions without therapeutic involvement to address their problem drinking [2]. Previous research has shown that students tend to prefer electronic counseling and feedback over face-to-face contact with professional counselors concerning their alcohol use [3].

A recent systematic review of the drinking patterns of European university students concluded that alcohol is consumed by a large group of students, which increases the risk of problematic drinking, making it an important issue for prevention [4]. More specifically, heavy drinkers, who are frequently targeted in prevention campaigns are also often not eager to seek help because they don't consider their drinking behavior problematic and, moreover, drinking is even seen as normal student behavior [4-6]. When heavy drinkers do seek help, they prefer low-threshold interventions such as computer-based interventions [7]. An electronic screening and brief intervention tool can offer several options for constructing such a computer-based intervention with a low threshold. In a search of the current literature, we found a variety of examples of interventions using email [8,9], a computer in a community health center [10], or a website [9,11-16] as key elements. Compared with the other options, Internet interventions present few barriers and keep the threshold for participation low.

Additionally, research indicates that male students are more at risk than women for harmful alcohol use (drinking larger quantities and on more occasions) [4], and women are more willing than men to seek help [17]. Therefore, developing an intervention that takes into account this gender issue presents an additional challenge.

Aside from lowering the participation threshold for interventions, electronic interventions offer several other advantages. They are perceived as more anonymous than face-to-face contact and create a safer environment for the user, thus minimizing the bias of giving socially acceptable answers [12]. Because of this advantage, electronic interventions are suitable for target populations with limited insight into their own problematic behavior and for people who do not seek help due to stigmatization [18,19]. Furthermore, online interventions are suitable for people who are not highly motivated to live a healthy lifestyle [19]. Also, previous research has shown that an electronic screening and brief intervention tool in particular can effectively increase the motivation of high-risk student drinkers to change their drinking behavior [9]. In general, online interventions that target alcohol consumption can be especially beneficial for at-risk drinkers and young people [20]. Current technologies make it possible to extend the intervention with movies, games, or simulations. In this way, an electronic intervention can become more attractive to young people. Moreover, the Internet makes it possible to reach a large sample of people in a relatively easy way and in a short period of time. Perhaps the biggest disadvantage of this approach (universal prevention) is the lack of personal contact, making verbal communication impossible (on such a large scale) [21].

The literature shows that a brief electronic intervention is significantly more effective in altering drinking behavior than no intervention at all [12,21]. Most of the existing initiatives consist of websites that provide a screening instrument and personalized feedback. The effectiveness of this type of intervention is independent of the feedback delivery mode (email or personal contact) [12,15]. The content or type of feedback differs: blood alcohol concentration, risk factors for alcohol-related harm, negative consequences of alcohol use, impact on surroundings, impact on sex life, or pointers for becoming a moderate drinker [15]. Another option is to offer personalized feedback on drinking norms, which appears to be effective and feasible [9] but needs further investigation [12,22].

Electronic interventions are positively experienced overall within a student population [9,12]. Various randomized controlled trials show that electronic interventions aimed at students in higher education can decrease the negative effects of alcohol use within this population [1,10,12-14,23]. Several other studies have shown a decrease in weekly alcohol consumption [24-26], heavy drinking [25,27], or average alcohol consumption [28] after implementation of an electronic intervention. This variety of outcome measures in research evaluating the effect of electronic screening and brief intervention tools does not, however, allow general statements to be made [20]. Although these results on the effectiveness of these tools are positive, more research is needed. Several literature reviews address the need for more methodological rigor to underpin statements about the effectiveness of electronic screening and brief intervention tools [29], online interventions [2,20], or computer-based interventions in general [21,25].

Next to differences in outcome measurements, another methodological issue is the lack of long-term follow-up measurements [20]. Moreira et al [22] reached a similar conclusion in a Cochrane review of the use of the social norms approach to reducing alcohol use in a student population. In a qualitative review, Elliot et al [21] advocated more studies over a longer stretch of time, assessing the influence of psychological factors on the effectiveness of e-interventions. The general results of these reviews were, however, in favor of electronically delivered interventions.

We designed an electronic screening and brief intervention to screen students with hazardous or problematic alcohol use. The aim of the intervention was to motivate students to reduce their alcohol consumption and to increase their willingness to seek

XSL•FO
RenderX

help. In this study, we assessed the following research questions. How is an electronic intervention received in a student population? Which group of students is reached by the intervention? What are students' experiences with the intervention? How can the intervention motivate students at risk for problematic alcohol use to think about their alcohol use and to change their drinking behavior?

Methods

Development of the Intervention

We developed a website (www.eentjeteveel.be in Dutch, "one too many" in English) to spread the intervention throughout the student population in Antwerp (the university and all institutions for higher education). The website comprised two major parts: an information section and the screening tool. The information section informed the visitors of the prevalence of alcohol use among students, the risks of alcohol use, contact details for further help or advice, the background of the screening tool, and the organizing research team.

Students were also provided with some pointers to help friends who are at risk for hazardous or problematic alcohol use. This part briefly pointed out different ways to recognize possible problematic drinking behaviour and how to respond. Frequently asked questions and existing misperceptions surrounding sexuality and alcohol use were also discussed. To determine the reach of this intervention, we asked visitors to respond to the following questions. "Is this the first time you have visited the website? (Yes/No)." In this way, we could record repeat visits. "Are you a student in Antwerp? (Yes/No)." We also asked visitors to fill in their age and gender. The screening tool assessed drinking behavior and included the 10 questions of the Alcohol Use Disorders Identification Test (AUDIT) [30]. This validated screening instrument has been identified as a useful and reliable tool for detecting alcohol abuse and dependence among college students [31]. Subsequently, we asked students to fill in the number of standard drinks (defined as 10 g ethanol/drink, as in European standards [32]) they consumed per day in a normal week. According to the sensible drinking guidelines from the British Medical Association (BMA), harmful drinking can be assessed in terms of the fact that more than 21 standard drinks per week for males (210 g ethanol or 26.5 units in the United Kingdom) and 14 standard drinks for females (140 g ethanol or 17.5 units) can cause physical damage due to alcohol intake. In total, the tool consisted of 16 questions as described above (including gender, age, and student campus).

Immediately after finishing the test, respondents were shown their personalized feedback. This feedback consisted of the respondent's personal AUDIT score and a standard AUDIT score table [33]. According to this personal score, additional information was added to inform the respondents about the risks of their alcohol intake. Respondents who scored 8 or more on the AUDIT or who exceeded the weekly standard guidelines as set out by the BMA were shown a table with health-related risks due to alcohol intake.

Specifically for the student visitors, we offered 5 options for further follow-up, based on the theoretical model of change [34]. Students who were not ready for follow-up or dropped out from the change model could stop the test and were referred back to the homepage. Students who wanted more information on alcohol use and the related risks were referred to the information section of the website. If students were ready to take further action, they could choose among the following options. "Where can I get some more advice?" "Can I talk to a student counselor?" "I'm ready to stop drinking/reduce my drinking; can I get some guidance from a student counselor?"

Students who wanted to take further action were referred to another webpage where a fill-in form was shown. This form gave them the chance to ask a more specific question directed at a student counselor of their choice. Student counselors, mostly psychologists, provide specific counseling and guidance on mental health and specific study problems. A list was shown of all student counselors on all college and university campuses (a picture of every student counselor and all contact details were shown). Additionally, an option was added to send the feedback to their personal email address, to the student counselor of their choice, or both. The first option gave the students the opportunity to take further action later. A copy of the feedback was sent to their personal mailbox with a link back to the website. Personal data (email addresses and names) were treated with discretion and were not stored on the Web server, due to privacy concerns expressed by the participating university and colleges for higher education. The questions posed by the students who chose to contact a student counselor, the name of the selected student counselor, and the personalized feedback were recorded in the data file. No consent was required for entrance to the website (which was freely available).

We informed students about the website and the intervention through a range of different channels: posters and flyers, messages on the digital platforms (websites that require a login used for offering students information on the courses of their study subject, eg, slides, and exams or other student activities), websites of student clubs and student counseling services, messages in student magazines, person-to-person, and direct referrals from counselors to the website. In addition to these ongoing promotion initiatives, two reminders were sent at the beginning and in the middle of the academic year, by sending messages to all student email addresses provided by the colleges and university for every student.

The intervention was evaluated after being online for 1 year (April 2008 to April 2009). We made important adjustments after an intermediate evaluation in October 2008. A list with contact details (including pictures) of all student counselors was added and the option was given to forward the personalized feedback to an email address of choice. These adjustments aimed to lower the threshold for students to contact a student counselor for help or advice.

Evaluation Method

The intervention was evaluated in two different ways intended to be complementary. First, we analyzed the data that were recorded in the online screening tool as students filled in the questionnaire. These quantitative data were obtained in Excel (Microsoft Corporation, Redmond, WA, USA) and descriptive

XSL•FO
RenderX

analyses (frequencies and cross-tabulations) were performed in SPSS 15.0 (IBM Corporation, Somers, NY, USA).

Second, we explored in depth the experiences, opinions, and perspectives of college and university students on the appearance, content, and effect of the intervention, which had not previously been explored.

Focus Group Discussion Method

Focus group discussions are a highly appreciated and valuable method for exploring the complex composition of experiences, opinions, and perspectives [35-37]. Research has shown that people are more inclined to discuss their experiences in a group than in a face-to-face approach [38]. All focus group discussions were moderated by an experienced moderator with thorough knowledge of motivational interviewing. The ability of the moderator to stimulate discussion and to guide the conversation in the right direction is essential in focus group discussions [38].

A semistructured interview guide of open questions was used to carefully elicit the experiences, opinions, and perspectives of the participants and to stimulate discussion. The interview guide consisted of an introduction (where confidentiality issues were explained), transitional questions, key questions, and subquestions (see Multimedia Appendix 1). The key question of the interview guide for the focus group discussions was "How did the intervention help you think about your alcohol use and change it?" This question was not used in the focus group discussions as such (see further details in Multimedia Appendix 1). Most themes were set out beforehand in the interview guide and concerned the general evaluation aspects of the interventions: knowledge of and participation in the website, positive and negative experiences with the website, and general results of the intervention relating to alcohol use among college and university students. Some other themes that emerged during the first focus group discussions (as suggested by the participants) were added to the script and used in the following focus group discussions (see Multimedia Appendix 1).

The composition of the discussion groups needs to meet the criterion of homogeneity. During the discussion, participants need to feel that they are among equals to be able to speak freely about their personal experiences. We randomly invited college and university students from Antwerp who were in the first 3 years of their educational program based on their willingness to participate in the discussion group (by email or personal invitation). Previous studies have shown that this younger group of students is more at risk for problematic alcohol use [39,40]. Convenience sampling was applied [37]. Another criterion for inclusion was participation in the intervention (visited the website and took the test), and we strived for an equal distribution by gender and study subject in the focus group discussions. We set a minimum of 4 and maximum of 10 participants for the focus group discussions. The number of focus group discussions is determined by saturation of the data (no new results can be obtained by adding a focus group discussion), which is usually reached after 4 or 5 focus group discussions. Representativeness of the participants is not a criterion in focus group discussions [38].

All the focus group discussions were audiorecorded digitally and transcribed verbatim. JF and BV independently coded all transcripts. Through an iterative process of constant comparison and reflection, we obtained a frame of codes giving insight into and explaining the perception of students regarding the electronic screening and brief intervention tool and the questions in the script. The applied method was inductive content analysis, which is commonly used in qualitative research [37]. In this paper we present a selection of the most important themes (a complete report in Dutch can be obtained from the corresponding author). Results of the analysis are illustrated with relevant quotes from the students in the focus group discussions.

Results

Quantitative Evaluation

Between April 7, 2008 and April 6, 2009, a total of 5664 people visited the website, 62.29% (n = 3528) of them students in Antwerp. More than half of the students who visited the website were male (n = 1936, 54.88%). The majority visited the website only once (n = 3395, 96.23%). The mean age was 21 (SD 3.8) years with a minimum age of 15 years and a maximum of 58 years. The mean age of all Flemish (from Flanders, the northern Dutch-speaking part of Belgium; Antwerp is situated in the center of Flanders) college and university students in the academic year 2007–2008 was 21 years, with a minimum age of 16 years and a maximum of 73 years [40]. In this study we obtained a representative sample of college and university students with regard to age.

On average, 10.39% of the students per participating institution for higher education visited the website at least once (3395 student visitors/33,222 students in the participating institutions). The proportion of males to females (54.55% and 45.45%, respectively) in the sample differed from the proportion in the population of Antwerp students (45.83% and 54.17%, respectively) (see Table 1). Thus, we reached proportionally more male than female students.

XSL•FO
RenderX

Table 1. Gender division for total number of college and university students in Antwerp and the students who visited the website www.eentjeteveel.be.

Gender	Number of visitors to the website		Total number of college and university students in Antwerp	
	n	%	n	%
Male	1852	54.55%	15,226	45.83%
Female	1543	45.45%	17,996	54.17%
Total	3395	100.00%	33,222	100.00%
Missing[a]	133	3.8%	0	0%

[a] These students did not fill in the question on gender (missing data not in total count).

Of the 3213 students who participated in the intervention, 41.15% (n = 1322) were at low risk for problematic alcohol use (score of 0–7 on the AUDIT), 40.34% (n = 1296) were at medium risk (score of 8–15 on the AUDIT), 9.7% (n = 311) were at high risk (score of 16–19 on the AUDIT), and 8.8% (n = 284) were at very high risk (AUDIT score of 20 or more) [30]. More male (481/1767, 27.3%) than female students (114/1446, 8.0%) were at high to very high risk (see Table 2). A relationship is observed between AUDIT scores and the results from the BMA guidelines. The results show that, when the threshold amount for hazardous drinking is exceeded, students have a high risk of problematic alcohol use (score of 16–40 on the AUDIT).

Table 2. Alcohol Use Disorders Identification Test (AUDIT) score versus gender.

AUDIT score range	Male students		Female students		All students	
	n	%	n	%	n	%
0–7[a]	446	25.2%	876	60.6%	1322	41.15%
8–15[a]	840	47.5%	456	31.5%	1296	40.34%
16–19[a]	254	14.4%	57	4%	311	9.7%
20–40[a]	227	12.9%	57	4%	284	8.8%
Missing[b]	0	0%	0	0%	297	9.2%
Total	1767	100.00%	1446	100.00%	3213	100.00%

[a] Statistically significant for $\chi^2_{3 = 452.6,}$ $P < .0001$.

[b] These students did not complete the test (missing data not in total count).

Of the students who did the test more than once, a larger proportion reported a higher risk for problematic alcohol use (score of 16–40 on the AUDIT) (n = 36, 29%; $\chi^2_{1 = 9.5,}$ $P < .0001$) than during their first visit (n = 559, 18.1%; $\chi^2_{1 = 9.5,}$ $P < .0001$) (see Table 3).

Table 3. Alcohol Use Disorders Identification Test (AUDIT) score for college and university students during their first or repeat visit to the website www.eentjeteveel.be.

AUDIT score range	First visit[a]		Repeat visit[b]		Total visits	
	n	%	n	%	n	%
0–15[c]	2530	81.90%	88	71%	2618	74.21%
16–40[c]	559	18.1%	36	29%	595	16.9%
Missing[d]	0	0%	0	0%	315	8.9%
Total	3089	100.00%	124	100.0%	3528	100.00%

[a] Counts all records with answer of yes to the question “Is this the first time you have visited the website? (Yes/No).”

[b] Counts all records with answer of no to the question “Is this the first time you have visited the website? (Yes/No).”

[c] Statistically significant for $\chi^2_{1 = 9.5,}$ $P < .002$.

[g] These students did not complete the test.

Of 2114 students who completed the test and chose 1 of the follow-up options, 82.73% (n = 1749) chose to return to the homepage and quit the intervention. Almost 15% of the students (n = 308, 14.6%) preferred to look for more information on their

XSL•FO
RenderX

alcohol use and 3% (n = 57) chose a follow-up action (advice, appointment, or guidance) (see Table 4). In total, 3 students sent an email to 1 of the student counselors. Of these, 2 wanted to receive guidance in reducing drinking and 1 student asked to make an appointment with a professional. The researcher consulted the student counselors who were contacted by the students to verify whether a follow-up took place after the student counselor received an email from the student through the website (the student's privacy was ensured during this process). All 3 students received a request for an appointment from the student counselor, as described by the standard procedures. In none of the cases was further follow-up achieved.

Table 4. Alcohol Use Disorders Identification Test (AUDIT) score for college and university students vs. choices for follow-up.

Choice	AUDIT score range				All students	
	0–15		16–40			
	n	%	n	%	n	%
Stop the test[a]	1452	84.71%	297	74.3%	1749	82.73%
More information[a]	228	13.3%	80	20%	308	14.6%
Further action[a]	34	2%	23	6%	57	3%
Missing (no action)[b]	0	0%	0	0%	1117	
Total	1714	100.0%	400	100.0%	2114	100.00%

[a] Statistically significant for $\chi^2_{2 = 32.4,}$ $P < .001$.

[b] These students did not choose 1 of the follow-up options, but did finish the test (not in total count).

There was an association between AUDIT scores and the choices for follow-up. Most of the students (1452/1714, 84.71%) in the low-risk group (score of 0–15 for the AUDIT) chose to stop the test. Proportionally fewer students (297/400, 74.3%) from the high-risk group (score of 16–40 for the AUDIT) also chose to stop the test. More students from the high-risk group (n = 80, 20.0%) than the low-risk group (n = 228, 13.3%) chose to get more information on their alcohol use. The outcome was similar for the follow-up actions: 6% (n = 23) of the high-risk group and 2% (n = 34) from the low-risk group chose a follow-up action (advice, appointment, or guidance) (see Table 4).

Qualitative Evaluation

In February and March 2009 (during the final phase of the online intervention), we carried out 5 focus group discussions with 17 male and 17 female students between 18 and 23 years old, with a mean age of 19. All participants were enrolled as bachelor's students at the Antwerp University or at one of the six participating institutions for higher education in the city of Antwerp. They were invited to visit the website before participating in 1 of the focus group discussions. Students in the focus group discussions indicated a mean alcohol intake of 7 standard drinks per week. A total of 4 students reported no drinking, 4 female students reported an average of 7 to 14 standard drinks per week, and no female students reported an average of more than 14 alcoholic beverages per week. Among the male students, 8 drank on average between 7 and 21 standard drinks per week, and only 1 reported an average of more than 21 alcoholic beverages per week (see Table 5).

XSL•FO
RenderX

Table 5. Characteristics of participants in the focus group discussions.

Focus group	Gender	Age (years)	Standard drinks/week	Study subject
1	Male	20	8	Nautical sciences
	Male	18	2	Nautical sciences
	Female	18	1	Nautical sciences
	Male	18	0	Nautical sciences
	Male	19	15	Nautical sciences
	Male	20	6	Nautical sciences
	Male	19	20	Nautical sciences
	Male	19	3	Nautical sciences
2	Male	21	8	Social studies
	Female	23	6–10	Social studies
	Female	19	7–14	Social studies
	Male	19	17	Social studies
	Female	22	0	Social studies
	Female	19	6	Social studies
	Female	23	5–8	Social studies
	Female	22	6–10	Social studies
3	Male	21	0	Social studies
	Male	21	30	Social studies
	Male	22	20	Social studies
	Female	19	5	Social studies
	Male	20	8	Social studies
	Male	22	7	Social studies
	Female	21	7	Social studies
4	Female	20	14	Veterinary medicine
	Female	19	6–7	Veterinary medicine
	Female	19	1–2	Veterinary medicine
	Female	20	2–3	Veterinary medicine
5	Female	18	2–3	Applied psychology
	Male	18	0	Applied psychology
	Female	18	4	Applied psychology
	Male	20	4	Applied psychology
	Female	18	3	Applied psychology
	Female	18	6	Applied psychology
	Male	19	3	Applied psychology

General Experiences With the Website

Generally, students in the focus group discussions experienced their visit to the website as positive. According to the students, the website offered clear information about their alcohol use, as illustrated in the following quotes (Q).

> *Q1: The name of the website is well chosen, it sounds nonjudgmental.*
>
> *Q2: I found the pointers for friends very useful. This way, the website aims not only at people with an alcohol problem, but also at people surrounding them. That can be useful.*
>
> *Q3: I've found some references for further help. That's a positive thing.*

XSL•FO
RenderX

Evaluation of Alcohol Use and Related Risks

This theme emerged spontaneously during the focus group discussions when exploring the experiences of the students with the website. Most students found it difficult to evaluate their own alcohol intake and related risks (Q4). Some felt that they had a realistic idea of their own drinking habits (Q5). However, they generally underestimated their drinking behavior (Q6, Q7). Indeed, when receiving the personal feedback, some students did not believe the results that were shown (Q7).

> *Q4: You think to yourself "I don't drink too much" and "it causes no harm," but then it appears that it does...*
>
> *Q5: I think everyone can evaluate his own drinking behavior; at least I can.*
>
> *Q6: I found the results of the test interesting because I had a score of 7. A score of 8 would have put me in the second risk category. That made me think for a second: "maybe I should be aware..." Because I expected a lower score.*
>
> *Q7: When I saw my results, I thought "Oh, I did something wrong, this can't be right."*

Students also underestimated the general risks of excessive alcohol use (Q8, Q9).

> *Q8: Maybe I drink 35 units on Friday and Saturday, and zero units the rest of the week. That's not addictive behavior in my opinion, or is it?*
>
> *Q9: The possible consequences seem so far away, you can't see them...*

Perceived Goal and Target Group of the Website

In general, students did not feel that the intervention was addressing them. The website can be useful only for people who have doubts about the amount of their own alcohol intake and people who are already planning to seek help or advice (Q10). The website cannot help people who are not aware of any existing alcohol-related problems, according to the students (Q11).

> *Q10: For someone who has the feeling "maybe it's getting to be a bit too much," the website can have an impact maybe.*
>
> *Q11: The people with the biggest problem—the ones who don't care but are not aware of the problem—are the most difficult ones to get on the website.*

Usefulness of the Website for Others

Mostly, the students reflected on possible negative consequences of alcohol use for others rather than for themselves. They spontaneously mentioned the importance of their own role as a friend in dealing with problematic alcohol use in their friends (Q12, Q13). Additionally, the website could provide useful information for friends, parents, and youth workers (Q14).

> *Q12: You have to be honest with your friends about their alcohol use.*
>
> *Q13: If one of your friends comes up to you and says "I have a drinking problem"...yeah, I would refer her, I think.*
>
> *Q14: ...you can fill in the test with leaders from youth movements, people who work with young people, so they can sensitize young people in their own context.*

Motivation to Change

Most of the students said that the intervention did not motivate them to change their alcohol use, as a second step in behavioral change (Q15). However, when their test results were more alarming, they would be stimulated to think about it, as a first step in behavioral change (Q16).

> *Q15: Now, when I start my fourth drink, I think "Ow, in fact, maybe four drinks is a bit too much," but I don't think [my drinking behavior] can change because of the website...*
>
> *Q16: I had a score of 8 on the test and I drink a glass of wine every night with dinner. If my score had been higher, I would consider drinking less. Just realizing that all sorts of bad things can happen to your liver...*

The students in the focus group discussions generally considered their own alcohol use not to be problematic, although at least one student did show risk for harmful alcohol use according to the BMA guidelines (see Table 5). They were stimulated to think about the alcohol use of their friends more than about their own alcohol use (Q17). A few students would consider talking about their alcohol use after visiting the website (Q18).

> *Q17: [The score] worried me, especially for my friends. Because I'm not a heavy drinker myself, and when I saw my score, I thought "Wow, my friends, if they did this test, they would score even higher!"*
>
> *Q18: You could talk with your parents about it, using the information from the website.*

Discussion

An electronic screening and brief intervention was developed, aimed at Antwerp college and university students, to test their alcohol use and to gain insight into their drinking behavior by offering an easily accessible tool. This is the only existing electronic screening and brief intervention tool in Flanders and Belgium specifically focusing on college and university students.

Although on average 10.39% of the students per participating institution for higher education in Antwerp visited the website, publicity for the website is a rather weak point. The sample of students that we obtained in the online intervention was representative according to age; however, we did not consider other dimensions for representativeness. During the focus group discussions, students stressed the lack of publicity initiatives for the website. We set up two major campaigns to reach students during the college year. These initiatives had a positive influence. However, we saw a steep decline in visitor numbers between and shortly after these initiatives. More persistent and repeated actions are needed to maintain students' attention, for example, advertising on social network sites such as Facebook and LinkedIn.

XSL•FO
RenderX

Only 3 students took further action and sent an email to a student counselor. We cannot know how many students approached the listed student counselors by personal or telephone contact following a visit to the website. After visiting the website, students could have approached other health services outside the possibilities offered in this intervention; however, it was not our intention to assess this.

Additionally, possibly relevant data were missed by not recording the number of times that students had personal feedback sent to their own email address. These results could inform us about the students and their intention to change their drinking behavior.

Although this study has some limitations, our results can offer social scientists and health workers insight into the experiences and attitudes of students toward an electronic screening and brief intervention aimed at reducing alcohol drinking among those with problematic or hazardous drinking behavior. Until now, this was an unexplored topic.

The results of the study show that students in high-risk groups are more inclined than those in low-risk groups to seek help or advice. This is confirmed in the qualitative research, where students indicated that they would be more motivated to take further action when the feedback showed alarming results. Also, more students from the high-risk group repeatedly visited the website. We can therefore conclude that students were motivated to think about their alcohol use after participating in the intervention and that this motivation was even increased when the risk for problematic alcohol use increased. These findings are in accordance with several other studies [9,12,20]. However, more research on the nature of this relationship is needed.

A previous study among Antwerp students showed that more male (10.2%–11.1%) than female (1.8%–6.2%) students are at risk for problematic alcohol use [16]. A recent study among Antwerp and Ghent students showed the same results (11.1% male and 1.7% female problematic alcohol users) [40]. A review on drinking in European universities found similar results [4]. Moreover, women are more willing than men to seek help [17]. In the quantitative analysis we found that more male than female students visited the website. Also, the proportion of students in high-risk groups was higher than in the previous study by Van Hal et al [39]. Therefore, the intervention succeeded in meeting the challenge to reach more men than women and more students at high risk than at low risk for problematic alcohol use. However, the selection of the cut-off points in the AUDIT score and the BMA standard to determine different risk groups is influenced by national and cultural standards, which are also determined by maximum consumption allowances [30]. In the United Kingdom, the cut-off point for the number of weekly standard drinks is 110.6 g (7.9 g × 14 drinks) of ethanol per week for women and 165.9 g (7.9 g × 21 drinks) or ethanol for men, compared with 140 g and 210 g, respectively, in Belgium. The results in this study, therefore, may imply an underestimation compared with harmful drinking in the United Kingdom.

With regard to the average alcohol intake per week reported by the participating students, we unintentionally gathered a mixed group of drinkers in every discussion group. Although it was not the intention of the study to gather a representative group of students with regard to alcohol intake, this can be considered a strength of the study. Heavy drinkers as well as abstainers participated in the focus group discussions and shared their opinions in the discussion. However, this can also be seen as a weakness of the study. The intervention aimed to address especially high-risk drinkers, and the group of participants in the focus group discussions was mixed with regard to alcohol use.

The role of friends in the management of alcohol use is important. Students were more likely to overestimate the alcohol intake of other students and to underestimate their own alcohol use, creating a situation where students are at risk for excessive alcohol intake. Previous research has indicated that perceived social norms are a realistic predictor of future behavior in students [41-44] regardless of gender [45]. Misperceptions can be tackled by correcting the perceived social norms [23,43,44,46-48]. Adding extra information to the personalized feedback in the intervention according to the social norms approach can address these misperceptions in the future.

The combined use of both quantitative and qualitative methods makes the current study highly valuable and rare within this subject area. On the one hand, the quantitative evaluation gives a good overview of the participation of the student population in the intervention and can show us trends in the status of alcohol use among the student population who participated in the intervention. On the other hand, the exploratory method of focus group discussions gives us a unique insight into the experiences, opinions, and perceptions of the same population on the intervention, which cannot be obtained in any other scientifically justified manner.

Conclusion

Recent studies have shown the effectiveness of freely available and anonymous online interventions in reducing alcohol use in student populations. To demonstrate the effectiveness of our intervention, a follow-up study needs to be performed with one or more control groups and one intervention group. However, this study shows that qualitative methods can be used in a pragmatic and a scientifically rigorous manner simultaneously. The results show that the intervention was well received in the student population, although most students did not feel addressed by it. It reached more male than female students and also more students in high-risk groups. The results show that the willingness to seek help increases when the risk for problematic alcohol use increases. However, the impact of the website on real behavior change needs further research. We were able to gain highly valuable information that deepens the knowledge base on the feasibility of an eHealth brief intervention tool for alcohol use aimed at college and university students. The results of this study can assist health providers and researchers in better understanding the perceptions of college and university students with regard to eHealth interventions.

XSL•FO
RenderX

Acknowledgments

Grants from the Flemish Agency for Care and Health funded this research. The Flemish Agency for Care and Health is an agency of the Flemish government and supports and governs diverse health initiatives in Flanders.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Script for focus group discussions.

[PDF File (Adobe PDF File), 57KB - jmir_v14i2e56_app1.pdf]

References

1. Chiauzzi E, Green TC, Lord S, Thum C, Goldstein M. My student body: a high-risk drinking prevention web site for college students. J Am Coll Health 2005;53(6):263-274. [doi: 10.3200/JACH.53.6.263-274] [Medline: 15900990]
2. Riper H, van Straten A, Keuken M, Smit F, Schippers G, Cuijpers P. Curbing problem drinking with personalized-feedback interventions: a meta-analysis. Am J Prev Med 2009 Mar;36(3):247-255. [doi: 10.1016/j.amepre.2008.10.016] [Medline: 19215850]
3. Kypri K, Saunders JB, Gallagher SJ. Acceptability of various brief intervention approaches for hazardous drinking among university students. Alcohol Alcohol 2003 Dec;38(6):626-628 [FREE Full text] [Medline: 14633653]
4. Wicki M, Kuntsche E, Gmel G. Drinking at European universities? A review of students' alcohol use. Addict Behav 2010 Nov;35(11):913-924. [doi: 10.1016/j.addbeh.2010.06.015] [Medline: 20624671]
5. Cho H. Readiness to change, norms, and self-efficacy among heavy-drinking college students. J Stud Alcohol 2006 Jan;67(1):131-138. [Medline: 16536137]
6. Cellucci T, Krogh J, Vik P. Help seeking for alcohol problems in a college population. J Gen Psychol 2006 Oct;133(4):421-433. [doi: 10.3200/GENP.133.4.421-433] [Medline: 17128960]
7. Buscemi J, Murphy JG, Martens MP, McDevitt-Murphy ME, Dennhardt AA, Skidmore JR. Help-seeking for alcohol-related problems in college students: correlates and preferred resources. Psychol Addict Behav 2010 Dec;24(4):571-580. [doi: 10.1037/a0021122] [Medline: 21198220]
8. Moore MJ, Soderquist J, Werch C. Feasibility and efficacy of a binge drinking prevention intervention for college students delivered via the Internet versus postal mail. J Am Coll Health 2005 Aug;54(1):38-44. [doi: 10.3200/JACH.54.1.38-44] [Medline: 16050327]
9. Bendtsen P, Johansson K, Akerlind I. Feasibility of an email-based electronic screening and brief intervention (e-SBI) to college students in Sweden. Addict Behav 2006 May;31(5):777-787. [doi: 10.1016/j.addbeh.2005.06.002] [Medline: 15996827]
10. Kypri K, Saunders JB, Williams SM, McGee RO, Langley JD, Cashell-Smith ML, et al. Web-based screening and brief intervention for hazardous drinking: a double-blind randomized controlled trial. Addiction 2004 Nov;99(11):1410-1417. [doi: 10.1111/j.1360-0443.2004.00847.x] [Medline: 15500594]
11. Cunningham JA, Humphreys K, Koski-Jännes A, Cordingley J. Internet and paper self-help materials for problem drinking: is there an additive effect? Addict Behav 2005 Sep;30(8):1517-1523. [doi: 10.1016/j.addbeh.2005.03.003] [Medline: 15893433]
12. Bewick BM, Trusler K, Mulhern B, Barkham M, Hill AJ. The feasibility and effectiveness of a web-based personalised feedback and social norms alcohol intervention in UK university students: a randomised control trial. Addict Behav 2008 Sep;33(9):1192-1198. [doi: 10.1016/j.addbeh.2008.05.002] [Medline: 18554819]
13. Kypri K, Langley JD, Saunders JB, Cashell-Smith ML, Herbison P. Randomized controlled trial of web-based alcohol screening and brief intervention in primary care. Arch Intern Med 2008 Mar 10;168(5):530-536 [FREE Full text] [doi: 10.1001/archinternmed.2007.109] [Medline: 18332300]
14. Walters ST, Vader AM, Harris TR. A controlled trial of web-based feedback for heavy drinking college students. Prev Sci 2007 Mar;8(1):83-88. [doi: 10.1007/s11121-006-0059-9] [Medline: 17136461]
15. Walters ST, Miller E, Chiauzzi E. Wired for wellness: e-interventions for addressing college drinking. J Subst Abuse Treat 2005 Sep;29(2):139-145. [doi: 10.1016/j.jsat.2005.05.006] [Medline: 16135342]
16. Kypri K, Stephenson S, Langley J, Cashell-Smith M, Saunders J, Russell D. Computerised screening for hazardous drinking in primary care. N Z Med J 2005 Oct 28;118(1224):U1703. [Medline: 16258578]
17. Benton SL, Benton SA, Downey RG. College student drinking, attitudes toward risks, and drinking consequences. J Stud Alcohol 2006 Jul;67(4):543-551. [Medline: 16736074]
18. Copeland J, Martin G. Web-based interventions for substance use disorders: a qualitative review. J Subst Abuse Treat 2004 Mar;26(2):109-116. [doi: 10.1016/S0740-5472(03)00165-X] [Medline: 15050088]

XSL•FO
RenderX

19. Van 't Riet J, Crutzen R, De Vries H. Investigating predictors of visiting, using, and revisiting an online health-communication program: a longitudinal study. J Med Internet Res 2010;12(3):e37 [FREE Full text] [doi: 10.2196/jmir.1345] [Medline: 20813716]
20. White A, Kavanagh D, Stallman H, Klein B, Kay-Lambkin F, Proudfoot J, et al. Online alcohol interventions: a systematic review. J Med Internet Res 2010;12(5):e62 [FREE Full text] [doi: 10.2196/jmir.1479] [Medline: 21169175]
21. Elliott JC, Carey KB, Bolles JR. Computer-based interventions for college drinking: a qualitative review. Addict Behav 2008 Aug;33(8):994-1005. [doi: 10.1016/j.addbeh.2008.03.006] [Medline: 18538484]
22. Moreira MT, Smith LA, Foxcroft D. Social norms interventions to reduce alcohol misuse in university or college students. Cochrane Database Syst Rev 2009(3):CD006748. [doi: 10.1002/14651858.CD006748.pub2] [Medline: 19588402]
23. Neighbors C, Larimer ME, Lewis MA. Targeting misperceptions of descriptive drinking norms: efficacy of a computer-delivered personalized normative feedback intervention. J Consult Clin Psychol 2004 Jun;72(3):434-447. [doi: 10.1037/0022-006X.72.3.434] [Medline: 15279527]
24. Bewick BM, West R, Gill J, O'May F, Mulhern B, Barkham M, et al. Providing web-based feedback and social norms information to reduce student alcohol intake: a multisite investigation. J Med Internet Res 2010;12(5):e59 [FREE Full text] [doi: 10.2196/jmir.1461] [Medline: 21169171]
25. Khadjesari Z, Murray E, Hewitt C, Hartley S, Godfrey C. Can stand-alone computer-based interventions reduce alcohol consumption? A systematic review. Addiction 2011 Feb;106(2):267-282. [doi: 10.1111/j.1360-0443.2010.03214.x] [Medline: 21083832]
26. Neighbors C, Lewis MA, Atkins DC, Jensen MM, Walter T, Fossos N, et al. Efficacy of web-based personalized normative feedback: a two-year randomized controlled trial. J Consult Clin Psychol 2010 Dec;78(6):898-911. [doi: 10.1037/a0020766] [Medline: 20873892]
27. Doumas DM, McKinley LL, Book P. Evaluation of two Web-based alcohol interventions for mandated college students. J Subst Abuse Treat 2009 Jan;36(1):65-74. [doi: 10.1016/j.jsat.2008.05.009] [Medline: 18657941]
28. Rooke S, Thorsteinsson E, Karpin A, Copeland J, Allsop D. Computer-delivered interventions for alcohol and tobacco use: a meta-analysis. Addiction 2010 Aug;105(8):1381-1390. [doi: 10.1111/j.1360-0443.2010.02975.x] [Medline: 20528806]
29. Bewick BM, Trusler K, Barkham M, Hill AJ, Cahill J, Mulhern B. The effectiveness of web-based interventions designed to decrease alcohol consumption--a systematic review. Prev Med 2008 Jul;47(1):17-26. [doi: 10.1016/j.ypmed.2008.01.005] [Medline: 18302970]
30. Babor TF, Higgins-Biddle JC, Saunders JB, Monteiro MG. World Health Organization. 2001. AUDIT: The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Care. 2nd edition URL: http://whqlibdoc.who.int/hq/2001/who_msd_msb_01.6a.pdf [accessed 2012-04-02] [WebCite Cache ID 66cUwk3Ir]
31. McCambridge J, Thomas BA. Short forms of the AUDIT in a Web-based study of young drinkers. Drug Alcohol Rev 2009 Jan;28(1):18-24. [doi: 10.1111/j.1465-3362.2008.00010.x] [Medline: 19320671]
32. Turner C. How much alcohol is in a 'standard drink'? An analysis of 125 studies. Br J Addict 1990 Sep;85(9):1171-1175. [Medline: 2224197]
33. Funk M, Wutzke S, Kaner E, Anderson P, Pas L, McCormick R, World Health Organization Brief Intervention Study Group. A multicountry controlled trial of strategies to promote dissemination and implementation of brief alcohol intervention in primary health care: findings of a World Health Organization collaborative study. J Stud Alcohol 2005 May;66(3):379-388. [Medline: 16047527]
34. Roche AM, Stubbs JM, Sanson-Fisher RW, Saunders JB. A controlled trial of educational strategies to teach medical students brief intervention skills for alcohol problems. Prev Med 1997 Feb;26(1):78-85. [doi: 10.1006/pmed.1996.9990] [Medline: 9010901]
35. Pope C, van Royen P, Baker R. Qualitative methods in research on healthcare quality. Qual Saf Health Care 2002 Jun;11(2):148-152 [FREE Full text] [Medline: 12448807]
36. Kitzinger J. Qualitative research. Introducing focus groups. BMJ 1995 Jul 29;311(7000):299-302. [Medline: 7633241]
37. Mortelmans D. Handboek Kwalitatieve Onderzoeksmethoden. Leuven/Voorburg: ACCO; 2007.
38. King JA. Focus Group Kit, volumes 1-6. Thousand Oaks, CA: SAGE Publications; 1998.
39. Van Hal G, Rosiers J, Bernaert I, Hoeck S. Hogere Sferen?, volume 1. Een Onderzoek naar het Middelengebruik bij Antwerpse Studenten. Antwerp: University of Antwerp; 2007.
40. Rosiers J, Hublet A, Van Damme J, Maes L, Van Hal G. Hogere Sferen?, volume 2. Een Onderzoek naar het Middelengebruik bij Vlaamse Studenten. Antwerp-Gent: University of Antwerp and University of Ghent; 2011.
41. Perkins HW. Social norms and the prevention of alcohol misuse in collegiate contexts. J Stud Alcohol Suppl 2002 Mar(14):164-172. [Medline: 12022722]
42. Neighbors C, Dillard AJ, Lewis MA, Bergstrom RL, Neil TA. Normative misperceptions and temporal precedence of perceived norms and drinking. J Stud Alcohol 2006 Mar;67(2):290-299. [Medline: 16562412]
43. Perkins HW, Craig DW. A successful social norms campaign to reduce alcohol misuse among college student-athletes. J Stud Alcohol 2006 Nov;67(6):880-889. [Medline: 17061005]

XSL•FO
RenderX

44. Dams-O'Connor K, Martin JL, Martens MP. Social norms and alcohol consumption among intercollegiate athletes: the role of athlete and nonathlete reference groups. Addict Behav 2007 Nov;32(11):2657-2666. [doi: 10.1016/j.addbeh.2007.04.030] [Medline: 17544589]
45. Lewis MA, Neighbors C. Gender-specific misperceptions of college student drinking norms. Psychol Addict Behav 2004 Dec;18(4):334-339. [doi: 10.1037/0893-164X.18.4.334] [Medline: 15631605]
46. DeJong W, Schneider SK, Towvim LG, Murphy MJ, Doerr EE, Simonsen NR, et al. A multisite randomized trial of social norms marketing campaigns to reduce college student drinking. J Stud Alcohol 2006 Nov;67(6):868-879. [Medline: 17061004]
47. DeJong W, Schneider SK, Towvim LG, Murphy MJ, Doerr EE, Simonsen NR, et al. A multisite randomized trial of social norms marketing campaigns to reduce college student drinking: a replication failure. Subst Abus 2009 Jun;30(2):127-140. [doi: 10.1080/08897070902802059] [Medline: 19347752]
48. Turner J, Perkins HW, Bauerle J. Declining negative consequences related to alcohol misuse among students exposed to a social norms marketing intervention on a college campus. J Am Coll Health 2008 Aug;57(1):85-94. [doi: 10.3200/JACH.57.1.85-94] [Medline: 18682350]

Abbreviations

AUDIT: Alcohol Use Disorders Identification Test
BMA: British Medical Association

Edited by G Eysenbach; submitted 15.06.11; peer-reviewed by B Bewick, U Whiteside; comments to author 25.08.11; revised version received 19.10.11; accepted 02.01.12; published 23.04.12.

Please cite as:
Fraeyman J, Van Royen P, Vriesacker B, De Mey L, Van Hal G
How is an Electronic Screening and Brief Intervention Tool on Alcohol Use Received in a Student Population? A Qualitative and Quantitative Evaluation
J Med Internet Res 2012;14(2):e56
URL: http://www.jmir.org/2012/2/e56/
doi:10.2196/jmir.1869
PMID:22525340

©Jessica Fraeyman, Paul Van Royen, Bart Vriesacker, Leen De Mey, Guido Van Hal. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 23.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Breakeven, Cost Benefit, Cost Effectiveness, and Willingness to Pay for Web-Based Versus Face-to-Face Education Delivery for Health Professionals

Stephen Maloney[1], BApplSc (Physio), MPH; Romi Haas[2], BApplSc (Physio), MPH; Jenny L Keating[1], PhD; Elizabeth Molloy[3], PhD; Brian Jolly[4], PhD; Jane Sims[5], PhD; Prue Morgan[1], BApplSc (Physio), MApplSc; Terry Haines[1,2], PhD

[1]Physiotherapy, Monash University, Melbourne, Australia

[2]Allied Health Research Unit, Southern Health, Melbourne, Australia

[3]Health Professions Education and Educational Research, Monash University, Melbourne, Australia

[4]Health Workforce Education and Assessment Research, Monash University, Melbourne, Australia

[5]Healthy Ageing Research Unit, Monash University, Melbourne, Australia

Corresponding Author:
Stephen Maloney, BApplSc (Physio), MPH
Physiotherapy
Monash University
PO Box 527, Frankston
Melbourne, 3199
Australia
Phone: 61 990 44240
Fax: 61 990 44812
Email: stephen.maloney@monash.edu

Abstract

Background: The introduction of Web-based education and open universities has seen an increase in access to professional development within the health professional education marketplace. Economic efficiencies of Web-based education and traditional face-to-face educational approaches have not been compared under randomized controlled trial conditions.

Objective: To compare costs and effects of Web-based and face-to-face short courses in falls prevention education for health professionals.

Methods: We designed two short courses to improve the clinical performance of health professionals in exercise prescription for falls prevention. One was developed for delivery in face-to-face mode and the other for online learning. Data were collected on learning outcomes including participation, satisfaction, knowledge acquisition, and change in practice, and combined with costs, savings, and benefits, to enable a break-even analysis from the perspective of the provider, cost-effectiveness analysis from the perspective of the health service, and cost-benefit analysis from the perspective of the participant.

Results: Face-to-face and Web-based delivery modalities produced comparable outcomes for participation, satisfaction, knowledge acquisition, and change in practice. Break-even analysis identified the Web-based educational approach to be robustly superior to face-to-face education, requiring a lower number of enrollments for the program to reach its break-even point. Cost-effectiveness analyses from the perspective of the health service and cost-benefit analysis from the perspective of the participant favored face-to-face education, although the outcomes were contingent on the sensitivity analysis applied (eg, the fee structure used).

Conclusions: The Web-based educational approach was clearly more efficient from the perspective of the education provider. In the presence of relatively equivocal results for comparisons from other stakeholder perspectives, it is likely that providers would prefer to deliver education via a Web-based medium.

Trial Registration: Australian New Zealand Clinical Trials Registry (ACTRN): 12610000135011; http://www.anzctr.org.au/trial_view.aspx?id=335135 (Archived by WebCite at http://www.webcitation.org/668POww4L)

(J Med Internet Res 2012;14(2):e47) doi:10.2196/jmir.2040

XSL•FO
RenderX

KEYWORDS

Economics; education; training programs; teaching methods; performance

Introduction

Continuing professional development for health professionals can change clinician behavior, affect patient outcomes, and influence the health of communities [1-3]. The availability of high-quality educational resources is not enough to ensure its uptake by clinicians or its delivery by educational institutions. Uptake is affected by the quality and sustainability of the product, and the accessibility and acceptability of its delivery [4].

Traditional delivery of continuing professional development has used live modalities such as lectures, tutorials, seminars, and conferences [5]. Emerging technologies enabling interactive Web-based learning environments have introduced further choice for both the provider and recipient [6]. Web-based coursework holds great promise for overcoming the key barriers of time and cost associated with the professional isolation often experienced by practitioners in rural and remote regions [7]. Evaluation of costs relative to effects would provide an important metric in assessing the value of educational resources.

In the context of the education of health professionals, there are costs associated with developing and delivering a course. Product success is determined by participant satisfaction and achievement of the defined learning targets [8]. No trials have compared the relative costs, benefits, and effectiveness of Web-based and face-to-face educational approaches for health professionals in a randomized controlled trial (RCT).

Evidence may be lacking due to the rapid expansion in the availability and acceptability of information and communication technologies used in Web-based education [9]. Furthermore, contrasting findings from economic analyses of Web-based education are often confounded by change in the assumptions that underlie the analyses, caused by changes in social expectations of access to such technologies. This creates the need to update costing models in line with any changes in social expectations—for example, some of the costs once borne by providers in providing Internet access are now paid by users who rent access to the Internet [10].

The cost effectiveness of Web-based versus face-to-face education for improving the practical skills of health professionals has not been previously reported [9-12]. This study examined the economic efficiency of Web-based versus face-to-face short-course delivery modalities in the context of falls prevention education for health professionals. The outcomes enable educational providers, health services, and health professional learners to make informed decisions about this type of investment in health professional education.

Methods

Design

The economic evaluation was conducted as part of an RCT comparing the educational outcomes of two short courses constructed for the education of health professionals in the skill of exercise prescription for falls prevention [13]. We conducted three analyses: (1) break-even analysis from the perspective of the education provider, (2) cost-effectiveness analysis from the perspective of the health service (the employer of the health professional), and (3) cost-benefit analysis from the perspective of the participant. We included sensitivity analyses, displaying different permutations of the variables that construct the results, to tailor the findings to different educational or workplace settings.

Participants and Setting

Participants were eligible to enroll if they held a minimum qualification of a bachelor's degree in any health science. We included physiotherapists, occupational therapists, nurses, and exercise physiologists working in Victoria, Australia. Participants were invited to take part in the study via the Victorian Department of Health email distribution channels.

Measurements

Measurements of Cost

The Web-based arm of the RCT was offered as an ongoing educational product by the delivering university after the initial RCT was completed. The course was developed over four iterations, shown in Figure 1. The alpha version of the program was informed by research scoping activities and delivered to representative consumers who volunteered to participate, including content specialists, educational specialists, and community members. Course version beta was delivered to practitioners who held a bachelor's degree in a health science, forming the RCT phase and the collection of data on learning outcomes and willingness to pay. Course version gamma was a fee-paying version of the course delivered to postgraduate clinicians, allowing validation of willingness to pay data. Course version delta was based on the modeled data, most closely simulating a realistic and ongoing short-course program.

Data on the labor and capital required to provide the traditional and face-to-face education programs were collected either concurrently with the RCT or modeled afterward. Table 1 describes the approach to measuring these costs and the subsequent cost analyses [14,15]. We used market prices where known to reflect real-life costs of providing the program.

XSL•FO
RenderX

Table 1. Method and analysis of cost items.

Item	Delivery approach		Measurement		Determination of value	Relevant analysis		
	Face-to-face	Web-based	Model	Actual cost from RCT[a]		BEA[b]	CEA[c]	CBA[d]
Internet	No	Yes	Yes	No	Internet costs were valued by adding the course learning materials download data size (in megabytes) to the mean data size of student uploads, totaling 800 MB. We selected an existing Telstra broadband plan (accessed October 6, 2010) to cover this data cost over a 1-month period excluding set-up costs. The data limit and plan would enable the participant sufficient bandwidth and download/upload capacity to view all learning resources, complete the learning tasks, and contribute to discussion rooms over the 4-week course schedule. As some remote participants may use satellite-based Internet access, this cost was also sourced to be included in the relevant sensitivity analysis.	No	No	Yes
Transport	Yes	No	No	No	The most common mode of transportation for participants was by car. We estimated fuel costs based on the average distance participants travelled to face-to-face course venues. The average distance travelled was based on post-code data volunteered in electronic survey undertaken by RCT participants.	No	No	Yes
Opportunity cost of free time forgone	Yes	Yes	Yes	No	With wage rate providing a proxy for the opportunity cost of leisure time, we calculated a value for the participants' time commitment by taking the mean number of hours participants required to complete the course multiplied by the hourly wage of the participant [14,15]. An hourly rate of AUD $45 an hour was used to reflect an early career physiotherapist (grade 2, year 1, Victorian Award), the largest representative group within the study demographics. In sensitivity analysis scenarios involving course participation outside of regular business hours, the wage rate was supplemented with time-and-a-half loading as would typically be experienced for clinical work outside of regular scheduled hours, ie, the weekend. These rates included 1.6 additional hours of course time for the Web-based group, as participants in this group were found within the RCT to spend significantly greater time engaged with further learning resources. Scenarios from the perspective of the health service include 17% on-costs, whereas on-costs were excluded for the CBA, as they are costs carried by the organization and not relevant from the participant's perspective.	No	Yes	Yes
Venue rental	Yes	No	No	Yes	Venues were valued from current market prices experienced in delivering the interventions in the RCT. We set venue capacity at 20 participants for both program delivery approaches to reflect the real-life limitations of supervision and feedback time that a single tutor could provide within the practical skills practice segments of the program.	Yes	No	No
Presentation equipment	Yes	No	No	Yes	Presentation equipment included rental of a laptop computer and digital projector. Costs were valued from current market prices experienced in delivering the interventions in the RCT.	Yes	No	No

XSL•FO
RenderX

Item	Delivery approach		Measurement		Determination of value	Relevant analysis		
	Face-to-face	Web-based	Model	Actual cost from RCT[a]		BEA[b]	CEA[c]	CBA[d]
Facilitator remuneration	Yes	Yes	Yes	No	We based remuneration for the facilitator's time in the face-to-face program delivery on the current Monash University enterprise bargaining agreement (accessed August 1, 2011) hourly sessional rate, excluding on-costs, for "repeat tutoring with a doctoral qualification." The rate was applied to the course duration of 8 hours. Alternatives of 12 hours and 16 hours were considered in the sensitivity analysis to reflect allowances for transportation and accommodation as may be experienced with the presenter attending courses set in rural or remote locations. We based the remuneration rate for the Web-based facilitator on the tutoring Monash University sessional rate, excluding on-costs, for "repeat tutoring without doctoral qualifications." The reduced rate for the Web-based facilitator reflected the alternative role of the Web-based facilitator, who is required to monitor and facilitate class activity, while the content is delivered by prerecorded video vignettes of a more highly qualified presenter. The Web-based facilitator was contracted for 16 hours to account for time associated with Web-based orientation enquiries from participants and accessing Web-based video submissions for feedback, which is commonly less efficient than live observation.	Yes	No	No
ICT[e] support	Yes	Yes	Yes	No	Costs involved in the operational support of the learning platform Moodle and live presenter ICT support were not directly measured and were obtained via an internal Monash University quotation of service.	Yes	No	No
ICT licensing fees	No	Yes	No	Yes	The Web-based learning system Moodle that we used in the RCT has no current or anticipated license fees and uses open-source code.	Yes	No	No
Practical tutor assistant	Yes	No	No	Yes	Costs were valued from current market prices experienced in delivering the interventions in the RCT.	Yes	No	No
Catering	Yes	No	No	Yes	Taken from RCT face-to-face delivery costs, averaged across the three face-to-face delivery venues.	Yes	No	No
Office and stationery consumables	Yes	Yes	No	Yes	Costs were valued from current market prices experienced in delivering the interventions in the RCT.	Yes	No	No
Course support DVDs	Yes	Yes	No	Yes	Costs were valued from current market prices experienced in delivering the interventions in the RCT.	Yes	No	No
Administrative support	Yes	Yes	Yes	No	Administrative staff support was used by both delivery approaches for tasks such as processing enrollments, and mailing student materials and certificates. Costs were valued at 12 hours of Monash University Professional Staff award rate of HEW3, level 7.	Yes	No	No

[a] Randomized controlled trial.

[b] Break-even analysis.

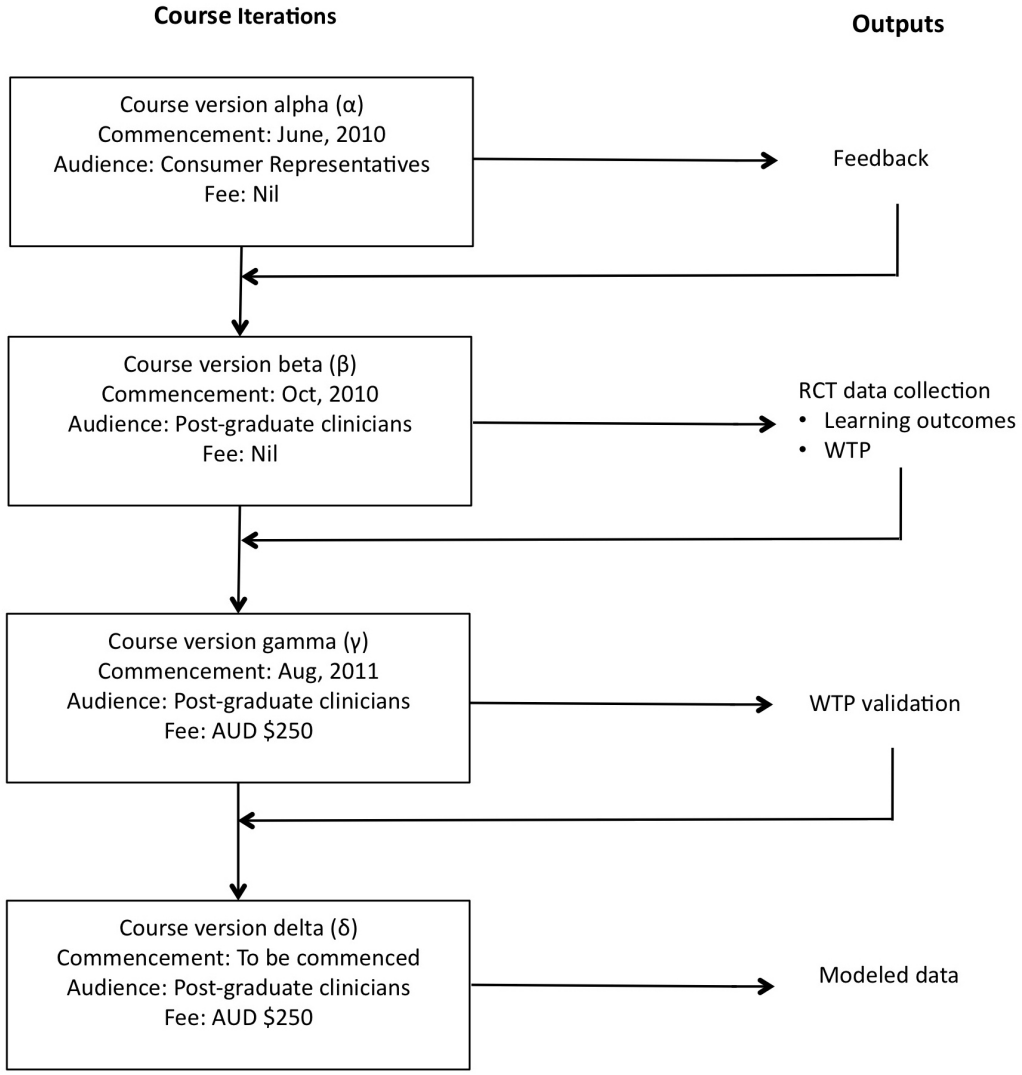
[c] Cost-effectiveness analysis.

[d] Cost-benefit analysis.

[e] Information and communication technology.

XSL•FO
RenderX

Figure 1. Strategy for development of the Web-based course and measurements used in the refinement and modeling of an acceptable cost framework. RCT = randomized controlled trial; WTP = willingness to pay.



Measurements of Outcome

We derived the measure of effectiveness used in the cost-effectiveness analysis from the mark awarded for the assignment and the examination score. An assessor, blind to group allocations, marked the course assignments. Examinations comprised multiple-choice questions that were automatically graded by the software that delivered the examinations.

Mean maximum willingness to pay for the short course (beta version) was evaluated in the RCT. Participant responses were collected using an open response format and used as a proxy measure for benefit in the cost-benefit analysis [16,17]. Participants were given the option to answer a question in an anonymous Web-based questionnaire: "If this short course had not been a trial, what would be the maximum you would have been willing to pay for this course in Australian dollars (AUD)?" We asked this question in the context of four scenarios: (1) "If the course was not recognized as professional development (ongoing learning) points," (2) "If the course had been subsidized 50% by your employer (you are indicating the presubsidized total cost)," (3) "If the course was recognized by your profession as professional development (ongoing learning) points," (4) "If the course was recognized as prior learning (of approximately 5%–10%) toward a university postgraduate qualification, eg, master's degree."

Procedure

The RCT included concealed allocation and outcome assessment by a blinded assessor for comparing face-to-face versus Web-based educational interventions.

Further details on the trial design, participants, setting, and interventions can be found in the accompanying paper of the original RCT [13].

The trial was registered with the Australian New Zealand Clinical Trials Registry, ACTRN12610000135011. We obtained ethics approval through both the Southern Health Ethics Committee and the Monash University Human Research Ethics Committee.

XSL•FO
RenderX

Analysis

Break-even Analysis

The break-even analysis, from the perspective of the education provider, estimated the minimum number of participants required for the course to operate without loss to the provider. The break-even point (Q: the number of participants required) is calculated by the point where the fixed costs (FC: costs that do not vary with participant numbers) and variable costs (VC: costs that vary with the number of participants) for each mode of program delivery are equaled by the savings (S) generated by participant fees, as represented by the equation Q = FC/(S – VC).

Table 1 presents the costs considered and how they were valued. We conducted 1-way sensitivity analyses to account for possible variation in costs and savings depending on the resources and fee structure used by the education provider. Sensitivity analyses were (1) the number of hours paid for a course facilitator, (2) variation in the hourly remuneration of the facilitator, (3) class capacity (the number of students able to undertake the course at one time), (4) variation in the enrollment fee, and (5) variation in all associated costs combined.

Cost-Effectiveness Analysis

Health care providers often pay for their staff to attend professional development opportunities. A cost-effectiveness analysis, from the perspective of the health service, compared the relative impact of the two programs in clinical units—that is, the costs of increasing the number of trained clinicians and their measured level of clinical competence.

We calculated the cost effectiveness for each course delivery method by first determining the quality of students' education with each method, or quality-adjusted students educated (QASE), using the formula QASE = number of students educated × the group's average grade. In this approach, average grade is used as a surrogate for measuring the improved ability of the staff member. To account for attrition, people who did not complete the course were given a zero in this weighting calculation. This is the measurement of effect in the incremental cost-effectiveness analysis. The incremental cost per QASE was calculated using the equation in Figure 2, resulting in an incremental cost-effectiveness ratio. Table 1 lists the costs considered in the cost-effectiveness analysis.

We conducted a sensitivity analysis for the following scenarios: (1) participant attendance occurring during regular working hours, (2) participant attendance occurring during unpaid leave, (3) participant attendance occurring during participant leisure time, (4) an alternative fee structure based on profit relative to costs, and (5) whether student attrition was equivalent between the two educational approaches.

Figure 2. Equation for calculating cost per quality-adjusted students educated (QASE) ratio. Cost F2F = cost to the health service of the face-to-face program; Cost Web-based = cost to the health service of the Web-based program; QASE F2F = number of quality-adjusted students educated with the face-to-face program; QASE Web-based = number of quality-adjusted students educated with the Web-based program.

$$\frac{\Delta\$}{\Delta QASE} = \frac{(Cost\ F2F\ - Cost\ Web\text{-}based)}{(QASE\ F2F\ - QASE\ Web\text{-}based)}$$

Cost-Benefit Analysis

A cost-benefit analysis, from the perspective of the participant, considered costs and benefits associated with the education relevant to the participant in monetary terms to enable a direct comparison.

Cost-benefit analysis requires the itemized costs experienced by each course participant along with the number of participants successfully completing the program. Net benefit, weighing the total expected costs against the total expected benefits, used the following equation: net benefit = (mean benefit face-to-face – mean cost face-to-face) – (mean benefit Web-based – mean cost Web-based), where mean benefit face-to-face is the benefit to the participant from the face-to-face method measured by the willingness-to-pay question; mean cost face-to-face is the cost to the participant to participate in the face-to-face method; mean benefit Web-based is the benefit to the participant from the Web-based method measured by the willingness-to-pay question; and mean cost Web-based is the cost to the participant in the Web-based method.

Benefit was valued in monetary terms using the participant's willingness to pay. Sensitivity analyses included the following variables: (1) whether the participant or health service paid for enrollment, and (2) whether the course occurred including during work hours or during leisure time. To test the construct validity of the willingness to pay values obtained from RCT participants, we compared the values obtained for the course contexts with Likert ratings of overall course satisfaction using Spearman rho. In this, we hypothesized that willingness to pay values should be associated with course satisfaction ratings if the willingness to pay values reflect the construct of the benefit from participation in the program [18].

Results

Demographics

Participant demographics (Table 2) indicate a relatively even distribution of baseline characteristics between the face-to-face and Web-based mode participants.

XSL•FO
RenderX

Table 2. Chi-square test outcomes for binary data and 2-sample *t* test outcomes for years since qualification.

Demographic item	Web-based (n = 46)	Face-to-face (n = 39)	*P* value
Male gender, n (%)	10 (22%)	7 (18%)	.43
Previous falls research participation, n (%)	2 (4%)	5 (13%)	.18
Previous falls publication, n (%)	1 (2%)	0 (0%)	.35
Previous falls professional development, n (%)	11 (23%)	10 (25%)	.85
Profession, n (%)			
Occupational therapy	5 (11%)	3 (8%)	.97
Physical therapy	26 (57%)	20 (51%)	.93
Nursing	10 (22%)	11 (28%)	.95
Exercise physiology	4 (9%)	4 (9%)	.96
Years since qualification, mean (SD)	4.17 (1.75)	4.15 (1.56)	.66

Randomized Trial

The RCT results indicated that there were no differences in outcomes between groups, except that Web-based education participants reported spending significantly more time (median, interquartile range of 1.0, 0.8–2.0 hours compared with 0.0, 0.0–1.0 hours) engaged with the additional learning materials than the face-to-face group (rank sum $P = .002$). The mean (SD) mark (used for calculating QASE in the cost-effectiveness analysis) for the combined examination and practical assignment grades was Web-based, 83.2% (9.9), and face-to-face, 81.6% (9.5).

Break-Even Analysis

Figure 3 presents the relationship between the costs and savings, for the primary scenario for face-to-face and Web-based delivery. Table 3 presents the fixed and variable costs considered in this analysis. Table 4 presents a sensitivity analysis, exploring the impact of variations in costs and savings. The break-even point for the primary Web-based scenario was obtained at 7 participants, whereas the primary scenario with the face-to-face delivery returned multiple break-even points (Table 5). Multiple break-even points occur in some of the sensitivity analyses when recurring fixed costs are incurred as a class reaches its enrollment capacity, causing the course to once again run at a loss until the new break-even point is reached as enrollments increase. This particular relationship, with the creation of multiple break-even points, is presented graphically for the face-to-face delivery approach in Figure 3.

Table 3. Fixed and variable costs (AUD $) for Web-based and face-to-face course delivery, for a maximum class size of 20.

Item	Web-based delivery		Face-to-face delivery	
	Fixed (per annum)	Variable (per participant)	Fixed (per course delivered)	Variable (per participant)
Venue			1000	
Presentation equipment rental			500	
Facilitator remuneration	840		810	
Faculty ICT[a] support fee	500		500	
Administrative support	250		250	
Catering				25
Stationary consumables		3		5
Delivery support DVD		5		5
Total	1590	8	3060	35

[a] Information and communication technology.

XSL•FO
RenderX

Table 4. Break-even and sensitivity analyses for Web-based course delivery mode.

Scenario number	Variable manipulated	Variable						Number of break-even point(s), up to 60 enrollments[a]
		Contracted facilitator hours	Presenter level ($/hour)	Maximum capacity	Other fixed costs	Variable costs	Enrollment fee (AUD $)	
1[b]		14	60	20	750	8	250	7
2	Facilitator hours	8	60	20	750	8	250	5
3	Facilitator hours	32	60	20	750	8	250	11–20, >22
4	Facilitator hours	40	60	20	750	8	250	13–20, >27
5	Facilitator hours	48	60	20	750	8	250	15–20, 30–40, 45–60
6	Presenter level	14	35	20	750	8	250	5
7	Presenter level	14	90	20	750	8	250	8
8	Presenter level	14	120	20	750	8	250	10
9	Presenter level	14	200	20	750	8	250	15–20, 30–40, 45–60
10	Class capacity	14	60	10	750	8	250	7
11	Class capacity	14	60	30	750	8	250	7
12	Class capacity	14	60	40	750	8	250	7
13	Class capacity	14	60	50	750	8	250	7
14	Class capacity	14	60	60	750	8	250	7
15	Fee	14	60	20	750	8	100	17–20, 35–40, 52–60
16	Fee	14	60	20	750	8	200	8
17	Fee	14	60	20	750	8	400	4
18	Fee	14	60	20	750	8	600	3
19	Fee	14	60	20	750	8	800	2
20	Fee	14	60	20	750	8	1000	2
21	All costs	100% increase in all associated costs (based on scenario 1)			250			14–20, >28
22	All costs	200% increase in all associated costs (based on scenario 1)			250			Doesn’t break even
23	All costs	300% increase in all associated costs (based on scenario 1)			250			Doesn’t break even
24	All costs	50% decrease in all associated costs (based on scenario 1)			250			3

[a] Break-even points are presented as a range when multiple break-even points are relevant to the analysis. Multiple break-even points occur in some of the analyses when the new fixed costs that are incurred when a class reaches its enrollment capacity once again lift the costs above the savings. This relationship is also presented for the face-to-face program in Figure 3.

[b] Primary analysis scenario.

XSL•FO
RenderX

Table 5. Break-even and sensitivity analyses for the face-to-face course delivery mode.

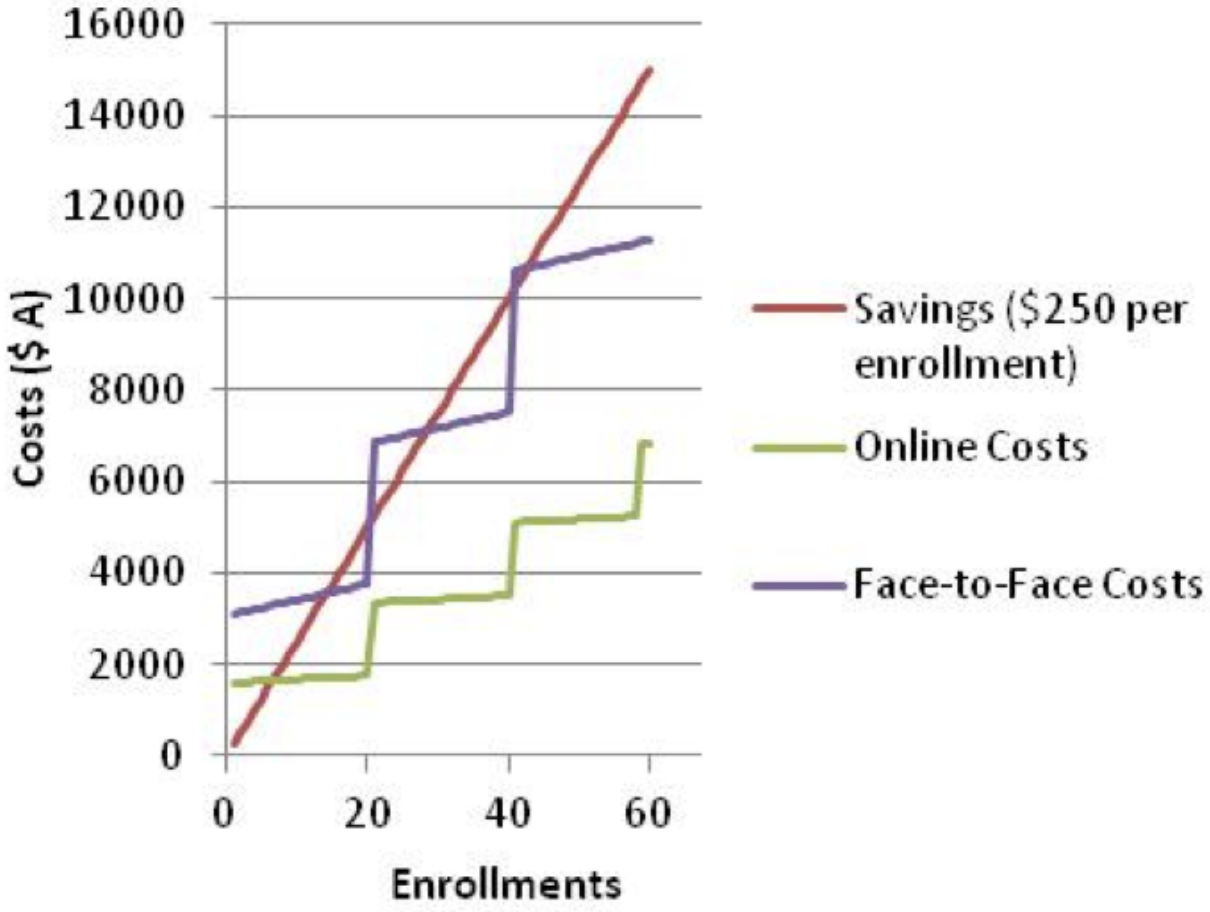
Scenario number	Variable manipulated	Variable						Number of break-even point, up to 60 enrollments[a]
		Contracted facilitator hours	Presenter level ($/hour)	Maximum capacity	Other fixed costs (AUD $)	Variable costs (AUD $)	Enrollment fee (AUD $)	
1[b]		9	90	20	2250	35	250	14–20, 29–40, 43–60
2	Facilitator hours	12	90	20	2250	35	250	16–20, 31–40, 47–60
3	Facilitator hours	16	90	20	2250	35	250	18–20, 35–40, 52–60
4	Presenter level	9	35	20	2250	35	250	12–20, >24
5	Presenter level	9	60	20	2250	35	250	14–20, >26
6	Presenter level	9	120	20	2250	35	250	16–20, 31–40, 47–60
7	Presenter level	9	200	20	2250	35	250	19–20, 38–40, 57–60
8	Class capacity	9	90	10	2250	35	250	Doesn’t break even
9	Class capacity	9	90	30	2250	35	250	15
10	Class capacity	9	90	40	2250	35	250	15
11	Class capacity	9	90	60	2250	35	250	15
12	Fee	9	90	20	2250	35	100	Doesn’t break even
13	Fee	9	90	20	2250	35	200	19–20, 38–40, 57–60
14	Fee	9	90	20	2250	35	400	8
15	Fee	9	90	20	2250	35	600	5
16	Fee	9	90	20	2250	35	800	4
17	Fee	9	90	20	2250	35	1000	3
18	All costs	100% increase in all associated costs (based on scenario 1			250			Doesn’t break even
19	All costs	200% increase in all associated costs (based on scenario 1)			250			Doesn’t break even
20	All costs	300% increase in all associated costs (based on scenario 1)			250			Doesn’t break even
21	All costs	50% decrease in all associated costs (based on scenario 1)			250			7

[a] Break-even points are presented as a range when multiple break-even points are relevant to the analysis.

[b] Primary analysis scenario.

XSL•FO
RenderX

Figure 3. Savings versus costs for enrollment, with savings set at AUD $250 per participant and maximum class size of 20 participants.



Cost-Effectiveness Analysis

The face-to-face educational approach, in course iteration beta, began with 68 participants, with 49 students completing the summative assessments with an average grade of 81.6%, or 38.98 QASE. Of the 67 participants who began the Web-based delivery, 44 completed the program with an average grade of 83.2%, or 35.78 QASE.

Through maintaining this attrition rate and mean grade for each delivery method, for a full class of 20 enrollments, the incremental cost-effectiveness ratio from the perspective of the health service for the primary analysis (scenario 1, Table 6) yields an incremental cost-effectiveness ratio of zero, therefore making face-to-face education more preferable from the health service perspective due to the higher rate of QASE.

XSL•FO
RenderX

Table 6. Sensitivity analysis of incremental cost per quality-adjusted students educated (QASE) (D$/DQASE) for Web-based (Web) and face-to-face (F2F) course delivery.

Time	Enrollment fee	Wages[a]	Backfill	Number registered	Number of completers		QASE		Costs(AUD $)		ICER[b] per participant (AUD $)
					F2F	Web	F2F	Web	F2F	Web	
Leisure time (weekend)[c]	No	Yes	Yes	20	14	13	11.42	11.63	5000	5000	0 (F2F preferred due to higher QASE)
	Yes	Yes	Yes	20	14	13	11.42	11.63	0	0	0 (F2F preferred due to higher QASE)
Working hours	No	No	No	20	14	13	11.42	11.63	21,848	25,216	–271.62
	Yes	No	No	20	14	13	11.42	11.63	16,848	20,216	–271.62
Unpaid study leave	No	Yes	No	20	14	13	11.42	11.63	13,424	15,108	–135.81
	Yes	Yes	No	20	14	13	11.42	11.63	8424	10,108	–135.81
Conditions of scenario 1 repeated with attrition equal at 14 completers (F2F QASE = 11.42, Web-based 11.63)				20	14	14	11.42	11.63	5000	5000	0 (Online preferred due to higher QASE)
Conditions of scenario 1 repeated with alternative fee of AUD $525 applied to F2F enrollments				20	14	13	11.42	11.63	10,500	5000	443.50

[a] Wages for the participant and backfill or replacement staff include 17% on-costs. Transport and Internet download costs are incurred by the participant. Negative dollar value indicates the value is in favor of face-to-face education.

[b] Incremental cost-effectiveness ratio.

[c] The primary scenario (scenario 1).

Table 6 shows a sensitivity analysis. The scenarios include manipulations of the costs carried by the health service, including the impact of the timing of course delivery. The analyses include an alternative course fee structure to account for a provider business model that calculates the fee as a percentage of profit above costs, increasing the enrollment fee for face-to-face participants. The relationship (difference in gradients) between face-to-face and Web-based costs for the primary scenarios (Figure 3) yields an inflation factor of 2.1; therefore, we adjusted the alternative face-to-face fee to AUD $525.00. The sensitivity analysis also includes a scenario of equal attrition rates between the face-to-face and Web-based approaches.

Cost-Benefit Analysis

Table 7 presents estimated costs incurred by the participant, along with a sensitivity analysis. Net benefit to the individual participant was calculated as AUD $60.88 in favor of the face-to-face program delivery, meaning that the Web-based program would need to cost $60.88 less than the face-to-face program to create equivalent benefit for the consumer. Table 8 presents willingness to pay for each mode of program delivery. Table 9 presents sensitivity analyses of the net benefit.

Table 9 presents the values of the cost-benefit analysis. The aforementioned alternative fee structure was applied in these analyses.

XSL•FO
RenderX

Table 7. Primary analysis and sensitivity analyses of participant expenses (in AUD $) for Web-based versus face-to-face course delivery modes.

Participant expenses	Web-based	Face-to-face
Primary analysis		
Downloads[a]	20.00	0.00
Transport	0.00	20.00
Fees	250.00	250.00
Time	648.00	540.00
Total	918.00	810.00
Sensitivity analysis		
With 50% increase in fees	1043.00	810.00
With 100% increase in fees	1168.00	935.00
With 200% increase in fees	1418.00	1060.00
With 50% decrease in fees	793.00	1310.00
With 25% increase in all associated costs	1147.50	685.00
With 50% increase in all associated costs	1377.00	1012.50
With 25% decrease in all associated costs	688.50	1215.00
With 50% decrease in all associated costs	459.00	607.50
With satellite-sourced Internet	923.00	Not applicable

[a] Download costs were calculated based on a user requiring a 1 GB data upload/download to complete the learning activities over 1 month. Costs were calculated from minimum Telstra broadband rates accessed on October 5, 2010, excluding set-up costs.

Table 8. Participant willingness to pay for Web-based versus face-to-face course delivery modes.

Context	Context description for willingness to pay	Web-based		Face-to-face		*P* value[b]	Correlation with overall course satisfaction: Spearman rho (*P* value)
		n[a]	mean (SD)	n[a]	Mean (SD)		
1	If course not recognized for professional development points	30	96.33 (56.37)	24	129.17 (117.25)	.41	.46 (.001)
2	If course is 50% subsidized by an employer	35	165.57 (102.16)	31	192.26 (201.46)	.46	.43 (.001)
3	If course contributes toward professional development points	36	159.72 (103.61)	30	199 (260.83)	.39	.53 (.001)
4	If coursework is recognized as prior-learning credit (5%) toward postgraduate qualification	32	190.94 (131.40)	29	314.14 (423.01)	.61	.45 (.001)

[a] Numbers vary due to some participants not completing all fields of the survey questions.

[b] *P* values between delivery methods obtained using single-sample mean comparison *t* test.

XSL•FO
RenderX

Table 9. Cost-benefit analysis results from the participant's perspective considering varying scenarios for Web-based (Web) versus face-to-face (F2F) course delivery modes.

Scenario	Payer	Time	Enrollment fee	Opportunity cost of lost work	Benefit (willingness to pay)	Net benefit (F2F vs Web; AUD $)[a]	Alternative fee structure (F2F vs Web; AUD $)[a]
1[b]	Health service	Working hours	Yes	Yes	No	60.88	Not applicable
2		Leisure time (weekend)	Yes	No	No	168.25	Not applicable
3	Participant	Working hours	No	Yes	No	60.88	–106.37
4		Leisure time (weekend)	No	No	No	168.88	1.63

[a] Positive values indicate more benefit in favor of face-to-face delivery mode.

[b] The primary scenario.

Discussion

Economic evaluation of face-to-face versus Web-based delivery has shown that the outcome depends on the stakeholder's perspective and the conditions applied to the analysis. Web-based education is the superior approach in the break-even analysis from the perspective of the education provider. The increased costs of face-to-face delivery create increased risk of financial loss if enrollment numbers are low. This is supported by what is seen in practice, where educational institutions are reluctant to run short courses in regional or remote areas where potential enrollments are lower. This barrier supports the notion that Web-based education has the potential to be more accessible and less discriminatory [4,19]. Cost-effectiveness analysis from the perspective of the health service favors face-to-face education, but the relatively small difference in quality of the clinicians' knowledge obtained from face-to-face and Web-based education means that the preference for an educational approach largely depends on when the course is undertaken and its impact on covering service delivery. Cost-benefit analysis, from the perspective of the participant, produced the most participant benefit from face-to-face education. Aside from the strong cost-minimization advantages to the education provider, the other analyses are contingent on the unique conditions and sensitivity analysis applied. This further highlights the novel methods used in this study, demonstrating the strong relationship between the provider, the health service, and the participant.

Economic analysis for health education has primarily focused on telemedicine technology or medical reviews by remote physicians, or has been concerned with the cost effectiveness of modalities for patient education [20,21] rather than upgrading the health professional's skills. To our knowledge this is the first economic evaluation of competing approaches to providing continuing professional development with tested educational equivalence in an RCT including the outcomes of satisfaction, knowledge construction, and self-reported change in practice. It is possible that the findings may be somewhat context specific in terms of the content area and nature of the health disciplines involved, the specific subject of the educational materials, and the quality of the educational materials presented in the chosen medium. However, as the principles of Web-based and face-to-face education that we investigated could be transferred to other disciplines and settings, this report provides a model that can be applied to different scenarios, modified with associated unique assumptions.

This study has highlighted the precarious balance that exists between the various stakeholders involved in education programs. Our break-even analysis highlighted that using the same fee structure for both Web-based and face-to-face modalities would lead to substantially greater profits for a Web-based course assuming equal enrollments; however, this would result in lower levels of benefits to the participants in the program. However, if the university were to choose to maintain the same relative profit ratio for Web-based and face-to-face courses, they would be able to offer the Web-based course at a lower cost to gain equivalent educational outcomes and participant benefit; society would therefore gain a greater volume of skilled professionals for a lower cost.

Potential miscellaneous benefits from each delivery method were excluded from the analysis due to the difficulty in quantifying them. For example, it is hypothesized that face-to-face education may foster stronger feelings of an education community, socialization, and networking opportunities [22], whereas Web-based education may provide better maintenance of corporate knowledge that is often lost with key personnel in short-course training and lost to the profession in situations such as retirement or maternity leave [23].

Other limitations that may have affected the findings of the analysis relate to the original RCT, the modeling of data, and underlying assumptions in the analysis formulas. The RCT measured the learning outcomes and change in practice behavior approximately 1 week following the conclusion of the training program. We do not know whether the effect of the training would have been different if the effects had been measured over a longer time frame. We also do not know whether the change in clinician practice behavior will result in real change in patient outcomes over time. We modeled data for the analysis on the fourth iteration of the training program, excluding costs involved in constructing the programs and additional expenses from "teething errors" in delivering the course with unfamiliar staff. These issues are particularly relevant to the introduction of the

XSL•FO
RenderX

Web-based modality. Phelps et al [11] recognized that setting up a Web-based course, or converting an existing course to a Web-based modality, requires a large human capital investment. Our experience in creating the course resources for the RCT reflected this sentiment, but we also found that this argument was true of beginning a face-to-face program. Audiovisual resources for the Web-based course were ideally created for both course delivery methods, but rather than being used as direct student resources in the face-to-face delivery, they were used as a way of training face-to-face presenters and maintaining corporate knowledge. We anticipate this to be cost prohibitive for many organizations without significant information and communication technology (ICT) infrastructure or with staff unfamiliar with using basic computers and software to commence a Web-based course [9,10], particularly with the expectation of making short-term savings.

Each formula used in the analysis involves calculations based on assumptions. These assumptions may be invalid depending on the context of the analysis or variation in reader perspective. Wells [24], Phelps et al [11], and Rumble [12] all reported that the shifting assumptions in information communication technologies affect the ability to contrast studies investigating the use of these technologies in education, such as who pays for what costs, the existing ICT infrastructure, and the degree of assumed user ICT literacy. For example, Rumble's [12] investigation required the university to supply computers to all students involved in the study. It could be argued that students are now assumed to have access to their own personal computer or readily accessible university or workplace computer facilities. In our study we required students to have their own access to a computer and the Internet.

The issue of who pays for what costs will naturally affect the economic evaluations. Our cost-benefit analysis assumed that students who did not complete the program did not obtain benefit from the small portion of the program that they may have completed. We averaged transport costs among the study cohort and limited them to transport by car. In reality, participants would have experienced a significant range of transport costs, which naturally depend on the location of the face-to-face delivery venue. The formulas used to calculate cost benefit and cost effectiveness require data on participant attrition in each delivery method. Participants were enrolled in the training program of the RCT at no cost. This lack of financial commitment to the program is likely to have negatively affected student attrition. This factor may have applied more to the Web-based education intervention, as it required a prolonged time commitment from students in its delivery over a 4-week period.

Although we do not know the true generalizability of the findings, the transparency of this analysis will assist decision makers to tailor the findings to their area of interest and delivery setting, whether it is undergraduate or postgraduate education. Key factors in this decision making would include the ICT capabilities of the provider, similarity of their desired course to the constructivist pedagogy used in the practical skill-teaching methods of this analysis, and other particular circumstances or resources of the provider.

We used willingness to pay as a proxy for determining participants' perceived benefit of participating in the program. Willingness to pay may have been underreported if participants considered that their responses might potentially influence the cost of education in a market in which they are the consumer. We expect that this bias would have minimal impact on the analysis between the two interventions, as the effect is likely to be equal between the two groups. Another potential bias influencing the willingness to pay values, and therefore the benefit and cost effectiveness of the delivery methods, is a possible perception that Web-based education produces greater savings for the educational institution, and that these savings should be passed on to the participant via savings in course fees [25]. Drummond et al [18] noted that it is often impossible to validate willingness to pay values within economic analyses due to the modeling of data being commonly based on theoretical or hypothetical products or services. This study was able to provide values based on programs purposefully designed for equivalent content delivery and experienced by the participants who provided the willingness to pay values. Construct validity of the willingness to pay values obtained was demonstrated through the moderate degree of correlation between the willingness to pay values and the participants' ratings of overall satisfaction (Table 9). Furthermore, the fee (AUD $250) used as the primary scenario in the economic evaluations was used in the fee-paying gamma version course iterations, a course that reached its full enrollment capacity (20 participants), indicating that this fee was a viable real-life fee structure and is comparable with fees for other Web-based professional development programs of equivalent length on the market.

QASE as represented in the cost-effectiveness analysis assumes that the health care service costs are the same for each delivery group. This may be debated depending on whether the participant requires study leave to complete the course or completes the course out of work hours. QASE and cost per QASE (Δ$/ΔQASE) is also grounded in the assumption that a clinician with better skills in falls risk client management will be a greater asset to the health service, producing better health outcomes for the clients.

Education providers vary in their opinion as to what practical class enrollment capacity is manageable in a face-to-face delivery environment. An increase in class capacity will often result in an overall decrease in fixed costs, affecting the result of a break-even analysis [26]. This is also true of Web-based education, although given the asynchronous nature of the student and teacher interaction, Web-based education is arguably less restricted by the course duration in providing supervision and feedback on participant practice, and in turn in producing greater flexibility in discerning the maximum class capacity.

We have highlighted several areas for further research in exploring the economics of delivery approaches to continuing professional development. These include further investigation into the attrition rates when contrasting free versus full fee paying. Investigating the allocation of costs in continuing professional development for health care professionals, particularly the contribution to the course fee between the participant and the health service, would allow greater insights

XSL•FO
RenderX

into the underlying assumptions in analyses. More broadly, we would encourage research into using this approach (ie, break-even analysis from the perspective of the provider, cost-effectiveness analysis from the perspective of the health service, and cost-benefit analysis from the perspective of the participant) to explore other educational approaches. Ultimately, an RCT would be conducted to investigate what may be the largest assumption in this study, that a more highly skilled clinician can affect health outcomes. For example, does the educational program to increase clinicians' management of falls-risk clientele, studied in this evaluation, have the ability to reduce falls in the community?

Conclusions

Economic analysis of Web-based versus face-to-face training for improving the clinical performance of health professionals varies depending on the type of analysis and stakeholder perspective undertaken. The Web-based educational approach was clearly more efficient from the perspective of the education provider. In the presence of equivocal results for comparisons from other stakeholder perspectives, it is likely that providers will seek to deliver education via a Web-based medium in preference to an alternative face-to-face approach.

With both Web-based and face-to-face delivery modalities offering their own unique strengths and weaknesses, it is important for decision makers to consider the application of these findings to their goals, their risk management capabilities, and their role in the delivery of high-quality health care to the community through the effective and efficient education of health service clinicians.

Acknowledgments

The authorship team would like to acknowledge the Department of Health, Victoria, Australia, for their sponsorship facilitating this research. Terry Haines was supported by a Career Development Award from the Australian National Health and Medical Research Council.

Conflicts of Interest

The authorship team has no conflicts of interest to declare in relation to the presented data or the original RCT on which it is based. Associate Professor Terry Haines is Director, Hospital Falls Prevention Solutions Pty Ltd. This company provides services for the prevention of falls in the hospital setting, which was not directly related to the subject of this research. Associate Professor Terry Haines has provided expert witness testimony in the area of prevention of falls in hospitals, which also was not directly related to the subject of this research.

References

1. Davis DA, Thomson MA, Oxman AD, Haynes RB. Changing physician performance. A systematic review of the effect of continuing medical education strategies. JAMA 1995 Sep 6;274(9):700-705. [Medline: 7650822]
2. Davis DA, Taylor-Vaisey A. Translating guidelines into practice. A systematic review of theoretic concepts, practical experience and research evidence in the adoption of clinical practice guidelines. CMAJ 1997 Aug 15;157(4):408-416 [FREE Full text] [Medline: 9275952]
3. Mazmanian PE, Davis DA. Continuing medical education and the physician as a learner: guide to the evidence. JAMA 2002 Sep 4;288(9):1057-1060. [Medline: 12204068]
4. Rovai AP, Downey JF. Why some distance education programs fail while others succeed in a global environment. Internet Higher Educ 2010;13(3):141-147. [doi: 10.1016/j.iheduc.2009.07.001]
5. Davis D, O'Brien MA, Freemantle N, Wolf FM, Mazmanian P, Taylor-Vaisey A. Impact of formal continuing medical education: do conferences, workshops, rounds, and other traditional continuing education activities change physician behavior or health care outcomes? JAMA 1999 Sep 1;282(9):867-874 [FREE Full text] [Medline: 10478694]
6. Bennett NL, Casebeer LL, Kristofco RE, Strasser SM. Physicians' Internet information-seeking behaviors. J Contin Educ Health Prof 2004;24(1):31-38. [doi: 10.1002/chp.1340240106] [Medline: 15069910]
7. Curran VR, Fleet L, Kirby F. Factors influencing rural health care professionals' access to continuing professional education. Aust J Rural Health 2006 Apr;14(2):51-55. [doi: 10.1111/j.1440-1584.2006.00763.x] [Medline: 16512789]
8. Jones D. A practical unit cost approach to budgeting and accountability in colleges. In: Levacic R, editor. Financial Management in Education. Milton Keynes: Open University Press; 1989.
9. Ng KC. Costs and effectiveness of online courses in distance education. Open Learn 2000;15(3):301-308. [doi: 10.1080/713688406]
10. Bartley SJ, Golek JH. Evaluating the cost effectiveness of online and face-to-face instruction. Educ Technol Soc 2004;7(4):167-175.
11. Phelps RH, Wells RA, Ashworth RL, Hahn HA. Effectiveness and costs of distance education usuing computer-mediated communication. Am J Distance Educ 1991;5(3):7-19. [doi: 10.1080/08923649109526759]
12. Rumble B. Online costs: interactivity at a price. In: Mason R, Kaye A, editors. Communication, Computers and Distance Education. Oxford: Pergamon Press; 1989.

XSL•FO
RenderX

13. Maloney S, Haas R, Keating JL, Molloy E, Jolly B, Sims J, et al. Effectiveness of Web-based versus face-to-face delivery of education in prescription of falls-prevention exercise to health professionals: randomized trial. J Med Internet Res 2011;13(4):e116 [FREE Full text] [doi: 10.2196/jmir.1680] [Medline: 22189410]
14. Becker G. A theory of the allocation of time. Econ J 1965;75(299):493-451.
15. Feather P, Shaw WD. Estimating the cost of leisure time for recreation demand models. J Environ Econ Manage 1999;38(1):49-65. [doi: 10.1006/jeem.1999.1076]
16. Haines T, Kuys SS, Morrison G, Clarke J, Bew P. Cost-effectiveness analysis of screening for risk of in-hospital falls using physiotherapist clinical judgement. Med Care 2009 Apr;47(4):448-456. [doi: 10.1097/MLR.0b013e318190ccc0] [Medline: 19279510]
17. Bayoumi AM. The measurement of contingent valuation for health economics. Pharmacoeconomics 2004;22(11):691-700. [Medline: 15250748]
18. Drummond M, O'Brien B, Stoddart G, Torrance G. Methods for the Economic Evaluation of Health Care Programmes. 2nd edition. Oxford: Oxford University Press; 1997.
19. Rabinowitz HK, Diamond JJ, Markham FW, Paynter NP. Critical factors for designing programs to increase the supply and retention of rural primary care physicians. JAMA 2001 Sep 5;286(9):1041-1048 [FREE Full text] [Medline: 11559288]
20. Bryce CL, Zickmund S, Hess R, McTigue KM, Olshansky E, Fitzgerald K, et al. Value versus user fees: perspectives of patients before and after using a web-based portal for management of diabetes. Telemed J E Health 2008 Dec;14(10):1035-1043. [doi: 10.1089/tmj.2008.0005] [Medline: 19119825]
21. Currell R, Urquhart C, Wainwright P, Lewis R. Telemedicine versus face to face patient care: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2000(2):CD002098. [doi: 10.1002/14651858.CD002098] [Medline: 10796678]
22. Besser H, Bonn M. Impact of distance independent education. J Am Soc Inf Sci 1996;47(11):880-883. [doi: 10.1002/(SICI)1097-4571(199611)47:11<880::AID-ASI14>3.0.CO;2-Z]
23. Na Ubon A, Kimble C. Knowledge management in online distance education. In: Banks S, Goodyear P, Hodgson V, McConnell D, editors. Proceedings of the 3rd International Conference: Networked Learning 2002. Sheffield: Sheffield University Press; 2002.
24. Wells RA. Computer-Mediated Communication for Distance Education: An International Review of Design, Teaching, and Institutional Issues. University Park, PA: American Center for the Study of Distance Education, College of Education, Pennsylvania State University; 1992.
25. Haines TP, McPhail S. Patient preference for falls prevention in hospitals revealed through willingness-to-pay, contingent valuation survey. J Eval Clin Pract 2011 Apr;17(2):304-310. [doi: 10.1111/j.1365-2753.2010.01441.x] [Medline: 21040242]
26. Carr S. Union publishes guide citing high cost of distance education. Chron High Educ 2001;47(35):39-41.

Abbreviations

ICT: information and communication technology
QASE: quality-adjusted students educated
RCT: randomized controlled trial

Edited by G Eysenbach; submitted 03.01.12; peer-reviewed by L Warmerdam, S Fraser, B Das; comments to author 27.01.12; revised version received 13.02.12; accepted 22.02.12; published 02.04.12.

Please cite as:
Maloney S, Haas R, Keating JL, Molloy E, Jolly B, Sims J, Morgan P, Haines T
Breakeven, Cost Benefit, Cost Effectiveness, and Willingness to Pay for Web-Based Versus Face-to-Face Education Delivery for Health Professionals
J Med Internet Res 2012;14(2):e47
URL: http://www.jmir.org/2012/2/e47/
doi:10.2196/jmir.2040
PMID:22469659

©Stephen Maloney, Romi Haas, Jenny L Keating, Elizabeth Molloy, Brian Jolly, Jane Sims, Prue Morgan, Terry Haines. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 02.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

A Conceptual Framework and Principles for Trusted Pervasive Health

Pekka Sakari Ruotsalainen[1], D.Sc (tech.); Bernd Gerhard Blobel[2], PhD; Antto Veikko Seppälä[3], MSc; Hannu Olavi Sorvari[4], MSc; Pirkko Anneli Nykänen[3], PhD

[1]National Instutute for Health and Welfare, Department of Information, Helsinki, Finland

[2]University Hospital Regensburg, eHealth Competence Center, University of Regensburg, Regensburg, Germany

[3]School of Information Sciences, Centre for Information and Systems, University of Tampere, Tampere, Finland

[4]University of Turku, Faculty of law, Turku, Finland

Corresponding Author:
Pekka Sakari Ruotsalainen, D.Sc (tech.)
National Instutute for Health and Welfare
Department of Information
PL 30
Helsinki, 00271
Finland
Phone: 358 0505004046
Fax: 358 206102443
Email: pekka.ruotsalainen@thl.fi

Abstract

Background: Ubiquitous computing technology, sensor networks, wireless communication and the latest developments of the Internet have enabled the rise of a new concept—pervasive health—which takes place in an open, unsecure, and highly dynamic environment (ie, in the information space). To be successful, pervasive health requires implementable principles for privacy and trustworthiness.

Objective: This research has two interconnected objectives. The first is to define pervasive health as a system and to understand its trust and privacy challenges. The second goal is to build a conceptual model for pervasive health and use it to develop principles and polices which can make pervasive health trustworthy.

Methods: In this study, a five-step system analysis method is used. Pervasive health is defined using a metaphor of digital bubbles. A conceptual framework model focused on trustworthiness and privacy is then developed for pervasive health. On that model, principles and rules for trusted information management in pervasive health are defined.

Results: In the first phase of this study, a new definition of pervasive health was created. Using this model, differences between pervasive health and health care are stated. Reviewed publications demonstrate that the widely used principles of predefined and static trust cannot guarantee trustworthiness and privacy in pervasive health. Instead, such an environment requires personal dynamic and context-aware policies, awareness, and transparency. A conceptual framework model focused on information processing in pervasive health is developed. Using features of pervasive health and relations from the framework model, new principles for trusted pervasive health have been developed. The principles propose that personal health data should be under control of the data subject. The person shall have the right to verify the level of trust of any system which collects or processes his or her health information. Principles require that any stakeholder or system collecting or processing health data must support transparency and shall publish its trust and privacy attributes and even its domain specific policies.

Conclusions: The developed principles enable trustworthiness and guarantee privacy in pervasive health. The implementation of principles requires new infrastructural services such as trust verification and policy conflict resolution. After implementation, the accuracy and usability of principles should be analyzed.

(J Med Internet Res 2012;14(2):e52) doi:10.2196/jmir.1972

KEYWORDS

pervasive health; ubiquitous computing; privacy; trustworthiness; digital bubbles; conceptual modeling

XSL•FO
RenderX

Introduction

Health is a wider concept than absence of disease or poor functionality. Broadly, health covers a person's physical and mental, as well as economic and social, well-being. Therefore, health is not only a state determined by health care professionals and related authorities, but also an individually experienced state with many determinants, such as lifestyle, environment, social, and cultural aspects.

Traditionally, health care is an institutionalized and regulated system that occurs in controlled environments. The availability of information and communication technologies (ICT), ubiquitous computing, ambient intelligence, motes, sensors, and sensor networks is changing health care. New service models, such as personalized health care and personal health systems (PHS), are developing [1-2]. Ubiquitous health care is another new paradigm, which is closely related to biomedical engineering, health informatics, and ubiquitous computing [3]. It uses ubiquitous technology for continuously monitoring patients anywhere, for proactive prevention and early detection of diseases, and for ubiquitous access to medical data [4-6].

Ubiquitous computing technology, sensor networks, and ambient intelligence have initiated the birth of pervasive health. Pervasive health and health care are separate concepts with many overlapping goals (ie, making services available to everyone). They are not distinguished by the information technology or information used. Both can collect and deploy any kind of personal health data and environmental information (eg, genomic, phenomic, epigenetic, and geospatial information).

Trust and Information Privacy

Trust is a relativistic, complex, and dynamic concept. From the information-processing point of view, trust defines the individual's expectations in the context of collection, processing, communication, and use of personal information [7]. It allows acceptance of risk and balances privacy needs against benefits. Trust can be based on knowledge and experiences of an entity about actors and processes involved in personal data, on regulations established for ruling actors' behavior and processes, and on legislation binding actors and enforcing processes (law enforcement).

In the case of health information, trust defines the data subject's (DS) confidence that his or her personal health information is processed and communicated in such a way that privacy and security are guaranteed and the data processing follows regulations, ethical rules, fair information practices, and the DS's personal preferences.

Privacy is a multifaceted, relativistic, and context-dependent concept [8]. It has been defined by Westlin as the "claim of individuals, groups, and institutions to determine for themselves when, how, and to what extent information about them is communicated to others" [9]. This paper focuses on the following privacy dimensions: right of informational self-determination and information privacy including privacy of personal behavior, freedom from surveillance, communication privacy, and data privacy [9-12]. Information privacy refers to a person's self-determination by respecting their wishes and demands regarding collection, processing, and communication of personal information, thereby preventing harm from disclosure.

Both information privacy and trust are related to the conditions demanded or expected in the collection, processing, communication, and use of personal information. Privacy policies, such as a patient's consent statement, explicitly express the DS's privacy requirements, while trust tackles them implicitly. Both privacy and trust relate to the information subject and include knowledge or assumptions about involved entities. Data disclosure means loss of privacy, but an increased level of trustworthiness reduces the need for privacy. The interest of the DS is to minimize loss of privacy at an acceptable level of trust.

Prior Work

In health care, internationally adopted principles and good practice rules—such as The United Nations (UN) Universal Declaration of Human Rights, the Organization for Economic Co-operation and Development (OECD) Guidelines for the Security of Information Systems and Networks, the European Directive 95/46/EC known as the Data Protection Directive (DPD), and ethical guidelines and codes published by The World Medical Association and the International Medical Informatics Association (IMIA)—together approved the high-level frameworks for ethics and privacy protection [13-16]. International standardization organizations are also developing standards targeting secure processing of health information, such as the International Organization for Standardization's (ISO) Health informatics TC 215 standard [17,18]. Wassernaar reported that the following privacy principles are widely used: the principle of existence of privacy, the principle of withholding, the principle of trusted usage, and the principle of controlled dissemination [12]. Langheinrich has proposed the following principles for privacy-aware ubiquitous systems: notice, choice and consent, proximity and locality, anonymity and pseudonymity, security access, and recourse [19]. His first principle, notice, is a subset of the awareness principle. Those documents and proposals stress that high-level policies such as withholding, trusted usage, controlled dissemination, legitimate grounds of processing, responsibilities of data processors, and purpose-based limitation are cornerstones in trusted information processing.

Researchers have recognized weaknesses and challenges in current privacy solutions. Coiera and Clark declared traditional access control systems inefficient because they are not content and context aware [20]. Anciaux et al identified that traditional electronic health records (EHR) have no security guarantee outside the health care service domain [21]. Ruotsalainen has pointed out that the patient has limited rights to control the use of EHRs [22]. Pallapa et al argued that systems using ubiquitous computing have no mechanism for people to reflect their intentions [23]. Mitseva et al noted that protection of privacy in sensor networks must support daily private life [24]. Hu and Weaver called current security and privacy solutions (based on a static role-based access control model) application dependent because they do not address new generations of eHealth requirements [25]. According to Joshi et al, security-based

XSL•FO
RenderX

authentication and role-based approaches are not sufficient in open systems [26]. Kim et al pointed out that informed consent is not possible in environments with a large amount of sensors [27].

New approaches have been proposed. Ball and Gold suggested that the individual should have control of their personal health record (PHR) and should be able to know who has entered which data into the record [28]. Kendall has proposed a patient-controlled EHR for the Information Age [29]. Kim et al recommended that data collection be under the sole control of the patient [27]. Haas et al proposed that the access and disclosure of EHRs be controlled by privacy policies [30]. They also stated that patients must be able to check how principles are implemented. Brown and Adams stated that the access to information should be under the control of the patient or the patient's guardian [31].

New principles and models have also been proposed. Solove pointed out that protection of privacy in the Information Age requires social design and an architectural solution [10]. Shankar et al stated that systems in a ubiquitous environment need dynamic- and context-based trust [32]. Kim et al recommended the use of a security policy that includes the following rules and principles: data collection must be under the sole control of the patient, a principle of disclosure, and principles of limitation and necessity [27]. Bhatti and Bhatti et al have pointed out that existing risks and the lack of common privacy and trust rules, regulations, and norms indicate that dynamic privacy rules are needed to make ubiquitous health care trusted [33,34]. Mandl et al and Huda et al have recommended personally controlled health records [35,36]. Shabo developed models for "patient-held records" with principles of personal control [37]. Coiera and Clarke developed models for e-Consent. One of those models is an active e-Consent system that can act as a gatekeeper [20]. Anonymization is proposed by Huda et al as a privacy tool [36]. Roger-France has developed a model of special gatekeepers that control the use of EHRs [38].

Not only researchers, but also international organizations and governments, have addressed the need for new rules. In a 2010 report to the president of the United States and to Congress, experts noted that current policies, such as the Health Insurance Portability and Accountability Act (HIPAA), leave many details vague. They also stated that tools and technologies are needed to empower individuals to manage their own health and that the definition for a formal privacy model is necessary [39]. The report also argued that current privacy policies and regulations are poorly specified and ineffective, and new mechanisms for trust management are needed. The American Medical Informatics Association (AMIA) has requested that every person have control over their own PHR (ie, all secondary uses of PHR data must be controlled by the person except as required by law) [40].

Although none of the proposal is targeted directly to pervasive health, they have addressed common aspects such as trustworthiness, awareness, and patient-/person-controlled use of the EHR/PHR.

Until now, pervasive health lacks a common definition, and principles—which can make it trusted—do not exist. In this paper, pervasive health is defined as a system. Principles, rules, and policies that guarantee the DS's privacy and information autonomy at the same time and make pervasive health trusted are proposed.

Methods

System analysis focuses on understanding a proposed system, identifying the problems, and recommending improvements. In this paper, "system" is understood as a group of independent elements that act together in a collective effort to achieve a goal. Pervasive health can be seen as a soft system because it involves social and cultural elements. In this study, a five-step system analysis method is used (similar steps can be found in the Soft Systems Methodology) to define pervasive health as a system and to develop privacy principles presented in this paper. The following steps were performed:

1. Defining the system in question (ie, pervasive health)

2. Identifying features and expressing problems of interest (eg, privacy and trustworthiness)

3. Discovering privacy risks and challenges in trustworthiness

4. Building a conceptual model for pervasive health

5. Developing improvements (ie, principles for trusted pervasive health)

Pervasive health is defined using the model (metaphor) of linked digital bubbles. The idea of digital bubbles was originally developed for pervasive environments and personal spaces [41]. A bubble is a digital territory and information walls between bubbles are virtual. A bubble includes one or more systems, their stakeholders, and the environment. Inside a bubble, systems have common privacy regulations and rules. The created high-level graphical model illustrates relations of bubbles in the information space. Features of pervasive health are derived from this model.

A conceptual model for pervasive health is developed using the recommended practice for architectural description of software-intensive systems created by the Institute of Electrical and Electronics Engineers (IEEE). The short name for this standard is IEEE 1471 [42]. Architecture in IEEE 1471 is the fundamental organization (eg, concepts and principles) of a system, its components, and their relationships. Using this method, a graphical framework model that describes trust- and privacy-related concepts and their relationships in pervasive health is developed.

In the final step of system analysis, principles for trusted pervasive health are developed by combining previously defined features of pervasive health, identified risks, selected high-level privacy principles, and their relationships described within the conceptual framework model.

Results

Definition of Pervasive Health

Figure 1 displays the developed graphical model for pervasive health. In this model, the information space is an open and

XSL•FO
RenderX

dynamic environment, which is characterized by the use of ubiquitous computing and by relations between bubbles. Its bubbles can be dynamically linked together, and information collecting and processing is poorly regulated (eg, privacy rules in bubbles are often unknown). In the case where a bubble includes many systems, they can have different business objectives, but they should have the same privacy regulations and rules.

Pervasive health is defined as a dynamic network of bubbles that offers health services to the person. In the information space, the person (DS) creates dynamically personal health networks and selects both systems that belong to the network and services used. The DS also defines what information is shared between bubbles and their systems. This means that pervasive health is a controlled (cybernetic) meta-system in the information space.

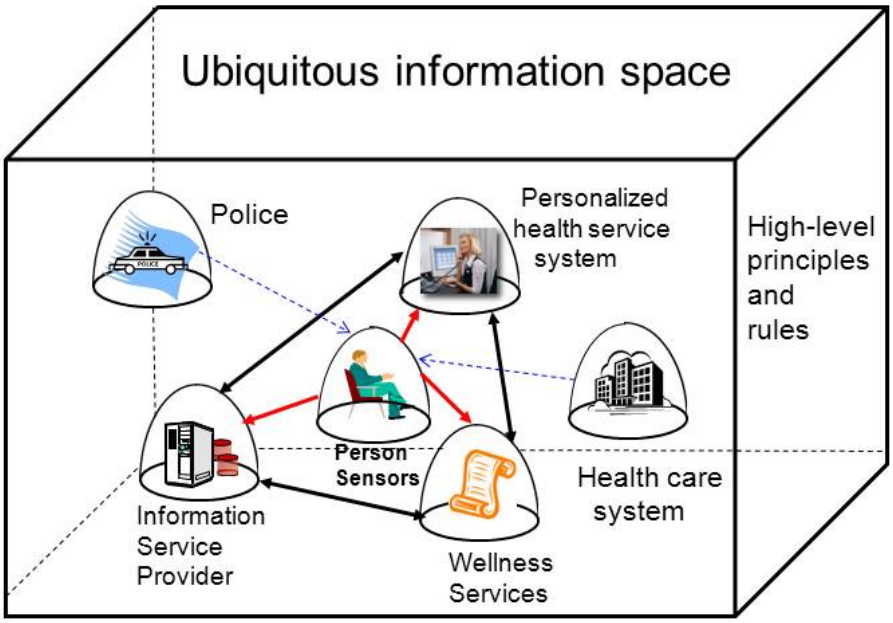
The current health care system can be understood as a bubble where public and private service providers offer health care services. In principle, those health care services which the DS uses outside the controlled health care environment can be part of the DS's pervasive health. Even so, the DS controls the use of those services and related data processing, except as required by law.

Despite the technology used and the available information, health care services are still defined, provided, and controlled by health professionals targeting the patient [4]. Contrary to this, services of pervasive health and related data processing are controlled by the DS and the target is a person who can select, tailor, and combine autonomously their own health service portfolio with the help of intelligent services of the network.

In health care, security and privacy rules are regulated by domain-specific laws and norms, which is not the case in pervasive health. Furthermore, in pervasive health personal health data is not stored in institutionalized EHRs as we will discuss subsequently.

In the information space are also other systems which are not members of the DS's pervasive health network, but which are interested in using DS's health information (Figure 1). Those systems are called secondary users.

Figure 1. Pervasive health in the information space.



Information Processing and Storing in Pervasive Health

In the information space and in pervasive health, autonomous programs and computer systems can collect and process personal information invisible to the DS [19]. In pervasive health, both the information content and how it is collected, processed, and stored differ radically from current practice in health care. In the latter, patient data is recorded and used by health care professionals and typically managed by a service provider

XSL•FO
RenderX

organization in the form of the EHR [43]. In health care, the EHR can be used by professionals participating in the care of an individual, or by entities for purposes defined in legislation [22].

In pervasive health, those rules do not apply and health care-specific legislation will not regulate how health data is processed. In pervasive health, any kind of personal information (including behaviors and social activities) covering the person's entire life is collected and processed. The use of health data is not limited to patient care, treatments, public health, or clinical research. Systems of pervasive health can process and exchange personal health information using their own rules. The data content coming from multiple sources exceeds what is used in current health care (and what EHRs contain). The authors use the term "lifelong personal wellness record" (LPWR) for this information. Personal health record (PHR) is an alternative term. Unfortunately, there is no consensus about the concept of a PHR, and some writers see it as an extension of the regulated EHR [44]. Another proposal is that the PHR and the EHR should be integrated [45]. In this paper, the LPWR is defined as an independent repository, and the authors claim that the legal EHR does not replace either the PHR or the LPWR [46].

Privacy Threats in Ubiquitous Computing and in Pervasive Health

The information space and ubiquitous computing generate many privacy threats. The following are typical as stated in the literature [10,35,47]:

- Multiple systems and authorities can collect, process, and share personal information. Their number is unknown in advance and it changes regularly [20].
- There is no predefined trust between systems.
- Information can be collected, processed, and shared in such a way that the DS cannot be aware of it.
- Rich contextual metadata is collected and used, both violating the DS's privacy interests.
- Privacy can be breached if authorization is made without contextual information.
- It is difficult (or even impossible) to destroy data stored in the information space.

Pervasive health creates additional trustworthiness and privacy challenges:

- The business objectives, trust features, and regulations systems applied can be unknown.
- It is not possible to know in advance the characteristics, rules, and regulations of secondary users.
- Processing of the LPWR takes place in various contexts (situations).
- Objects of the LPWR can have different, situation-dependent sensitivity.

It is evident that, in pervasive health, the DS should be protected against the previously discussed risks and threats.

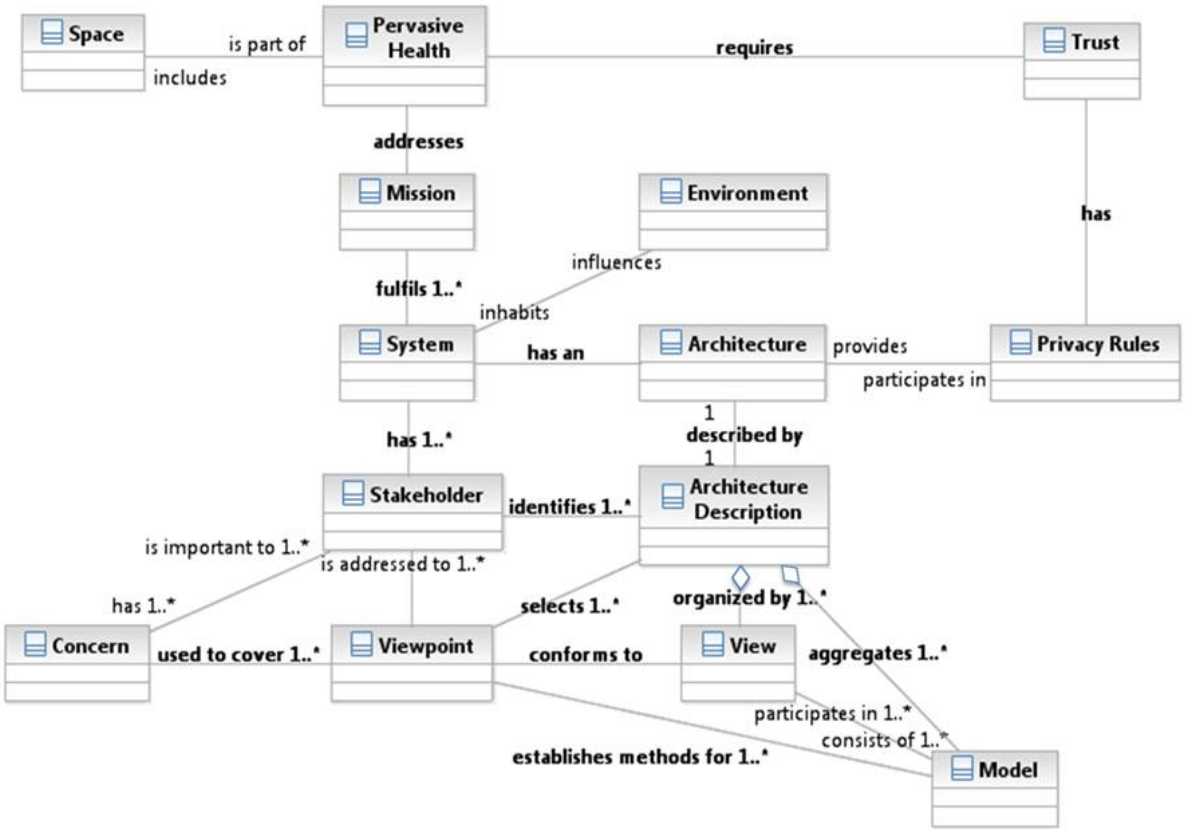
A Conceptual Model for Pervasive Health

The conceptual framework model developed is shown in Figure 2. The model links the key concepts of the authors' approach to pervasive health in the context of the research questions of data processing trustworthiness and information privacy.

Key concepts in the model are information space, pervasive health, trust, systems, stakeholders' interest/concerns, environment, and privacy. Environmental features in the model include regulatory issues. Features of the information space and its systems impact the existing level of trust. To be acceptable and effective, the pervasive health network requires that the level of trust that the DS needs, and what systems and stakeholders offer, be balanced.

XSL•FO
RenderX

Figure 2. Conceptual framework for pervasive health.



Stakeholders and Interests

Typical stakeholders (or actors) in pervasive health are the DS, wellness service providers, and data processing organizations. Stakeholders have different concerns or interests and viewpoints (eg, looking to meeting their business objectives, information availability, and usability). The DS's main interests are benefits of services, trustworthiness, and privacy and information autonomy. Also, conflicting interests can occur. For example, other systems in the information space, which are not members of the pervasive health array, might have interest in the DS's health information [48]. They collect and deploy health information for different kinds of secondary use, as demonstrated in Table 1.

Table 1. Typical primary and secondary uses of health data.

Primary use	Secondary use
Direct care and treatment	Surveillance and continuous monitoring
Disease management	Research and statistics
Medication management	Drug development
Management of physical and social functionality for delaying of their weakening	Public health management
Proactive prediction of patient's health problems and prevention of diseases	Business application development
Management of patient's health status	Hindering behaviors not accepted by controllers (or authorities) or by society in general

Those secondary users are third parties such as public authorities, private organizations, community care providers, public health planners, communication vendors, employers, insurance institutes, researchers, and even homeland security organizations.

Principles for Trusted Pervasive Health

Trustworthiness in pervasive health means that the whole network of systems is trusted; the DS's privacy has been protected; and data is processed ethically, legally, and in line with the rules set by the DS. The resulting principles must offer protection against risks of ubiquitous technologies, facilitate

XSL•FO
RenderX

trustworthiness, and support the DS's information autonomy. As previously mentioned, the fact that there are no predefined common rules for privacy and trustworthiness in pervasive health should be also considered. Becker stated that specification documents, in real life, are unclear, ambiguous, and incomplete [49]. Therefore, principles should be more detailed and implementable than the previously discussed high-level principles.

From those privacy principles, the authors have selected trusted use and controlled dissemination, withholding, transparency, awareness, and the data processor's responsibility together with the principle of context-aware personal privacy as the basis for new principles and rules. This implies that the DS acts as a data controller and determines where, by whom, why, how, in which context, and to what extent, his or her personal health information is used and communicated (ie, the DS can define personal preferences and policies).

The following requirements have been derived from relationships in the framework model (Figure 2):

- All systems should fulfill the mission (ie, trustworthiness and privacy) and, therefore, they should accept common rules.
- Pervasive health requires trust. This implies the need for trust verification.
- Trust needs privacy rules.

The conceptual model also implies that the environment impacts the rules, and systems can use different rules. From the dynamic nature of the information space follows that the DS cannot be informed in advance which secondary users are using the LPWR.

The principles developed (named in this paper as principles for Trusted eHealth and eWelfare Space - ie, THEWS principles) are derived by combining selected principles and identified requirements. The THEWS principles state that the DS shall have the right to [50]:

- Dynamically verify the trustworthiness of the pervasive health network she has created.
- Verify the trustworthiness of any system in the information space that requires or uses the DS's personal health data for secondary purposes.
- Control the processing of personal health information, both inside systems and between them.
- Be aware of all events, situations, and contexts where the DS's health data is collected, processed, stored, and disclosed.
- Define situation-specific, context-aware, and granular personal privacy and trust policies, which regulate how his or her health data is collected, processed, disclosed, shared, stored, or destroyed.

Systems and stakeholders have the responsibility to ensure:

- Trust verification by publishing their privacy policies, environmental, and contextual features.
- Openness of their interest, business needs, and policies as well as their relationships with other systems in the information space.
- Transparency of data processing.

The THEWS principles imply that, in pervasive health, the entity DS is a person without an a priori assigned role as a patient or object of care. The DS should not only be aware of the use of his or her personal health data, but the DS also has to be able to verify trust and to control how data is collected, used, processed, and shared. Tables 2-4 demonstrate how the THEWS principles are related to high-level principles, and against which risks they offer protection.

Advance verification of trust is a prerequisite and it should be seen as a mandatory requirement, as shown in Table 2. For this purpose, all systems in the information space must publish their trust and privacy attributes or, even better, their policies.

Table 2. Principles of trust verification.

Privacy and trust risks[a]	THEWS principle	High-level privacy principle
Unknown stakeholders' business needs, interest, purposes, and policies	Right to use trust verification	
No predefined trust to any system	Mandatory to publish systems' trust parameters and policies	Trusted use of data
Unknown secondary users	Trust level calculation	
Invisible ubiquitous infrastructure	Untrusted systems and users cannot participate in the DS's health network	

[a] in the information space and in pervasive health

More closely, any system that collects health data or processes it shall publish the following information:

- Relevant regulations and ethical rules;
- Identification of all stakeholders who are participating to the data processing;
- Security and privacy features of computer systems and applications that can process the LPWR; and
- Agreements made between the system's stakeholders and other systems.

The principle of context-aware personal policy implies that the DS has the right to define dynamic personal privacy and security policies (thereby setting own privileges and obligations) for all systems and stakeholders regarding the collection, processing, and disclosure of its health data, as shown in Table 3. The DS

XSL•FO
RenderX

can also define to what extent the content of the LPWR can be accessed by third parties and deployed for secondary uses. This principle is close to the theory of individual preference [49]. The principle of withholding is one dimension of the personal policy. Withholding means that the DS can modify, update, and delete any object in his or her LPWR at any time and from any place. Also, the "principle of acceptable reason" used in health care is part of the personal policy.

In pervasive health, the DS defines which reasons are acceptable for a situation in question. Therefore, reasons are a part of the policy. The DS's policy defines contexts and situations where the data can be processed; there is no necessity to use a separate concept of relationship (ie, the patient–doctor relationship). Furthermore, the "need to know" principle used in health care is not needed because permissions to use data are defined in the personal policy. The proposed model of personal policy also supports the following widely accepted privacy features: limitations of access, secrecy, control over personal information, personhood, and intimacy. Policies can be used to trigger situation-dependent acts such as anonymization of data and federation of access control. The principle of controlled data creation, processing, and disclosure is old. The new feature is that the DS's control is dynamic, context-aware, and linked to awareness and verification services.

In pervasive health, need for transparency is not limited to the processing of the LPWR, as shown in Table 4. It covers situations where data is collected or used as well as all contextual metadata. Furthermore, transparency means that a person should be aware of regulations, security features, and policies of systems and the organizations and computer applications that process, request, disclose, store, or destroy the DS's health data.

Awareness covers activities such as browsing, mining and drilling, linking, and merging data at the granular level. Finally, the DS should be aware of all events where a conflict between his or her personal policy and the stakeholders' policy exists.

The THEWS principles are a paradigm shift from traditional static protection and risk-based thinking to dynamic management of trust and privacy. The principles offer new rights and power to the DS and, therefore, empower the DS's information autonomy. The principles also set new responsibilities to systems in the information space.

Table 3. Principles of personal policies.

Privacy and trust risks[a]	THEWS principle	High-level privacy principle
The DS cannot control what health data is collected and by whom	Personal dynamic context-aware policies rule the collection, processing, storing, sharing, and destroying of data	Right to control the use of data
The DS cannot control the use of the LPWR and its metadata	Possibility to control any secondary use of the LPWR and its metadata	
No control over data linking, unknown secondary use of data, and the information space has unlimited memory	Policy defines rules for data linking and destroying as well as situations where the LPWR can be processed	Withholding

[a] in the information space and in pervasive health

Table 4. Principles of awareness.

Privacy and trust risks[a]	THEWS principle	High-level privacy principle
Invisible data collection, processing, preservation, and sharing	Awareness and transparency is defined by the DS's policy	
No need to inform the DS the level of trust and of relations between systems	Stakeholders and systems shall publish their trust parameters and relations to other systems	Transparency
No need to notify the DS of policy conflicts	Notification of conflicting interest and policies	

[a] in the information space and in pervasive health

Discussion

In this paper, pervasive health is defined as a system that takes part in the information space. The trustworthiness and privacy challenges of pervasive health are analyzed. A conceptual model is built, and principles and rules, which can make pervasive health trustworthy, are proposed. Principles give the DS the right to use personal polices and the right to verify trust. Full transparency and awareness give the DS power that currently does not exist. The THEWS principles protect the DS's health information against new, fast-developing technologies such as data mining, drilling, and browsing as well as against multidimensional profiling and re-identification. The use of dynamic policies makes it possible to balance on-the-fly access requester's purposes and the DS's personal preferences and policies. The authors' solution falls in line with modern policy and context-enabled security and privacy protection models developed for ubiquitous data processing [51].

The model of personal polices means that every person can have their own dynamic and context-dependent policies. This makes it difficult to manage policies and to automatically resolve their conflicts. A solution to this problem is the use of common

XSL•FO
RenderX

privacy ontology and terminology. On that basis, it is possible to develop a set of policy profiles from where the DS can select the most suitable. It is also possible to allow the DS to simulate different policies and their impacts in advance. Policy conflicts between personal and local policies can be solved with the help of negotiation and conflict resolution services. A challenge is how the DS can make informed decisions to balance personal benefits with privacy and trust needs. One solution to this problem is the use of a software mediator between the DS and the access requestor or the health service provider [27].

A political challenge is getting the THEWS principles accepted by companies, governments, and health care organizations. The idea that the whole LPWR is under personal control of the DS in all situations may not be accepted by all stakeholders and systems automatically. Reasons for this include that it will make ICT systems expensive, complicated, and difficult to develop; it can cause problems for proactive prevention and make public health monitoring difficult; and it restricts governments' and bureaucrats' ability to monitor and control peoples' lifestyle and unwanted behaviors [19]. The THEWS principles also strengthen the person's autonomy and weaken common paternalism of current health care. Therefore, some health professionals will be resistant to these principles.

It is unclear whether all data subjects have reasonable interest or capacity to manage their personal security and privacy policies actively, or if some people will need a personal trust assistant to work on their behalf. From the regulatory viewpoint, there is a need to balance personal privacy and information autonomy against other interests and values, such as public and business benefits and secondary use of health data. New privacy regulations are also essential to trusted information space [52,53].

Implementing the THEWS principles requires services that do not exist currently. Both new infrastructural privacy services and a new data model for the LPWR are needed. The developed principles should be validated after implementation and their accuracy and usability should be analyzed.

Acknowledgments

Results presented in this paper are based on findings of the THEWS project (Trusted eHealth and eWelfare Space). The project is supported by the Finnish Academy during 2009-2012 via the MOTIVE research program.

Conflicts of Interest

None declared

References

1. Vogenberg FR, Barash CI, Pursel M. Personalized Medicine: Part 1: Evolution and Development into Theranostics. P&T 35 2010 Oct;35(10):560-576. [Medline: 21037908]
2. Kiefer S. European Commission Information Society. 2007. Personal Health Systems (PHS): Overview and research trends URL: http://ec.europa.eu/information_society/events/phs_2007/docs/slides/phs2007-kiefer-s1a.pdf [accessed 2012-03-19] [WebCite Cache ID 66HaxmDUN]
3. Bardram JE. Pervasive healthcare as a scientific discipline. Methods Inf Med 2008;47(3):178-185. [doi: 10.3423/ME9197] [Medline: 18473081]
4. Arnrich B, Mayora O, Bardram J, Tröster G. Pervasive healthcare: Paving the way for a pervasive, user-centered and preventive healthcare model. Methods Inf Med 2010;49(1):67-73. [doi: 10.3414/ME09-02-0044] [Medline: 20011810]
5. Varchney U. Pervasive healthcare. Computer 2003;36(12):138-140. [doi: 10.1109/MC.2003.1250897]
6. Codagnone C. European Commission Information Society. 2009 Aug. Reconstructing the whole: Present and future of personal health systems URL: http://ec.europa.eu/information_society/activities/health/docs/projects/phs2020/phs2020-book-rev16082009.pdf [accessed 2012-03-19] [WebCite Cache ID 66HaL4Eds]
7. Wanigasekera C, Feigenbaum J. Sensitive information in a wired world course (CS457). Newhaven, CT: Yale University; 2003 Dec 12. Trusted systems: Protecting sensitive information through technological solutions URL: http://zoo.cs.yale.edu/classes/cs457/backup/ [accessed 2012-01-27] [WebCite Cache ID 650H14LTe]
8. Lederer S, Deay AK, Mankoff J. UC Berkeley College of Engineering Technical Reports. Berkeley, CA: Computer Science Division, University of California; 2002 Jun. A conceptual model and metaphor of everyday privacy in ubiquitous computing environments URL: http://www.eecs.berkeley.edu/Pubs/TechRpts/2002/CSD-02-1188.pdf [accessed 2012-03-19] [WebCite Cache ID 66HZyp9vK]
9. Westin AF. Social and political dimensions of privacy. Journal of Social Issues 2003 Jul;59(2):431-453.
10. Solove D. The Digital Person: Technology and Privacy in the Information Age. New York, NY: New York University Press; 2004.
11. Wohlgemuth S, Muller G. Privacy with delegation of rights by identity management. In: Emerging Trends in Information and Communication Security Lecture Notes in Computer Science, 2006. Germany: Springler Verlang; 2006:175-190.
12. Wassernaar J. www.w3.org. 2006. Privacy rules, a steeple chase for systems architects URL: http://www.w3.org/2006/07/privacy-ws/papers/04-borking-rules/ [accessed 2012-01-27] [WebCite Cache ID 650I5cGMn]

XSL•FO
RenderX

13. European Commission. European Commission Justice Data Protection Policies. 1995. Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data URL: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31995L0046:EN:HTML [accessed 2012-01-27] [WebCite Cache ID 650KVEhUK]
14. United Nations. Geneva, Switzerland: United Nations; 2007. Universal Declaration of Human Rights URL: http://www.un.org/events/humanrights/2007/hrphotos/declaration%20_eng.pdf [accessed 2012-03-19] [WebCite Cache ID 66HYMvMaH]
15. Organisation for Economic Co-operation and Development (OECD). 2002. OECD guidelines for the security of information systems and networks: Towards a culture of security URL: http://www.oecd.org/dataoecd/16/22/15582260.pdf [accessed 2012-01-27] [WebCite Cache ID 650MSPyWi]
16. International Medical Informatics Association (IMIA). International Medical Informatics Association.: IMIA The IMIA Code of Ethics for Health Information Professionals URL: http://www.imia-medinfo.org/new2/pubdocs/Ethics_Eng.pdf [accessed 2012-01-27] [WebCite Cache ID 650N2Zm60]
17. International Organization for Standardization (ISO). ISO/IEC 27799 Health Informatics-Information Security Management in Health Using ISO/IEC 27002. Geneva, Switzerland: ISO; 2008.
18. International Organization for Standardization (ISO). ISO TS 22600 Health Informatics-Privilege Management and Access Control. Geneva, Switzerland: ISO; 2009.
19. Langheimreich M. Swiss Federal Institute of Technology Zurich. Zurich, Switzerland: Swiss Federal Institute of Technology (ETH) Privacy by design: Principles of privacy-aware ubiquitous systems URL: http://www.vs.inf.ethz.ch/res/papers/privacy-principles.pdf [accessed 2012-03-27] [WebCite Cache ID 66U0efwZR]
20. Coiera E, Clarke R. e-Consent: The design and implementation of consumer consent mechanisms in an electronic environment. J Am Med Inform Assoc 2004 Apr;11(2):129-140 [FREE Full text] [doi: 10.1197/jamia.M1480] [Medline: 14662803]
21. Anciaux N, Benzine M, Bouganim L, Jacquemin L, Pucheral P, Yin S. Restoring the patient control over her medical history. In: 21st IEEE Symposium on Computer-based Medical Systems. Los Alamitos, CA: IEEE Computer Society Press; 2008:132-137.
22. Ruotsalainen P. Security infrastructure services for patient managed lifelong health record. In: Travel Health Informatics and Telehealth: EFMI Special Topic Conference, Antalya, Turkey, 2009. Istanbul, Turkey: Victor Babes University Publishing House; 2009:51-29.
23. Pallapa G, Kumar M, Das K. Privacy infusion in ubiquitous computing, networking and services. In: Proceedings of MobiQuitous 2007. 2007 Presented at: MobiQuitous 2007; August 6-10, 2007; Philadelphia, PA. [doi: 10.1109/MoBIQ.2007.4451030]
24. Mitseva A, Wardana SA, Pradad NR. Context-aware privacy protection for wireless sensor networks in hybrid hierarchical architecture. In: Proceedings of International Wireless Communications and Mobile Computing 2008 Conference.: IEEE; 2008 Presented at: 2008 International Wireless Communications and Mobile Computing Conference; August 6-8, 2008; Crete Island, Greece. [doi: 10.1109/IWCMC.2008.134]
25. Hu J, Weaver AC. Pervasive Security, Privacy and Trust (PSPT4), August 2005. 2005. Dynamic, context-aware access control for distributed healthcare applications URL: http://www.cs.virginia.edu/~acw/security/doc/Publications/A%20Dynamic,%20Context-Aware%20Security%20Infrastructure% 20for%20Distri~1.pdf [accessed 2012-03-19] [WebCite Cache ID 66HVhI3rd]
26. Joshi A, Finin T, Kagal L, Parker J, Patwardhan A. Security policies and trust in ubiquitous computing. Philos Transact A Math Phys Eng Sci 2008 Oct 28;366(1881):3769-3780 [FREE Full text] [doi: 10.1098/rsta.2008.0142] [Medline: 18672450]
27. Stajano F, Kim HJ, Chae J, Kim S. Towards a security policy for ubiquitous healthcare systems (Position paper). In: Ubiquitous Convergence Technology First International Conference, ICUCT 2006, Jeju Island, Korea, December 5-6, 2006: revised selected papers. Berlin, Germany: Springer; 2007.
28. Ball MJ, Gold J. Banking on health: Personal records and information exchange. J Healthcare Inf Management 2006;20(2):71-83. [Medline: 16669591]
29. Kendall DB. Harvard Law and Policy Review. Protecting patient privacy in the information age URL: http://www.hlpronline.com/kendall.pdf [accessed 2012-03-19] [WebCite Cache ID 66HVTSzjj]
30. Haas S, Wohlgemuth S, Echizen I, Sonehara N, Müller G. Aspects of privacy for electronic health records. Int J Med Inform 2011 Feb;80(2):e26-e31. [doi: 10.1016/j.ijmedinf.2010.10.001] [Medline: 21041113]
31. Brown I, Adams AA. The ethical challenges of ubiquitous healthcare. International Review of Information Ethics 2007;8:53-60 [FREE Full text]
32. Shankar N, Balfanz D. Enabling secure ad-hoc communication using context-aware security services. In: Proceedings of UBICOMP 2002-Workshop on Security in Ubiquitous Computing. 2002 Presented at: UBICOMP 2002; 2002; Gothenburg, Sweden URL: http://www.teco.edu/~philip/ubicomp2002ws/organize
33. Bhatti R. X-GTRBAC: An XML-based policy specification framework and architecture for enterprise-wide access control. ACM Transactions on Information and System Security 2005;8(2):187-227. [doi: 10.1145/1065545.1065547]
34. Bhatti R, Moidu K, Ghafoor A. Policy-based security management for federated healthcare databases (or RHIOs). In: HIKM '06 Proceedings of the International Workshop on Healthcare Information and Knowledge Management. New York, NY: ACM; 2006.

XSL•FO
RenderX

35. Mandl KD, Simons WW, Crawford WC, Abbett JM. Indivo: a personally controlled health record for health information exchange and communication. BMC Med Inform Decision Making 2007;7(25) [FREE Full text] [doi: 10.1186/1472-6947-7-25] [Medline: 17850667]
36. Huda MN, Sonehara N, Yamada S. Journal of Engineering Science and Technology (JESTEC). 2009. A privacy management architecture for patient-controlled personal health record systems URL: http://jestec.taylors.edu.my/Vol%25204%2520Issue%25202%2520June%252009/Vol_4_2_154-170_MD_NURUL_HUDA.pdf [accessed 2012-03-19] [WebCite Cache ID 66HUH8rwr]
37. Shabo A. A global socio-economic-medico-legal model for the sustainability of longitudinal electronic health records. Part 1. Methods Inf Med 2006;45(3):240-245. [Medline: 16685331]
38. France F. eHealth in Belgium, a new "secure" federal network: role of patients, health professions and social security services. Int J Med Inform 2011 Feb;80(2):e12-e16. [doi: 10.1016/j.ijmedinf.2010.10.005] [Medline: 21035383]
39. President's Council of Advisors on Science and Technology (PCAST). The White House. Washington, DC; 2010 Dec. Report to the President and Congress: Designing a digital future: Federally funded research and development in networking and information technology URL: http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-nitrd-report-2010.pdf [accessed 2012-03-19] [WebCite Cache ID 66HipPled]
40. American Health Information Management Association and American Medical Informatics Association. The value of personal health records: A joint position statement for consumers of health care. In: Bos L, Blobel B, Marsh A, Carroll D, editors. Medical and Care Compunetics 5 (Technology and Informatics). Amsterdam, Netherlands: IOS Press; 2008.
41. Kapadia A, Henderson T, Fielding JJ, Kotz D. Virtual walls: Protecting privacy in pervasive environments. In: Proceedings Pervasive Computing, 5th International Conference, PERVASIVE 2007. Berlin: Springler Verlag; 2007 Presented at: The 5th International Conference on Pervasive Computing; May 13-16, 2007; Toronto, Ontario. [doi: 10.1007/978-3-540-72037-9_10]
42. Institute of Electrical and Electronics Engineers (IEEE) Computer Society. IEEE Standard 1471-2000: Recommended Practice for Architectural Description of Software-Intensive Systems. Piscataway, NJ: IEEE; 2000.
43. National Electronic Health Records Taskforce, Commonwealth of Australia. A health information network for Australia. In: Report to Health Ministers by the National Electronic Health Records Taskforce. Australia: Minister of Health; 2000.
44. US Department of Health and Human Services. National Committee on Vital and Health Statistics. 2006. Personal health records and personal health record systems: A report and recommendations from the National Committee on Vital and Health Statistics URL: http://ncvhs.hhs.gov/0602nhiirpt.pdf [accessed 2012-03-19] [WebCite Cache ID 66HRqyKAr]
45. Tang PC, Ash JS, Bates DW, Overhage JM, Sands DZ. Personal health records: definitions, benefits, and strategies for overcoming barriers to adoption. J Am Med Inform Assoc 2006;13(2):121-126 [FREE Full text] [doi: 10.1197/jamia.M2025] [Medline: 16357345]
46. Detmer D, Bloomrosen M, Raymond B, Tang P. Integrated personal health records: transformative tools for consumer-centric care. BMC Med Inform Decis Mak 2008;8:45 [FREE Full text] [doi: 10.1186/1472-6947-8-45] [Medline: 18837999]
47. Samarati P, Bertino E, Jajodia S. An authorisation model for distributed hypertext system. IEEE Transactions on Knowledge and Data Engineering 1996;8(4):555-562. [doi: 10.1109/69.536249]
48. Safran C, Bloomrosen M, Hammond WE, Labkoff S, Markel-Fox S, Tang PC, Expert Panel. Toward a national framework for the secondary use of health data: an American Medical Informatics Association White Paper. J Am Med Inform Assoc 2007;14(1):1-9 [FREE Full text] [doi: 10.1197/jamia.M2273] [Medline: 17077452]
49. Becker MY. A formal security policy for an NHS electronic health record service. In: University of Cambridge, Technical Report number 628, March 2005. London, UK: University of Cambridge; Mar 01, 2005.
50. Ruotsalainen P, Blobel B, Nykänen P, Seppälä A, Sorvari H. Framework model and principles for trusted information sharing in pervasive health. Stud Health Technol Inform 2011;169:497-501. [Medline: 21893799]
51. Blobel B, Nordberg R, Davis JM, Pharow P. Modelling privilege management and access control. Int J Med Inform 2006 Aug;75(8):597-623. [doi: 10.1016/j.ijmedinf.2005.08.010] [Medline: 16199198]
52. European Commission. Brussels, Belgium: European Commission; 2010 Apr 11. Communication from the Commission to the European parliament, the council, the economic and social committee and the committee of the regions: A comprehensive approach on personal data protection in the European Union URL: http://ec.europa.eu/justice/news/consulting_public/0006/com_2010_609_en.pdf [accessed 2012-03-27] [WebCite Cache ID 66U8qB7LI]
53. Hussain S, Yang LT, Laforest F, Verdier C. Pervasive health care services and technologies. Int J Telemed Appl 2008;946082 [FREE Full text] [doi: 10.1155/2008/946082] [Medline: 18825271]

Abbreviations

AMIA: American Medical Informatics Association
DPD: Data Protection Directive
DS: data subject
EHR: electronic health records
HIPAA: the Health Insurance Portability and Accountability Act

XSL•FO
RenderX

ICT: information and communication technologies
LPWR: lifelong personal wellness record
OECD: Organization for Economic Co-operation and Development
PHR: personal health record
PHS: personal health systems
THEWS: Trusted eHealth and eWelfare Space
UN: United Nations
WHO: World Health Organization

Edited by G Eysenbach; submitted 25.10.11; peer-reviewed by S Koch, P Chhanabhai; comments to author 16.11.11; revised version received 02.02.12; accepted 09.03.12; published 06.04.12.

Please cite as:
Ruotsalainen PS, Blobel BG, Seppälä AV, Sorvari HO, Nykänen PA
A Conceptual Framework and Principles for Trusted Pervasive Health
J Med Internet Res 2012;14(2):e52
URL: http://www.jmir.org/2012/2/e52/
doi:10.2196/jmir.1972
PMID:22481297

©Pekka Sakari Ruotsalainen, Bernd Gerhard Blobel, Antto Veikko Seppälä, Hannu Olavi Sorvari, Pirkko Anneli Nykänen. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 06.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Analysis of eHealth Search Perspectives Among Female College Students in the Health Professions Using Q Methodology

Michael Stellefson[1], PhD; Bruce Hanik[2], PhD; J. Don Chaney[1], PhD; Bethany Tennant[1]

[1]Center for Digital Health and Wellness, Department of Health Education and Behavior, University of Florida, Gainesville, FL, United States

[2]Office of Health Informatics, Department of Health and Kinesiology, Texas A&M University, College Station, TX, United States

Corresponding Author:
Michael Stellefson, PhD
Center for Digital Health and Wellness
Department of Health Education and Behavior
University of Florida
P.O. Box 118210
Gainesville, FL, 32611
United States
Phone: 1 352 294 1805
Fax: 1 352 392 1909
Email: mstellefson@ufl.edu

Abstract

Background: The current "Millennial Generation" of college students majoring in the health professions has unprecedented access to the Internet. Although some research has been initiated among medical professionals to investigate the cognitive basis for health information searches on the Internet, little is known about Internet search practices among health and medical professional students.

Objective: To systematically identify health professional college student perspectives of personal eHealth search practices.

Methods: Q methodology was used to examine subjective perspectives regarding personal eHealth search practices among allied health students majoring in a health education degree program. Thirteen (n = 13) undergraduate students were interviewed about their attitudes and experiences conducting eHealth searches. From the interviews, 36 statements were used in a structured ranking task to identify clusters and determine which specific perceptions of eHealth search practices discriminated students into different groups. Scores on an objective measure of eHealth literacy were used to help categorize participant perspectives.

Results: Q-technique factor analysis of the rankings identified 3 clusters of respondents with differing views on eHealth searches that generally coincided with participants' objective eHealth literacy scores. The proficient resourceful students (pattern/structure coefficient range 0.56-0.80) described themselves as using multiple resources to obtain eHealth information, as opposed to simply relying on Internet search engines. The intermediate reluctant students (pattern/structure coefficient range 0.75-0.90) reported engaging only Internet search engines to locate eHealth information, citing undeveloped evaluation skills when considering sources of information located on the Internet. Both groups of advanced students reported not knowing how to use Boolean operators to conduct Internet health searches. The basic hubristic students (pattern/structure coefficient range 0.54-0.76) described themselves as independent procrastinators when searching for eHealth information. Interestingly, basic hubristic students represented the only cluster of participants to describe themselves as (1) having received instruction on using the Internet to conduct eHealth searches, and (2) possessing relative confidence when completing a search task.

Conclusions: Subjective perspectives of eHealth search practices differed among students possessing different levels of eHealth literacy. These multiple perspectives present both challenges and opportunities for empowering college students in the health professions to use the Internet to obtain and appraise evidence-based health information using the Internet.

(J Med Internet Res 2012;14(2):e60) doi:10.2196/jmir.1969

KEYWORDS

eHealth literacy; college students; Q methodology; Internet search; health professionals; medical education

XSL•FO
RenderX

Introduction

The Internet continues to be widely used to facilitate research and learning for health and medical information. Eight out of 10 Internet users look online for health information, making it the third most popular Web activity next to checking email and using search engines [1]. The pervasiveness of the Internet and the continued evolution of devices that employ Web-based technologies makes obtaining, processing, and understanding health information a critical competency area for medical professionals in training. Among medical professionals around the world, mobile information and communication technologies (eg, smartphones, iPads, and notebook computers) enable frequent Web 2.0 searches for health information [2-5]. Recent studies have highlighted limitations in measuring and evaluating the interchangeable and interrelated skills necessary for information gathering in the highly social Web 2.0 environment [6-8]. The ability to conduct an effective Internet search to locate health information is particularly important for health and medical professional students who represent an especially "plugged in" subgroup of the future public health workforce. Approximately 76% of college students use the Internet frequently for research or homework, while 86% report spending at least some time on social networking sites each week [9]. Given the wealth of health and medical information that exists on the Internet, implementing evidence-based health and medical Internet searches becomes far more complex than simply entering a medical condition or health term into an Internet search engine (eg, Google or Bing) and clicking on the most prominent search result within the selected Web browser.

Obtaining health information using the Internet involves a variety of competencies that health information seekers generally lack [10,11], such as: (1) conducting both basic and advanced information searches; (2) applying Boolean operators to limit Internet search results; (3) differentiating between scholarly documents, authoritative sources, periodicals, and primary versus secondary sources of health information; and (4) comprehending ambiguous eHealth terminology.

Increasingly, health and medical professionals must use at least basic eHealth literacy skills to perform their job-related responsibilities [4,5]. "eHealth literacy" refers to the ability of individuals to seek, understand, and evaluate health information from electronic resources and apply such knowledge to addressing or solving a health problem [12]. The construct reflects the composite of both analytic and context-specific skills that require cognitive-behavioral capabilities to work with technology, critically think about issues of media and science, and navigate through online decision-making resources. The literature has established the need to begin unraveling the basis for cognitive Internet search tasks among medical professionals, especially tasks that may be repeated over long periods of time [4,5,13]. Medical professionals are aware of the need to make evidence-based decisions using eHealth resources [4]; yet, they rarely make evaluative judgments regarding the sources of health and/or medical information they are consuming and habitually visit websites that are perceived to represent high levels of information quality, where cognitive authority is presumed to be high [13].

College students who are professionally trained in the health and medical professions should be taught the knowledge and skills necessary to conduct advanced eHealth information searches on the Internet. These search tasks are complemented by critical appraisals of both the information content and source [14]. The medical education community has recognized the important responsibility of fostering the use of eHealth technologies among future health professionals who will continue to work in the Internet age [15]. Although college students do not encounter the environmental, physical, and resource-related barriers associated with surfing the Internet [8], this population still reports an inability to find desired materials in the digital age [16]. Recent investigations have examined eHealth literacy among college students [14,17]. Stellefson and colleagues [14] conducted a systematic literature review of studies assessing eHealth literacy among college students and found that college students generally lack eHealth literacy skills. Few studies have examined the unique patterns and underlying reasons for college students' health information search behaviors on the Internet [18], which has led to an incomplete understanding of these tasks. The limited current understanding of eHealth literacy is especially disconcerting when considering the importance of Internet search capabilities among young people studying to become future health and medical professionals.

Hanik and Stellefson [17] attempted to fill the gap in this literature by investigating perceived and actual eHealth literacy among undergraduate health education students studying to become allied health professionals. Participants were asked to complete the Research Readiness Self-Assessment-Health (RRSA-h) [19] online assessment, which measures knowledge/skill sets necessary for performing eHealth searches on specific health and medical topics. The multi-part eHealth search task was operationally defined as: (1) making a determination into possible sources of quality health information; (2) conducting an actual health information search on the Internet; (3) evaluating the quality of the health information retrieved; and (4) answering questions following the analysis of health information that was located and evaluated. A total of 77 undergraduate students (88% female) completed this online assessment and earned subpar actual eHealth literacy test scores (mean overall ability score = 42.6%) [17] as compared to results from a previous study in a similar population [19]. However, it was noted that more advanced students (eg, juniors and seniors) had higher overall eHealth literacy than their younger counterparts did. Although the more senior level students exhibited higher levels of eHealth literacy, it could not be determined whether specific eHealth search attributes were qualitatively different among students possessing high versus low eHealth literacy. It was determined, however, that actual eHealth literacy was markedly inferior to ratings of perceived eHealth literacy [17].

In light of these preliminary research findings, it is important to better understand how personal eHealth search practices are perceived among health and medical professional students. These insights may provide a context for determining the types of characteristics that predict and explain eHealth literacy achievement within this population. The purpose of the current

XSL•FO
RenderX

research study was to systematically identify health professional college student perspectives of eHealth search practices. The current study addressed three research questions in hopes of achieving this research aim:

1. How many clusters of health professional college students exist, given information about perceptions of personal eHealth search practices?

2. Which college students belong to the eHealth search clusters that emerge?

3. Which specific perceptions of personal eHealth search practices provide the basis for differentiating the clusters that emerge?

Methods

To systematically identify health professional college students' perspectives of their own eHealth search practices, Q methodology [20] was employed. The Q method is a systematic way to study subjectivity and it can be used to reveal various social perspectives that exist on a given topic [20-22]. The Q method fits under the broad umbrella of discourse analysis techniques, which constitutes a large category of research methods that systematically analyzes text-based statements in order to determine underlying patterns or meaning [22]. Within this analysis, individuals are clustered into different typologies based on how they describe themselves [23]. This method of inquiry can provide exceptional insight into how many types of people there are, which people belong to different groups, and which particular variables best differentiate types of people [24]. It also enables researchers to systematically explore a variety of perspectives about an issue to identify important areas that may overlap or differ among unique populations [25]. This methodology has been applied in various disciplines including general nursing research [26], clinical decision making among nurses [27,28], and health care informatics [29].

In Q-method research, participants are the independent variables and the text-based statements they are asked to evaluate are the subject of analysis. Participants are asked to systematically order (or "Q sort") text-based statements presented to them according to how those statements fit into their own belief system regarding how they believe themselves to be. After participants sort the text-based statements presented to them, the Q method seeks to identify patterns embedded within the Q sorts completed by different participants. Any existing patterns suggest intersubjective orderings of beliefs shared among participants, thus revealing social perspectives [22]. This research technique is valuable because it capitalizes on the strengths of both qualitative and quantitative research [30,31]. For more on the mechanics of Q methodology, the reader is directed to guideline tutorials published within the health and medical research literature [21,26,29].

In the context of the current study, it was hoped that the Q method would help detect any qualitative patterns within undergraduate health professional students asked to consider beliefs about their own personal eHealth search practices. Specifically, the researchers were interested in whether the intersubjective orderings of eHealth search beliefs were common among participants possessing distinct levels of eHealth literacy (eg, basic, intermediate, and proficient). To facilitate this analysis, the Q study protocol was split into three sequential steps: (1) development of the concourse, (2) facilitating the Q sort procedure, and (3) interpreting data from the Q sorts.

Concourse Development

In Q methodology, a "concourse" is the list of statements that sufficiently represents the "universe of viewpoints" about a topic [32]. To create a concourse of statements made by health professional students regarding attitudes and experiences conducting eHealth searches, a convenience sample of 42 health education majors were recruited from a large research institution in the southwestern United States. Traditional sampling principles and methods used in survey research are not of particular relevance to person sampling in Q methodology; thus, a pragmatic participant selection process was used [29]. Students were asked to respond to a set of statements meant to elicit responses about the students' personal experiences conducting eHealth searches. All statements were based on cognitive-behavioral constructs posited to be relational within the atomic components of thought theory (ACT) [33], which explains skill development as a process of encoding, strengthening, and proceduralizing declarative and procedural knowledge [34]. Declarative knowledge describes what one knows (eg, facts), whereas procedural knowledge describes whether individuals understand "how to" complete tasks. Complex tasks, such as searching for eHealth information on the Internet, can be described as combinations of declarative and procedural knowledge put to work. The 12 open-ended statements that students were asked to respond to represented combinations of declarative and procedural knowledge necessary for locating and evaluating health information on the Internet.

The 12 statements informed by ACT were written on index cards, color coded, and numbered and each student was given corresponding index cards to write open-ended responses to each statement. For example, each student was asked to respond to the statement, "List the source you use most when you search for health information on the Internet." After all participants responded to each statement, 504 unique statements (42 students × 12 statements) were generated. Repetitive responses were removed, and a literature review [14] informed the content validity of the 380 statements that were retained for the final concourse. The statements were edited for grammar and readability only to ensure face validity [26] and were grouped together into broad themes that emerged throughout the concourse by way of a constant comparison analysis [35]. To cultivate a greater sense of the most important concepts reported by participants, the number of times each code emerged (across each theme) was quantified to assess saturation within the statement pool. The four overarching identified themes were (frequency of emergent codes corresponding to each theme specified in parenthesis): educational experiences related to conducting eHealth searches (n = 111), confidence in ability to conduct eHealth searches (n = 99), knowledge about conducting eHealth searches (n = 87), and how students engaged the eHealth search process (n = 83).

XSL•FO
RenderX

Q Sort Procedure

After the final concourse was developed, a subset of 36 representative statements (known as a "Q sample") was selected to provide a miniature depiction of the larger concourse. This practice is suggested when using Fisher's experimental design principles in Q methodology [36]. Each statement was randomly assigned a unique numerical identifier from 1 to 36 in order to reduce the probability that participants would recognize conceptually similar statements and cluster related statements together without cognitively processing each statement separately. Table 1 lists the 36 Q statements.

Table 1. Statements used for participant Q sorts.

Statement #	Statement content
1	I use Web sources that are easy to cite.
2	I rely on search engines (eg Google, Bing) to find health information for research projects.
3	I have been taught how to find reliable health information on the Internet.
4	I have had assignments that required me to evaluate online health information sources.
5	I use up-to-date information for assignments that require me to find health information online.
6	I use the library databases (eg, EBSCO or CSA) when I search for information.
7	I seek help from library staff for difficult Web searches.
8	I get feedback from professors regarding the quality of Web resources I use for homework assignments.
9	I check the ending of Web addresses (eg, .com, .gov, or .edu) when I search for information online.
10	I consider the source of online information when I find useful information for my research projects.
11	I usually have at least one assignment per semester that requires me to conduct a Web search for health information.
12	I brainstorm to help figure out the health information that is important for my project.
13	I know how to critically evaluate online health information sources.
14	I evaluate online health information that I use for projects such as research assignments.
15	I finish research projects, such as papers, at least one week before their due dates.
16	I look for up-to-date online health information when I conduct Web searches.
17	I go to the library when I start a research project.
18	I can figure out how to find information that is unfamiliar to me.
19	I know where to find reliable online health information.
20	When I am assigned to complete a research paper, I do not hand in the first draft as the final product.
21	I use search engines (eg, Google or Bing) when I search for health information online.
22	I get flustered looking for health information I know little or nothing about.
23	I find it difficult understanding new health information found on the Internet.
24	I do not know where to find reliable online health information.
25	I know how to use Boolean operators.
26	I know what is meant by "peer review."
27	I am confident in my ability to find reliable health information online.
28	I use health information that I can easily understand.
29	I know what Boolean operators are.
30	I have difficulty finding information when I use library databases such as EBSCO or CSA.
31	I evaluate health information sources when conducting health information searches on the Internet.
32	I know what a primary source is.
33	I go to my professor for help to make sure I use quality health information for research projects.
34	I follow references back to the original source when I find online research studies/reports that are useful for research assignments.
35	I can find useful sources of health information using the library database.
36	I use refined search parameters to narrow my online health information searches.

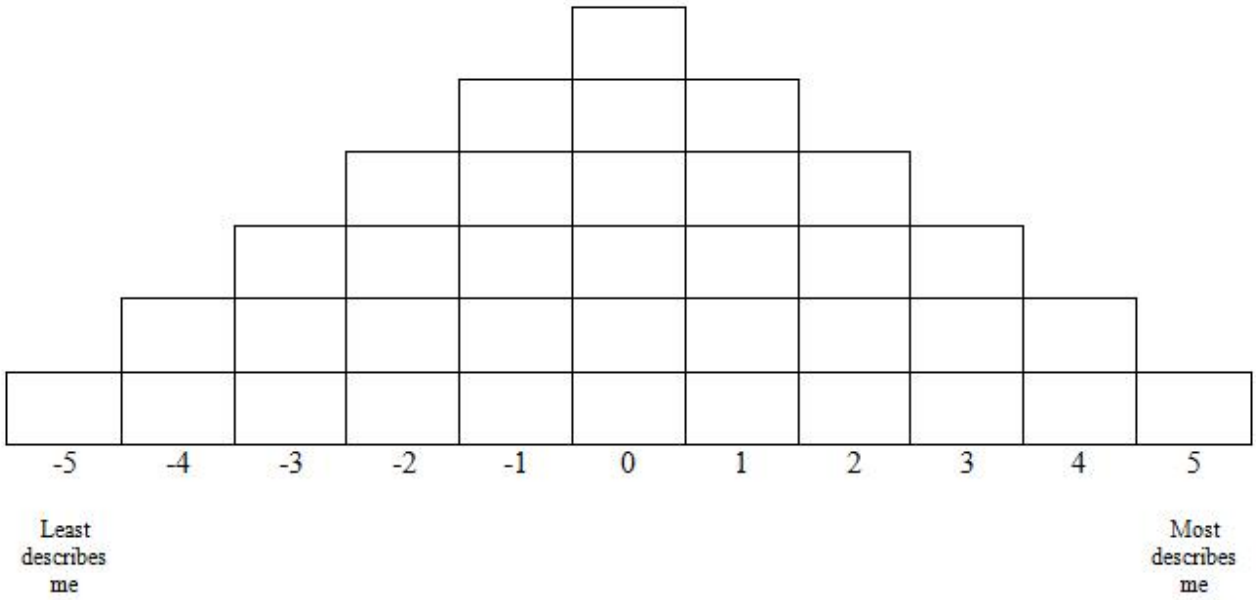
XSL•FO
RenderX

These representative statements were then rank-ordered by the study participants in what is known as a Q sort task. To complete the Q sort, participants were instructed to order the statements according to which statements described them the most and which described them the least when considering their attitudes and experiences conducting eHealth searches. This encouraged participants to sort the cards such that the completed sort would have the shape of a triangle. Columns at both extremes of the triangle possess one card and each column incrementally closer to the center possesses an additional card, with the middlemost column containing 6 cards (thus resembling a quasi-normal distribution). Each participant's Q sort consisted of 11 columns. The leftmost column was assigned a score of –5 (least descriptive) and the rightmost column was assigned a score of +5 (most descriptive). Figure 1 provides a visual illustration of the quasi-normal distribution of each participant's Q sort.

In order to make the overwhelming task of rank-ordering 36 statements more manageable, participants were instructed to read all the statements first to get an impression of the range of statements they were asked to evaluate, and then they were asked to sort the cards into 3 distinct piles: one pile for statement cards that described them the least, one pile for cards that did not describe them at all, and one pile for statement cards that described them the most. Participants were then told to take the cards that were least descriptive and order them according to the pattern depicted in Figure 1, beginning at the leftmost side of the distribution pattern. Once the least descriptive index cards had been sequentially laid out, the same procedure was initiated from the right side of the triangle, this time beginning with the most descriptive index cards. The cards in the neutral pile were assigned to the remaining positions that were left vacant in the middle of the distribution after plotting the least and most descriptive statements. Each participant received instructions for completing this task and completed their individual Q sorts in a room by themselves with no help from others.

Once the ranking task was completed, each card was assigned a score based on the column position it occupied (see Figure 1). For example, if a student assigned Index Card 23 to the second column (from the left), that card would be assigned a score of –4, which would reflect that the student believed she had little difficulty when attempting to understand new health information found on the Internet. The authors entered each participant's rating for each card into a data matrix for analysis.

Figure 1. Final distribution of Q sort procedure (Q sort table).



Participants

To recruit participants to complete the Q sort procedure, personalized emails were sent to a convenience sample of 20 undergraduate health education students who had recently participated in the aforementioned study assessing eHealth literacy among college students [17]. The recruitment email requested participation in what was described as a follow-up study. Emails were sent weekly over the course of approximately one month to solicit participation. Participants were eligible to receive US $10 for participation. The recruitment goal was to secure participation from 18 individuals because the number of participants in a Q study should be less than or equal to one-half the number of Q statements [23]. In Q-method research, the number of participants is not necessarily important; rather, it is important that there exists representation of different viewpoints about the theme of the study [37]. Eligible participants were asked to provide relevant biographical and demographic information upon enrollment in the Q study, such as major, emphasis area, grade point average (GPA), and age.

In Q-method research, factor interpretation frequently involves considering relevant independent variables to determine characteristics that may be shared among clusters of participants [25]. Thus, to further aid in interpreting and defining factors, Q study participants completed the RRSA-h before completing the Q sort, and their scores were recorded [17]. The RRSA-h consists of multiple choice knowledge questions and skill-based

XSL•FO
RenderX

problems that generate an overall actual ability score (score range 0-23). Within the current investigation, the research team used the overall scores from administration of this assessment (mean 18.46 points, SD 4.11) to categorize Q study participants as having basic, intermediate, or proficient eHealth literacy. Students in the basic group were defined as those students scoring at or below the 25th percentile of all scores (ie, ≤ 16 points); the intermediate group was defined as those students scoring within the interquartile range (ie, 17-19 points), and the proficient group was defined as those students scoring at or above the 75th percentile (ie, ≥ 20 points).

Data Analysis

Data from participants' Q sorts of the 36 statements were analyzed using Q-technique exploratory factor analysis (EFA) [21]. This analytical technique clusters individuals into "types" and provides quantitative data that describes the similarities of participants using correlations between the individual Q sorts completed by participants [23,29,38]. Whereas "R-technique" EFA [39] typically analyzes a two-dimensional data matrix where the rows are defined by participants and the columns are defined by variables, Q-technique factor analysis considers a two-dimensional data matrix where the rows are defined by the statements sorted by the participants and the columns are defined by the participants themselves. Similar Q sorts that correlate significantly with each other form a group, and each factor represents a group of individuals that share similar views and experiences related to the study theme [25]. Q-technique factor analysis produces a weighted, or synthetic, Q sort for each rotated factor by using a weighted averaging method to calculate the score for each statement for each factor [32]. The final data obtained from the individual Q sorts were entered into SPSS version 17.0, and Q-technique EFA using principal components analysis with varimax rotation was used to identify patterns among the Q sorts to determine which participants were correlated with factors retained in the analysis. To determine the correct number of factors to retain for analysis, bootstrap factor analysis was used concomitantly with the eigenvalues-greater-than-one rule [40,41].

The final step in the analysis involved an effort to determine which (if any) of the 36 statements provided a basis for differentiating the clusters of students identified (ie, the factors). Factor scores were computed for each statement and plotted for each retained factor to determine the extent to which each cluster of students agreed or disagreed with how descriptive each statement was regarding their own perspectives on conducting eHealth searches. Factor scores less than –1.0 and more than +1.0 were more than one standard deviation from the factor score mean, so these were the statements of least or most agreement among the individuals defining the factors [24]. Negative factor scores indicated that participants making up the cluster did not agree that the statement described their attitudes or experiences conducting eHealth searches. Positive factor scores indicated that participants did agree that the statement described their perspective on conducting eHealth searches.

Results

A total of 13 students agreed to participate in the Q study following recruitment (response rate = 65%). All participants were female and the majority (8/13, 77%) were third- and fourth-year students (ie, juniors and seniors) majoring in health education with an emphasis in the allied health professions. This number of participants was judged to be sufficient given that Q-method research requires the number of participants be small relative to the number of ranked variables [22,23]. The students possessed an average GPA of 3.26 (SD 0.42) points on a 4-point scale and were categorized as having either basic (n = 4), intermediate (n = 5), or proficient (n = 4) eHealth literacy based on their performance on the RRSA-h. The mean RRSA-h score was 18.46 (SD 4.11) out of a maximum of 23. The scores derived from the administration of the RRSA-h demonstrated adequate internal reliability (alpha = .78). Table 2 describes relevant Q study participant characteristics.

Table 2. Demographic characteristics of participants.

Characteristic	n (%)
Sex	
Female	13 (100)
Student classification	
Freshman	1 (8)
Sophomore	4 (31)
Junior	2 (15)
Senior	6 (46)
Degree track	
Allied health	12 (92)
Community health	1 (8)

The Q-technique EFA of the 36 statements yielded 3 factors representing 3 salient perspectives among study participants. The 3-factor structure suggests there were 3 types of health education students with regard to eHealth search practices. The varimax-rotated factor pattern coefficients (ie, the correlations between each participant with each of the 3 factors) suggested that the 3 factors were reasonably independent of one another. Table 3 describes the varimax-rotated component matrix that

XSL•FO
RenderX

lists the pattern/structure coefficients for each participant on all three retained factors. Every participant had at least one pattern/structure coefficient on one factor that was at least equal to 0.5, which indicates that each participant was moderately correlated with at least one retained factor [42].

Table 3. Factor pattern/structure coefficients for participants.

Participant[a]	Proficient resourceful	Intermediate reluctant	Basic hubristic
P1	0.56[b]	0.24	0.46
P2	0.67[b]	0.12	0.25
P3	0.73[b]	0.26	0.47
P4	0.80[b]	0.31	-0.26
I3	0.71[b]	0.24	0.36
I4	0.78[b]	-0.01	0.38
I5	0.60[b]	0.35	0.36
I1	0.11	0.89[b]	0.09
I2	0.34	0.85[b]	0.05
B3	0.20	0.75[b]	0.39
B1	0.23	0.19	0.54[b]
B2	0.08	0.40	0.74[b]
B4	0.37	-0.13	0.76[b]

[a] P = proficient group, I = intermediate group, B = basic group

[b] Pattern/structure coefficients above 0.50

The first factor was correlated with all participants who were proficient achievers on the RRSA-h and with3 participants who were intermediate achievers. The second factor was highly correlated with two participants from the intermediate group and one participant from the basic group. The third factor was correlated with the 3 remaining participants in the basic group. Thus, after analyzing quantitative performance on the RRSA-h in relation to findings from the Q-technique EFA, it was determined that perspectives of personal eHealth search practices did, in fact, differ among health professional students of basic, intermediate, and proficient eHealth literacy. More than half of the students (7/13, 54%) clustered on the proficient factor, while 3 students clustered on each of the 2 other factors. The authors determined that the magnitude of the differences between the primary and cross loadings for each participant across each factor were large enough (≥ 10% difference) to consider each participant as a defining individual for the factor with their largest pattern/structure coefficient.

The factor scores [38] of each of the 36 statements rated by the Q participants were used to determine which eHealth search practices were associated the most and the least with each of the three types of students. In the lexicon of Q methodology, these statements are called “distinguishing statements” because they help to explain the uniqueness of each factor [25]. Table 4 presents the statement factor scores greater than 1.0 or less than –1.0. These statements informed the specific differences in eHealth search perspectives among participants possessing different levels of objective eHealth literacy, and also provided a deeper understanding of the opinions that discriminated the three clusters of students. Moreover, the factor scores were used to further represent the characteristics of each cluster, with the first factor describing proficient resourceful students; the second factor describing intermediate reluctant students; and the third factor describing basic hubristic students.

XSL•FO
RenderX

Table 4. Salient statements for retained factors less than –1 and greater than +1.[a]

Statement #	Proficient resourceful	Intermediate reluctant	Basic hubristic
2	-1.96	1.34	
3			1.99
6	1.85		
7	1.12	-1.38	-1.11
8		-1.07	
9		1.37	
11			1.21
12	1.01		-1.50
13		-1.23	
15			-1.64
16	1.15		
17		-1.37	
18			1.24
19			1.83
20	1.53	2.04	-1.79
21	-1.09	2.31	
22	-1.49		
23			-1.08
24	-1.25		-1.04
25	-1.66	-1.56	
26			1.62
27			1.64
28	-1.29	1.87	
29	-1.75	-1.52	
32	1.28		
34		-1.16	

[a] Factor scores between –1.0 and +1.0 were removed from table

Proficient Resourceful and Intermediate Reluctant Students

The proficient resourceful students (PRS) described themselves as relying on multiple resources to obtain eHealth information (Statements 2, 6, and 12), as opposed to simply relying on Internet search engines to conduct Web searches (Statements 2 and 21). They also indicated that they worked well with research partners (including library staff members) to brainstorm ideas for research projects and seek further assistance to conduct difficult Internet searches (Statements 7 and 12). Conversely, intermediate reluctant students (IRS) reported relying solely on Internet search engines when conducting eHealth searches (Statements 2 and 21). The IRS group also described themselves as working more independently with less reliance on using library resources or instructors to obtain assistance when searching (Statements 7, 8, and 17).

The PRS group described being able to search for up-to-date, even unfamiliar, health information on the Internet (Statements 16, 22, and 24), whereas IRS tended to limit the breadth of their eHealth searches, tending not to seek out original documents from the reference sections of books and manuscripts (Statement 34). Furthermore, IRS perceived themselves as lacking critical skills for evaluating sources of eHealth information (Statement 13). Both types of students reported not knowing what Boolean operators were or how to use them to effectuate eHealth searches (Statements 25 and 29).

Basic Hubristic Students

Basic hubristic students (BHS), like their IRS counterparts, preferred to search for eHealth information independently (Statements 7 and 12). They also reported being procrastinators who were more likely to identify with submitting a first draft as a final research product (Statements 15 and 20). However, BHS were the only participants to strongly identify with (1) receiving some instruction and practical experience conducting health research on the Internet (Statements 3 and 11), and (2) possessing confidence when attempting to locate and recognize

XSL•FO
RenderX

reliable eHealth information, even when researching an unfamiliar topic (Statements 18, 19, 23, 24, 26, and 27).

Discussion

Q methodology was chosen as a robust qualitative technique to measure the subjective perspectives of eHealth search practices among undergraduate students enrolled in a health professional degree program. This study applied a Q sort technique to identify clusters of students representing different levels of eHealth literacy. Each cluster was described in terms of perceived skill level, confidence in ability to conduct eHealth searches, and past educational experiences. Three distinct viewpoints were revealed concerning perceptions of eHealth search practices among different "types" of students. These three viewpoints were found to share some common elements, especially when considering participants' personal eHealth literacy (ie, basic, intermediate, or proficient). In addition, the specific similarities and differences between student clusters are useful to consult when determining which component eHealth search skills are typical among different types of undergraduate health professional students. The following discussion makes use of the distinctive statements identified above to shed light on how results from this Q-method study might be used to suggest implications for the instruction of different "types" of college students majoring in the health professions.

Proficient Resourceful and Intermediate Reluctant Students

The PRS described themselves as students who relied on multiple resources to obtain eHealth information, as opposed to simply relying on Internet search engines. They worked well with library personnel to brainstorm ideas for research projects and sought guidance on how to conduct difficult searches. A previous study on eHealth search tendencies among college students noted that students are apt to seek digital health information from multiple, complementary sources of information [43]. Health professional students may benefit from being made aware of library support services within college and university settings that can be utilized to strengthen information literacy competencies necessary to ensure students know (1) how eHealth information is organized, (2) where to find reputable sources of health information on the Internet, and (3) how eHealth information should be used in practice. For example, it has been noted elsewhere that university librarians, along with the resources they can provide, play a critical role in providing insights and guidelines for health information literacy and Internet search skills [18].

The IRS were more reliant on Internet search engines to conduct eHealth searches. College students have reported using Internet search engines almost exclusively to locate online health information [18,44,45]. Research has also shown that college students resort to using rudimentary retrieval methods (eg, the use of unrefined search terms or selecting only the most apparent and visible search results) to gather online health information [44,46]. This study is the first to report that even moderately eHealth-literate students identify with only using search engines when conducting eHealth searches. To support continued eHealth literacy development, training programs in computer literacy can increase both absolute and relative access to eHealth resources by teaching students to make use of new and existing technological resources (ie, library research databases, RSS feeds, Twitter, and Facebook). These accessible, information-seeking technologies can augment students' general exploration using Internet search engines. Additionally, general social media skills should become extended into training programs designed to provide instruction in eHealth literacy [47]. As part of the movement towards Medicine 2.0 [48], it has been suggested that dimensions of social media, such as synthesizing professional and non-professional advice and using apomediaries (ie, expert sources) to filter relevant and trustworthy information, be included within eHealth literacy interventions. Instruction in these additive content areas will help ensure that health professional students are able to locate, evaluate, and use eHealth information at a level greater than the general population.

The IRS also perceived they lacked evaluation skills when considering sources of eHealth information. Previous work has shown perceived ability to evaluate eHealth information to correspond with actual evaluation ability among college students in the health professions [17]. Search protocols and criteria for evaluating eHealth information are often implied and not explicitly understood by health professional college students; thus, they resort to simply trusting search engine results [18,49] and/or relying on the website sponsor, appearance, or other non-content–related cues to form credibility judgments [50]. Even intermediate eHealth-literate college students may recognize personal limitations evaluating eHealth information, which indicates the need for explicit criteria that students can reference when evaluating eHealth information in a multifaceted, complex Web environment. These guidelines should support health and scientific literacy by enabling students to perform literary and numerical tasks necessary to comprehend and respond to health care information that is provided in an often-convoluted Web context. Standards should clearly articulate the importance of systematically evaluating sources of eHealth information to verify reputability, ensure validity of information, and promote understanding [18].

Interestingly, neither PRS nor IRS reported receiving formalized training on how to search for quality health information on the Internet. There are a variety of competencies associated with obtaining eHealth information, including the knowledge, skills, abilities, and other attributes (KSAOs) necessary to conduct basic and advanced information searches, apply Boolean operators to limit search results, and understand (sometimes ambiguous) eHealth terminology. These KSAOs may be limited, even among high-performing students. Previous research has shown that college students are not equally capable of accessing health information online [43]; therefore, to ensure that students of all eHealth literacy levels (even proficient levels) are appropriately searching for eHealth resources, it is important that multidisciplinary training programs be integrated within allied health and medical education programs to deliver instruction that will provide health professional students with experiences to further develop KSAOs in each facet of eHealth literacy. While such KSAOs may be overlooked when training students who have aspirations of gaining employment in patient

XSL•FO
RenderX

care settings (eg, nursing, medical assistants, physical therapy, and occupational therapy), students living in the Internet age will likely need to be prepared to use search guidelines in the clinical and community environment to assist in finding preventive, diagnostic, and treatment information.

Navigating through health information obtained on a mobile device can present the user with unique Internet search and retrieval obstacles that are separate and distinct from searches of the Internet on a desktop CPU. Novel coursework in media literacy can assist in training health professional students living in the digital age to access and use health information available in the new age of mHealth applications. More practical continuing education and learning experiences should be provided to both instructors and students alike to ensure that mobile and digital technologies are included as a subtopic of eHealth literacy. It is important that attention is given to supporting instructional programs using mHealth applications within public health interventions.

Basic Hubristic Students

The BHS, like the IRS, preferred to work independently when searching for eHealth information. Students who possess inferior skills searching for and evaluating eHealth information should be encouraged to seek out consultation during the eHealth information-seeking process. Other research indicates that simply observing the thought processes and search tendencies of higher-level students could indirectly result in better learning outcomes [51]. This perspective suggests that modeling effective skills, abilities, and other attributes (SAOs), such as task adherence, may help to enhance searches completed by lower-performing students who may be negatively affected by tendencies toward procrastination. Users' affective states and social context affecting information needs are relevant variables that may influence perceived search task difficulty, search effort, and success [18]. By delaying the search for quality eHealth information, students may tend to resort to using elementary Internet search methods, such as using general search terms within basic Internet search engines. Procrastination may also limit the effort that students can devote to using more scholarly sources of health information from institutional eLibrary databases. Future research should determine the particular cognitive and personality characteristics that predict and explain eHealth literacy outcomes among health professional students.

The BHS were the only participants to describe themselves as receiving instruction on how to conduct Internet searches for health information. Furthermore, the BHS described themselves as possessing confidence in their ability to find and recognize reliable eHealth information even when researching an unfamiliar topic. This is one major distinguishing characteristic that separated low performers from the more advanced student clusters. Speculation in previous research [14,17,19,52] suggests that low-performing college students may have an inflated sense of their eHealth literacy skills. While college students majoring in the health professions may believe they possess the necessary KSAOs to effectively engage in eHealth searches on the Internet, this belief of personal capability may not be substantiated when considering evidence of their eHealth "illiteracy" (eg, proficient and intermediate performers unaware of what Boolean operators were). A common phenomenon in engagement with health and research based information is a sense of overconfidence in the skills required to understand and utilize data [53]. To investigate whether this phenomenon is relevant to the current line of inquiry, the continued measurement of self-efficacy for conducting eHealth searches should help determine how perceived eHealth search behaviors map onto actual behaviors among a variety of health professional college students.

Table 5 provides definitions of the dimensions of eHealth literacy [12] discussed above plus practical application examples that can be used in the training of health professional students. College students preparing to become medical and allied health professionals should obtain customized eHealth literacy training in areas where competency deficiencies are present.

XSL•FO
RenderX

Table 5. Practical applications for training allied health students using the dimensions of eHealth literacy.

Dimension	Definition	Practical applications for training
Media	Skills to apply cognitive process and critical thinking to media messages	Provide opportunities for students to gather and assess health information from a variety of media sources.
		The authors suggest instructors of courses utilize the media literacy lesson plans created as part of student reporting labs at PBS (http://www.studentreportinglabs.com/lesson-plans).
Information	Skills to know where to go to find the appropriate information and how to use the information once collected	Information literacy skills should be incorporated very early into the curricula. The authors suggest readers review Kingsley et al [54,55] and Levine et al [56] for case studies on incorporating information literacy skills in an allied health curriculum.
Computer	Skills to be able to use computers to solve problems	Provide online or hybrid computer literacy training that requires students to become more comfortable with using computers.
		Provide assignments that require allied health students to conduct Internet searches and validate the information found.
Scientific	Skills to understand the political and sociological dimensions of science	Require a research-training component as part of all allied health degree programs.
Health	Skills to understand health information and make appropriate health decisions	Incorporate training within allied health classes on how students use valid and reliable health information from sources to make health decisions.
		Incorporate the free, online Health Resources and Services Administration (HRSA) training (http://www.hrsa.gov/publichealth/healthliteracy/index.html).

Limitations

Participation in the current study was limited to a convenience sample of female respondents. It is important to note that this limitation was reflective of the disproportionate number of female students enrolled in this particular health education major, and the literature has indicated that female students are more likely than male students to use the Internet to locate health information [43]. Nevertheless, future studies would benefit from using multiple demographic and psychographic variables to inform participant sampling designs for the purpose of uncovering more descriptive differences in self-reported perspectives.

There was also an uneven number of first- and second-year students versus third- and fourth-year students. This potentially skewed the results considering that the more senior students likely possessed more experience searching for health information on the Internet. Because of the small, nonrandom samples characteristic in Q methodology, findings may not be broadly applicable to various groups of undergraduate health professionals. The current Q study can only be considered representative of the continuum of perspectives that may exist about eHealth search practices among undergraduate female health education students attending a large, research-oriented university. Eliciting subjective perspectives of personal eHealth search practices at multiple types of college and universities, representing schools of diverse backgrounds (eg, different research and teaching institutions) with varied allied health and medical specialty areas (eg, nursing, physical therapy, public health, and physician assistants), may very well result in different perspectives emerging. To fully develop population validity for the variety of students in the health and medical professions, future studies should examine the link between health profession major area of emphasis and perceptions of eHealth search practices.

Although the Q technique has strengths, such as enabling comparisons across subjective topics [19,57], it is possible that other perspectives do exist and were not reflected in the factor structure reported in the current study. The meaning (and naming) ascribed to each of the three retained factors was contrived by the research team on the basis of results from previous research [17]; this could represent research bias that is a threat to the internal validity of Q studies [58]. In future replications of this research design, it would be useful to assess the inter-rater reliability of the number of factors retained, and especially how retained factors are described by different raters. Also, any number of participants in this study may have misunderstood what could have been perceived as complex instructions for the Q sort, which could have led students to misrepresent their perspectives on eHealth search practices. Future studies should confirm whether or not students clearly understood the instructions for the Q sorting procedure.

As well, study participants had already completed the RRSA-h assessment and also received feedback on their performance before completing their individual Q sorts. This represented a testing threat to the internal validity of results from this study because feedback on the RRSA-h may have altered students' perceptions of personal eHealth search skills along with their perceived need for instruction and assistance when searching for eHealth information. Finally, the reliability of the Q sorts could not be verified by a test–retest procedure due to time limitations inherent within the research protocol.

Conclusion

The context where eHealth literacy is applied and understood is dynamic and evolving [47]. Thus, the need for instructional eHealth literacy programs has received [18,44], and should continue to receive, widespread support from the public health and medical education communities. The findings of this study suggest a careful analysis of multiple perspectives that exist

XSL•FO
RenderX

related to eHealth search practices among female health professional college students. Results offer an important context for deepening knowledge about the dynamics of participation and empowerment related to eHealth literacy in this population. Previous research has shown college students to have varying degrees of eHealth literacy [14,17]. This study is among the first to reveal multiple, practically significant student perspectives on eHealth search skills and behaviors. It also helped to begin the discourse conceptualizing the different ways that eHealth search practices may differ when considering the KSAOs students may or may not possess. The subjective perspectives of participants clustered across three relatively distinct factors that coincided with participant performance on a valid and reliable eHealth literacy assessment. The characteristics describing each of these cluster sets (ie, basic hubristic, intermediate reluctant, and proficient resourceful) provide future eHealth literacy researchers with opportunities to test interesting hypotheses that can further explain achievement traits among different types of health and medical professional students. With more instruction and coursework specifically devoted to addressing the rapid shifts in the informational landscape created by Web 2.0 tools and environments, it is likely that any chasms existing between upper- and lower-performing health professional students will be reduced. Moreover, there will a greater proportion of undergraduate students in the allied health and medical professions who will become proficient when using the Internet to locate and evaluate eHealth information.

Conflicts of Interest

None declared.

References

1. Fox S. Pew Internet & American Life Project. Washington, DC: Pew Internet & American Life Project; 2011. Health topics: 80% of Internet users look for health information online URL: http://pewinternet.org/~/media/Files/Reports/2011/PIP_HealthTopics.pdf [accessed 2011-10-09] [WebCite Cache ID 62JTk4T9o]
2. Casebeer L, Bennett N, Kristofco R, Carillo A, Centor R. Physician Internet medical information seeking and on-line continuing education use patterns. J Contin Educ Health Prof 2002;22(1):33-42. [doi: 10.1002/chp.1340220105] [Medline: 12004639]
3. Cullen RJ. In search of evidence: family practitioners' use of the Internet for clinical information. J Med Libr Assoc 2002 Oct;90(4):370-379. [Medline: 12398243]
4. Hughes B, Joshi I, Lemonde H, Wareham J. Junior physician's use of Web 2.0 for information seeking and medical education: a qualitative study. Int J Med Inform 2009 Oct;78(10):645-655. [doi: 10.1016/j.ijmedinf.2009.04.008] [Medline: 19501017]
5. Metzger MJ, Flanagin AJ. Using Web 2.0 technologies to enhance evidence-based medical information. J Health Commun 2011;16 Suppl 1:45-58. [doi: 10.1080/10810730.2011.589881] [Medline: 21843095]
6. van der Vaart R, van Deursen AJ, Drossaert CH, Taal E, van Dijk JA, van de Laar MA. Does the eHealth Literacy Scale (eHEALS) measure what it intends to measure? Validation of a Dutch version of the eHEALS in two adult populations. J Med Internet Res 2011;13(4):e86 [FREE Full text] [doi: 10.2196/jmir.1840] [Medline: 22071338]
7. Xie B. Effects of an eHealth literacy intervention for older adults. J Med Internet Res 2011;13(4):e90 [FREE Full text] [doi: 10.2196/jmir.1880] [Medline: 22052161]
8. Chan CV, Kaufman DR. A framework for characterizing eHealth literacy demands and barriers. J Med Internet Res 2011;13(4):e94 [FREE Full text] [doi: 10.2196/jmir.1750] [Medline: 22094891]
9. Higher Education Research Institute. The American freshman: National norms for Fall.: Higher Education Research Institute; 2007. 2008 URL: http://www.heri.ucla.edu/PDFs/pubs/briefs/brief-012408-07FreshmanNorms.pdf [accessed 2011-10-09] [WebCite Cache ID 62JPjFe7a]
10. Eysenbach G, Köhler C. How do consumers search for and appraise health information on the world wide web? Qualitative study using focus groups, usability tests, and in-depth interviews. BMJ 2002 Mar 9;324(7337):573-577. [Medline: 11884321]
11. Zeng QT, Kogan S, Plovnick RM, Crowell J, Lacroix EM, Greenes RA. Positive attitudes and failed queries: an exploration of the conundrums of consumer health information retrieval. Int J Med Inform 2004 Feb;73(1):45-55. [doi: 10.1016/j.ijmedinf.2003.12.015] [Medline: 15036078]
12. Watson N, Wyld PJ. The importance of general practitioner information in selection of volunteers for clinical trials. Br J Clin Pharmacol 1992 Feb;33(2):197-199. [Medline: 1550701]
13. Hughes B, Wareham J, Joshi I. Doctors' online information needs, cognitive search strategies, and judgments of information quality and cognitive authority: How predictive judgments introduce bias into cognitive search models. Journal of the American Society for Information Science and Technology 2009;61(3):n/a-452. [doi: 10.1002/asi.21245]
14. Stellefson M, Hanik B, Chaney B, Chaney D, Tennant B, Chavarria EA. eHealth literacy among college students: a systematic review with implications for eHealth education. J Med Internet Res 2011;13(4):e102 [FREE Full text] [doi: 10.2196/jmir.1703] [Medline: 22155629]
15. Association of American Medical Colleges. Recommendations for clinical skills curricula for undergraduate medical education. 2008. URL: https://www.aamc.org/download/130608/data/clinicalskills_oct09.qxd.pdf.pdf [accessed 2011-10-09] [WebCite Cache ID 62JRiiJWE]

XSL•FO
RenderX

16. Head AJ, Eisenberg MB. Finding context: What today's college students say about conducting research in the digital age. University of Washington: Project Information Literacy Progress Report; 2009. Finding context: What today's college students say about conducting research in the digital age URL: http://projectinfolit.org/pdfs/PIL_ProgressReport_2_2009.pdf [accessed 2011-10-09] [WebCite Cache ID 62JRGMXoU]
17. Hanik B, Stellefson M. EHealth literacy competencies among undergraduate health education students. Int Electronic J of Health Educ 2011;14:46-58 [FREE Full text]
18. Kim H, Park SY, Bozeman I. Online health information search and evaluation: observations and semi-structured interviews with college students and maternal health experts. Health Info Libr J 2011 Sep;28(3):188-199. [doi: 10.1111/j.1471-1842.2011.00948.x] [Medline: 21831218]
19. Ivanitskaya L, O'Boyle I, Casey AM. Health information literacy and competencies of information age students: results from the interactive online Research Readiness Self-Assessment (RRSA). J Med Internet Res 2006;8(2):e6 [FREE Full text] [doi: 10.2196/jmir.8.2.e6] [Medline: 16867969]
20. Thomas DM, Watson RT. Q-sorting and MIS research: A primer. Comm Assoc Inform Syst 2002;8:141-156 [FREE Full text]
21. Stephenson W. The study of behavior: Q-technique and its methodology. Chicago: University of Chicago Press; 1953.
22. Webler T, Danielson S, Tuler S. Using Q method to reveal social perspectives in environmental research. Greenfield MA: . : Social and Environmental Research Institute; 2009. URL: http://www.seri-us.org/sites/default/files/Qprimer.pdf [accessed 2011-10-09] [WebCite Cache ID 62JQznglP]
23. Thompson B. Validity of an evaluator typology. Educ Eval Policy An 1980;2(2):59-65 [FREE Full text]
24. Thompson B. Exploratory and Confirmatory Factor Analysis: Understanding Concepts and Applications. Washington, DC: American Psychological Association (APA); 2004.
25. Akhtar-Danesh N, Baumann A, Cordingley L. Q-methodology in nursing research: a promising method for the study of subjectivity. West J Nurs Res 2008 Oct;30(6):759-773. [doi: 10.1177/0193945907312979] [Medline: 18337548]
26. Cordingley L, Webb C, Hillier V. Q methodology. Nurse Researcher 2005;4:31-45.
27. McCaughan D, Thompson C, Cullum N, Sheldon TA, Thompson DR. Acute care nurses' perceptions of barriers to using research information in clinical decision-making. J Adv Nurs 2002 Jul;39(1):46-60. [Medline: 12074751]
28. Thompson C, McCaughan D, Cullum N, Sheldon TA, Mulhall A, Thompson DR. Research information in nurses' clinical decision-making: what is useful? J Adv Nurs 2001 Nov;36(3):376-388. [Medline: 11686752]
29. Valenta AL, Wigger U. Q-methodology: definition and application in health care informatics. J Am Med Inform Assoc 1997 Dec;4(6):501-510 [FREE Full text] [Medline: 9391937]
30. Dennis KE, Goldberg AP. Weight control self-efficacy types and transitions affect weight-loss outcomes in obese women. Addict Behav 1996 Feb;21(1):103-116. [Medline: 8729712]
31. Sell DK, Brown SR. Q methodology as a bridge between qualitative and quantitative research: Application to the analysis of attitude change in foreign study program participants. In: Vacca JL, Johnson HA, editors. Qualitative research in Education. Kent, OH: Kent State University; 1984:79-87.
32. Brown SR. Operant Subjectivity; 16: 91-138. 1993. A primer on Q methodology URL: http://projectinfolit.org/pdfs/PIL_ProgressReport_2_2009.pdf [accessed 2011-10-09] [WebCite Cache ID 62JRS2QTT]
33. Anderson JR, Lebiere C. The atomic components of thought. Mahwah, N.J.: Lawrence Erlbaum Associates; 1998.
34. Ritter S, Anderson JR, Koedinger KR, Corbett A. Cognitive tutor: applied research in mathematics education. Psychon Bull Rev 2007 Apr;14(2):249-255. [Medline: 17694909]
35. Lincoln YS, Guba EG. Naturalistic inquiry. Beverly Hills, Calif.: Sage Publications; 1985.
36. Brown SR. On the use of variance designs in Q methodology. Psych Rec 1970;20:179-189.
37. Dennis KE. Q methodology: relevance and application to nursing research. ANS Adv Nurs Sci 1986 Apr;8(3):6-17. [Medline: 3083769]
38. Gorsuch RL, Dreger RM. "Big Jiffy": A more sophisticated factor analysis and rotation program. Educational and Psychological Measurement 1979;39(1):209-214. [doi: 10.1177/001316447903900131]
39. Cattel RB. The data box: Its ordering of total resources in terms of possible relational systems. In: Cattel RB, editor. Handbook of multivariate experimental psychology. Chicago: Rand-McNally; 1966:67-128.
40. Stellefson ML, Hanik BW, Chaney BH, Chaney JD. Factor retention in EFA: strategies for health behavior researchers. Am J Health Behav 2009 Oct;33(5):587-599. [Medline: 19296749]
41. Zientek LR, Thompson B. Applying the bootstrap to the multivariate case: bootstrap component/factor analysis. Behav Res Methods 2007 May;39(2):318-325. [Medline: 17695360]
42. Hinkle DE, Wiersma W, Jurs SG. Applied statistics for the behavioral sciences. Boston, Mass.: Houghton Mifflin; 2003.
43. Percheski C, Hargittai E. Health information-seeking in the digital age. J Am Coll Health 2011 Apr;59(5):379-386. [doi: 10.1080/07448481.2010.513406] [Medline: 21500056]
44. Buhi ER, Daley EM, Fuhrmann HJ, Smith SA. An observational study of how young people search for online sexual health information. J Am Coll Health 2009;58(2):101-111. [doi: 10.1080/07448480903221236] [Medline: 19892646]

XSL•FO
RenderX

45. Fox S, Jones S. Pew Internet and American Life Project.: Per Research Center; 2009. The Social Life of Health Information URL: http://www.pewinternet.org/~/media//Files/Reports/2009/PIP_Health_2009.pdf [accessed 2011-10-13] [WebCite Cache ID 62PS6g5qn]
46. Pan B, Hembrooke H, Joachims T, Lorigo L, Gay G, Granka L. In Google we trust: users' decisions on rank, position, and relevance. Journal of Computer-Mediated Communication 2007;12(3):801-823. [doi: 10.1111/j.1083-6101.2007.00351.x]
47. Norman C. eHealth literacy 2.0: problems and opportunities with an evolving concept. J Med Internet Res 2011;13(4):e125 [FREE Full text] [doi: 10.2196/jmir.2035] [Medline: 22193243]
48. Eysenbach G. Medicine 2.0: social networking, collaboration, participation, apomediation, and openness. J Med Internet Res 2008;10(3):e22 [FREE Full text] [doi: 10.2196/jmir.1030] [Medline: 18725354]
49. Eysenbach G, Powell J, Kuss O, Sa ER. Empirical studies assessing the quality of health information for consumers on the world wide web: a systematic review. JAMA 2002;287(20):2691-2700 [FREE Full text] [Medline: 12020305]
50. Flanagin AJ, Metzger MJ. The role of site features, user attributes, and information verification behaviors on the perceived credibility of Web-based information. New Media & Society 2007;9(2):319-342. [doi: 10.1177/1461444807075015]
51. Nihalani PK, Wilson HE, Thomas G, Robinson DH. What determines high- and low- performing groups? The superstar effect. Journal of Advanced Academics 2010;21(3):500-529. [doi: 10.1177/1932202X1002100306]
52. Ivanitskaya L, Brookins-Fisher J, O Boyle I, Vibbert D, Erofeev D, Fulton L. Dirt cheap and without prescription: how susceptible are young US consumers to purchasing drugs from rogue internet pharmacies? J Med Internet Res 2010;12(2):e11 [FREE Full text] [doi: 10.2196/jmir.1520] [Medline: 20439253]
53. Covell DG, Uman GC, Manning PR. Information needs in office practice: are they being met? Ann Intern Med 1985 Oct;103(4):596-599. [Medline: 4037559]
54. Kingsley KV, Kingsley K. A case study for teaching information literacy skills. BMC Med Educ 2009 Jan;9:7 [FREE Full text] [doi: 10.1186/1472-6920-9-7] [Medline: 19178715]
55. Kingsley K, Galbraith GM, Herring M, Stowers E, Stewart T, Kingsley KV. Why not just Google it? An assessment of information literacy skills in a biomedical science curriculum. BMC Med Educ 2011;11:17 [FREE Full text] [doi: 10.1186/1472-6920-11-17] [Medline: 21518448]
56. Levine AE, Bebermeyer RD, Chen JW, Davis D, Harty C. Development of an interdisciplinary course in information resources and evidence-based dentistry. J Dent Educ 2008 Sep;72(9):1067-1076 [FREE Full text] [Medline: 18768449]
57. Corr S. An introduction to Q-methodology, a research technique. Brit J of Occupational Therapy 2001;64(6):293-297.
58. Barbosa JC, Willoughby P, Rosenberg CA, Mrtek RG. Statistical methodology: VII. Q-methodology, a structural analytic approach to medical subjectivity. Acad Emerg Med 1998 Oct;5(10):1032-1040. [Medline: 9862598]

Abbreviations

ACT: atomic components of thought theory
BHS: basic hubristic students
EFA: exploratory factor analysis
GPA: grade point average
IRS: intermediate reluctant students
KSAOs: knowledge, skills, abilities, and other attributes
PRS: proficient resourceful students
RRSA-h: Research Readiness Self-Assessment-Health
SAO: skills, abilities, and other attributes

Edited by G Eysenbach; submitted 18.10.11; peer-reviewed by L Ivanitskaya, C Thompson, J Kim, F Pappalardo; comments to author 07.12.11; revised version received 20.01.12; accepted 06.02.12; published 27.04.12.

Please cite as:
Stellefson M, Hanik B, Chaney JD, Tennant B
Analysis of eHealth Search Perspectives Among Female College Students in the Health Professions Using Q Methodology
J Med Internet Res 2012;14(2):e60
URL: http://www.jmir.org/2012/2/e60/
doi:10.2196/jmir.1969
PMID:22543437

©Michael Stellefson, Bruce Hanik, J. Don Chaney, Bethany Tennant. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 27.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction

XSL•FO
RenderX

in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Health Care Professionals' Beliefs About Using Wiki-Based Reminders to Promote Best Practices in Trauma Care

Patrick Michel Archambault[1,2,3,4], MD, MSc, FRCPC; Andrea Bilodeau[1,5], MSc; Marie-Pierre Gagnon[4,5], PhD; Karine Aubin[1,5], MSc; André Lavoie[3], PhD; Jean Lapointe[1,6], MD, CSPQ; Julien Poitras[1,2,3], MD, CSPQ; Sylvain Croteau[7], MD; Martin Pham-Dinh[7], MD; France Légaré[2,4], MD, PhD

[1]Centre de santé et de services sociaux Alphonse-Desjardins (Centre hospitalier affilié universitaire de Lévis), Lévis, QC, Canada

[2]Département de médecine familiale et de médecine d'urgence, Faculté de médecine, Université Laval, Quebec, QC, Canada

[3]Traumatologie – Urgence – Soins intensifs, Centre de recherche FRQS du CHA universitaire de Québec, Quebec, QC, Canada

[4]Centre de recherche du Centre hospitalier universitaire de Québec (CRCHUQ), Quebec, QC, Canada

[5]Faculté des sciences infirmières, Université Laval, Quebec, QC, Canada

[6]Institut national d'excellence en santé et services sociaux, Montreal, QC, Canada

[7]Hôpital de Gatineau, Gatineau, QC, Canada

Corresponding Author:
Patrick Michel Archambault, MD, MSc, FRCPC
Centre de santé et de services sociaux Alphonse-Desjardins (Centre hospitalier affilié universitaire de Lévis)
143, rue Wolfe
Lévis, QC, G6V 3Z1
Canada
Phone: 1 418 835 7121 ext 3905
Fax: 1 418 835 7276
Email: patrick.m.archambault@gmail.com

Abstract

Background : Wikis are knowledge translation tools that could help health professionals implement best practices in acute care. Little is known about the factors influencing professionals' use of wikis.

Objectives : To identify and compare the beliefs of emergency physicians (EPs) and allied health professionals (AHPs) about using a wiki-based reminder that promotes evidence-based care for traumatic brain injuries.

Methods : Drawing on the theory of planned behavior, we conducted semistructured interviews to elicit EPs' and AHPs' beliefs about using a wiki-based reminder. Previous studies suggested a sample of 25 EPs and 25 AHPs. We purposefully selected participants from three trauma centers in Quebec, Canada, to obtain a representative sample. Using univariate analyses, we assessed whether our participants' gender, age, and level of experience were similar to those of all eligible individuals. Participants viewed a video showing a clinician using a wiki-based reminder, and we interviewed participants about their behavioral, control, and normative beliefs—that is, what they saw as advantages, disadvantages, barriers, and facilitators to their use of a reminder, and how they felt important referents would perceive their use of a reminder. Two reviewers independently analyzed the content of the interview transcripts. We considered the 75% most frequently mentioned beliefs as salient. We retained some less frequently mentioned beliefs as well.

Results : Of 66 eligible EPs and 444 eligible AHPs, we invited 55 EPs and 39 AHPs to participate, and 25 EPs and 25 AHPs (15 nurses, 7 respiratory therapists, and 3 pharmacists) accepted. Participating AHPs had more experience than eligible AHPs (mean 14 vs 11 years; $P = .04$). We noted no other significant differences. Among EPs, the most frequently reported advantage of using a wiki-based reminder was that it refreshes the memory (n = 14); among AHPs, it was that it provides rapid access to protocols (n = 16). Only 2 EPs mentioned a disadvantage (the wiki added stress). The most frequently reported favorable referent was nurses for EPs (n = 16) and EPs for AHPs (n = 19). The most frequently reported unfavorable referents were people resistant to standardized care for EPs (n = 8) and people less comfortable with computers for AHPs (n = 11). The most frequent facilitator for EPs was ease of use (n = 19); for AHPs, it was having a bedside computer (n = 20). EPs' most frequently reported barrier was irregularly updated wiki-based reminders (n = 18); AHPs' was undetermined legal responsibility (n = 10).

XSL•FO
RenderX

Conclusions : We identified EPs' and AHPs' salient beliefs about using a wiki-based reminder. We will draw on these beliefs to construct a questionnaire to measure the importance of these determinants to EPs' and AHPs' intention to use a wiki-based reminder promoting evidence-based care for traumatic brain injuries.

(J Med Internet Res 2012;14(2):e49) doi:10.2196/jmir.1983

KEYWORDS

Wiki; Collaborative writing applications; Web 2.0; traumatic brain injury; interprofessional collaboration; reminders; computerized clinical decision-support system; knowledge translation; evidence-based medicine; theory of planned behavior

Introduction

As many as half of all patients with major traumatic injuries do not receive the recommended care [1-6]. Medical errors are common in critically ill trauma patients and mistakes occur frequently in emergency departments [6,7], where unconscious acts of omission and information overload [8,9] contribute to the problem. Indeed, emergency health care professionals must often make quick decisions, mostly based on intuitive reasoning [9]. Intuitive reasoning is fast, impulsive, effortless, and reflexive: while it serves the emergency health care professionals well, it is also prone to error. Reminders (eg, care protocols, order sets, and treatment algorithms) are knowledge tools that can improve intuitive decision making and help professionals implement best practices [9]. In particular, systematic reviews have indicated that computer reminders to health care professionals at the point of care can be effective at promoting best practices in a variety of clinical areas [10-19], including acute care, where they improve process-of-care outcomes [20]. Such reminders range from simple prescribing alerts to more sophisticated support for decision making. That said, different stakeholders have rejected many reminder systems on the grounds that they are slow, incompatible with work processes, unable to be adapted to local practices, difficult to access, or costly to implement [19]. A wiki, in contrast, stands as a low-cost means of permitting stakeholders from a single or many emergency departments to collaborate asynchronously on creating and updating reminders without duplicating their efforts or spending too much time.

A wiki is a webpage or a collection of webpages whose content can be modified by those who access it [21,22]. Wikis are being used to encourage and make it easier for researchers and clinicians working in medicine to share information and expertise [23-28]. Wikis can also help users adapt knowledge to local contexts within the knowledge-to-action cycle [19,29] and help patients and clinicians collaborate in developing patient support tools [30,31]. Studies have found that clinicians use reminders less than expected [32-35], but by giving clinicians an easy-to-use tool for creating, sharing, and updating reminders for their own and others' use, wikis could reverse this trend. Wikis' low cost makes them especially attractive. Clinical decision support systems that are not flexible enough to accommodate regular updating are very expensive [36,37]. For this reason, numerous authors have suggested exploring collaborative Web-based applications to share, create, and update clinical decision support content [19,36,38-40].

Although several wikis exist in health care, a wiki containing reminders to treat trauma patients does not exist yet. These wiki-based reminders for trauma would be created by a multidisciplinary group of clinicians interested in improving the quality of trauma care by implementing care protocols to help standardize trauma care. Using a wiki to share reminders could be a potentially powerful tool to allow a multidisciplinary group of health care professionals within the same hospital or situated in different hospitals to collaborate in the creation of high-quality, evidence-based reminders. The wiki would serve as a shared online repository available for health care professionals at the point of care.

Despite preliminary surveys showing health care professionals' interest in wikis [28,41,42], very little is known about the determinants that influence professionals' intention to use the information from wikis in clinical practice. To our knowledge, only one study [43] has explored the intention of physicians to use wikis to share medical information with other physicians. Although this study found that physicians were unsure about sharing medical information with other physicians, this behavior is different from using information from a wiki in clinical practice and has different determinants. Furthermore, trials exploring how eHealth applications—such as wikis—are used by patients have been plagued by high dropout rates, a phenomenon that the founding editor of this journal has termed the law of attrition [44]. No study has yet shown this phenomenon to apply to health professionals, but to minimize dropout in future trials exploring health professionals' use of wiki-based reminders, we must design wikis that health professionals find helpful in caring for patients. To do this, we must understand what causes emergency physicians (EPs) and allied health professionals (AHPs) to use or to eschew the reminders. To this end, we plan to construct a questionnaire, based on the theory of planned behavior, that will ask health care professionals to quantify the influence of each determinant on their use of a wiki-based reminder in clinical practice. According to the theory of planned behavior, the constructs must be measured using a specific target, action, context, and time, as well as a specific population, to obtain results representative of that population [45]. The choice of trauma care for the setting of this study is linked to the investigators' research interests and is only the first step in investigating the use of wiki-based reminders in other contexts and with different health care professionals. In particular, wiki-based reminder systems have the potential to support collaboration in clinical settings where multidisciplinary teams work together asynchronously (eg, group-based primary care). The results of this questionnaire will then help construct a theory-based intervention to increase the use of a wiki-based reminder by EPs and AHPs. This research project is the first step in that endeavor. Its goal is to solicit as complete as possible an array

XSL•FO
RenderX

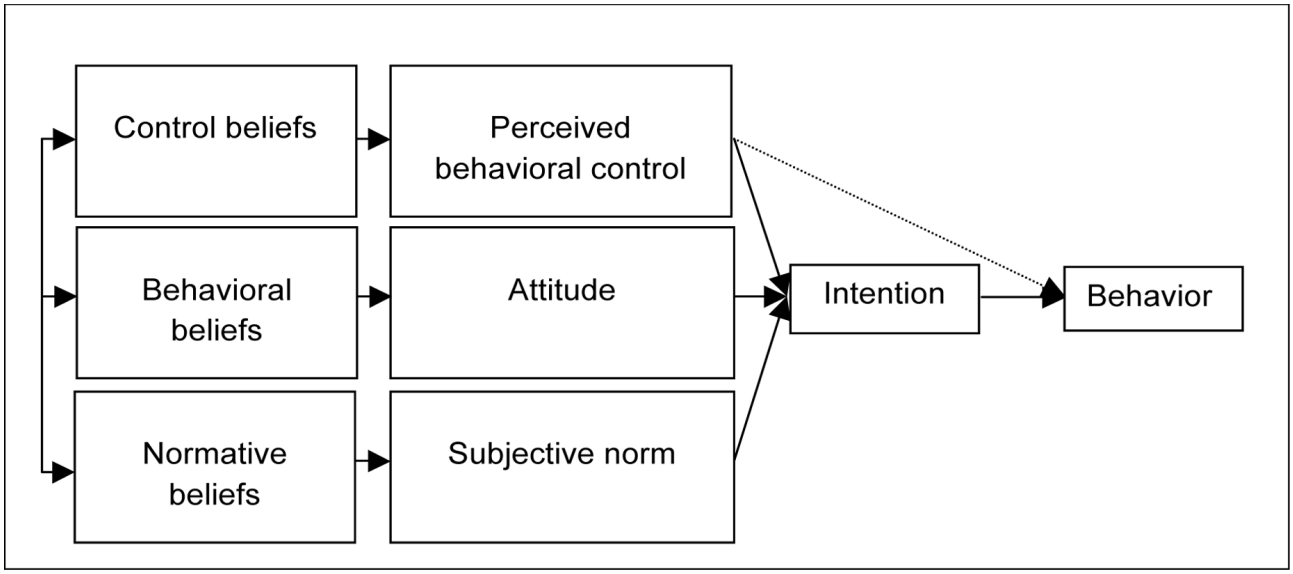
of beliefs concerning health professionals' use of wiki-based reminders that promote best practices in trauma care, and to identify the most salient beliefs for inclusion in the questionnaire.

Conceptual Underpinnings of the Proposed Study

The theory of planned behavior (Figure 1 [45,46]) is well known for its application to the study of health care professionals' behaviors [47-56]. A recent systematic review has shown that Internet-based interventions based on the theory of planned behavior tend to have substantial effects on behavior [57]. This theory provides a theoretical account of the ways in which attitude, subjective norm, and perceived behavioral control combine to predict behavioral intention [55]. It postulates that when an individual has some control over a situation, intention is the immediate determinant of behavior [45]. Furthermore, if the individual's perceived behavioral control reflects the individual's actual behavioral control, this variable can be used to predict behavior directly.

Intention is influenced by three constructs: attitude, subjective norm, and perceived behavioral control. Attitude toward the behavior is a person's evaluation of the consequences of adopting the behavior. Attitude is thus determined by the actor's behavioral beliefs about the advantages and disadvantages of adopting the behavior. Subjective norm refers to perceived social pressure to engage or not to engage in a behavior. Subjective norm thus represents the actor's normative beliefs—that is, his or her beliefs about how people who are in some way important to the actor would like the actor to behave. Finally, perceived behavioral control is the actor's perception of how easy or difficult it is to perform the behavior. This perception is determined by the presence of perceived barriers and facilitators: control beliefs. According to Ajzen [45], an individual or a group's salient beliefs are the beliefs that the individual or group reports most frequently with respect to the attributes of performing a particular behavior.

Figure 1. Theoretical framework of the theory of planned behavior.



Objectives

Our goal was to identify and compare the salient beliefs of EPs and AHPs about using a wiki-based reminder that promotes best practices in the management of patients with a severe traumatic brain injury in emergency departments in the province of Quebec, Canada.

Methods

Study Design

The detailed protocol of this research project has been published elsewhere [58]. Briefly, this paper presents the results of a qualitative survey that used semistructured interviews.

Participants and Setting

The study took place in three officially designated trauma centers in the province of Quebec, Canada: a level I, a level II, and a level III trauma center (see Multimedia Appendix 1 for definitions). Our study involved EPs (excluding residents and medical students) and AHPs (nurses, respiratory therapists, and pharmacists) involved in planning and caring for trauma patients. We purposefully recruited participants to obtain a representative sample of professionals from each level of trauma center and to elicit the widest possible range of beliefs. Thus, we aimed to recruit 10 EPs and 10 AHPs in each of the level I and II centers and 5 EPs and 5 AHPs in the level III center. To recruit participants, we sent an email to the heads of each emergency department to help us target and obtain the email addresses of potential participants, and to help us target local opinion-leader health care professionals known to be reluctant to use computers and new technology, and members of local trauma committees responsible for monitoring the quality of care. We also intentionally recruited both junior and senior staff members and at least one member of each AHP profession from each trauma center. Following the department heads' recommendations, we then contacted selected members of each unit within each trauma center by telephone, by email, or in person. Interviews were conducted on site. Our study was approved by the ethics review boards of all three hospitals.

XSL•FO
RenderX

Data Collection Procedure

The data collection process began by each participant meeting a researcher (AB) individually to obtain informed consent. During this meeting, the researcher, who had conducted other surveys using the theory of planned behavior, explained the study process, outlined anonymity and confidentiality issues, and stated that the participant would not be remunerated for his or her time. All meetings were conducted in French and all took place in person except one, which took place by phone. After obtaining the participant's consent, the researcher showed the participant a video that gave a brief, simple explanation of how different health care professionals could use wikis to collaborate in creating and updating wiki-based reminders for the care of traumatic brain injury patients. The video finished with a real-life enactment of the clinician performing the behavior of interest (using a wiki-based reminder) at a patient's bedside. A different version of the video was produced for each professional group participating in the survey (physicians, nurses, respiratory therapists, and pharmacists; see Multimedia Appendix 2, Multimedia Appendix 3, Multimedia Appendix 4, and Multimedia Appendix 5 for original videos in French). The videos were adapted with permission from the *Wikis in Plain English* video created by Lee LeFever and Common Craft [59]. Two medical informatics experts (SC, MPD) ensured that the video appropriately described how the professional would incorporate the wiki-based reminder into his or her daily practice. After viewing the video, the participant read a clinical vignette that described in detail the behavior of interest presented in the video (using a wiki-based reminder in a typical case of severe traumatic brain injury) (see Multimedia Appendix 6). Vignettes are often used in qualitative research and may have various goals [60]. In this research, we used the vignette to make the participants think of a clinical encounter with a patient with a serious traumatic brain injury and to imagine how they would use the wiki-based reminder in a real-life situation. This helped prepare the participants for the semistructured questions about using a wiki-based reminder for their care of their patients. The clinical vignette was written with the help of three clinical experts, two of whom (JL, AL) were members of Quebec's accreditation board for trauma centers (Trauma Care Continuum Assessment Team). The researcher then conducted a semistructured interview with the participant and elicited the participant's feedback on three topics: (1) the advantages and disadvantages of the professional's adoption of the behavior (behavioral beliefs), (2) influential people (referents) who would approve or disapprove of the participant's adoption of the behavior (normative beliefs), and (3) barriers and facilitators to the professional's adoption of the behavior (control beliefs). Each interview was digitally recorded, transferred to a computer, and transcribed. The interviewer also noted each participant's answers on paper forms. All participants were assigned a number and remained anonymous. The voice recordings were heard only by people who were not acquainted with the respondents.

Data Analysis

To identify participants' beliefs, two researchers (AB, KA) experienced with the theory of planned behavior independently analyzed the contents of the interview transcripts and the notes taken during the interviews. Using deductive content analysis [61] as described in the theory of planned behavior, each researcher read the transcript of each interview to identify all of the beliefs expressed by each participant. Each belief was categorized in one of three Excel (Microsoft Corporation, Redmond, WA, USA) spreadsheets according to the type of belief (behavioral, normative, and control). Each belief was identified with a unique identifying number linking it to the questionnaire from which it was taken. The researchers also classified each belief as positive or negative (eg, ease of use vs time constraints) according to how the participant had perceived it in the interview. If some participants considered a belief to be positive while others considered it to be negative, the researcher classified the belief as positive if more respondents considered it positive than considered it negative, and classified it as negative in the opposite case. The two researchers then compared their findings to agree on the beliefs identified. This was done separately for EPs and AHPs, therefore creating a total of six lists.

The next step consisted of grouping the beliefs that expressed the same idea. This was done by the first researcher (AB) and validated by the second (KA). At this point, the researchers compared the beliefs with one another to remove duplicates. Dissent about grouping beliefs that expressed similar but slightly different ideas was resolved through discussion. When necessary, the principal investigator made the final decision.

Through discussion, the researchers then labeled the beliefs inductively without a predetermined taxonomy based on the ideas expressed by the participants. To better compare our results with the results of other studies of beliefs about the use of new information technology in health care, we appropriated some of the labels in the taxonomy developed by Gagnon et al [62]. We used these labels only when the beliefs identified in our survey were exactly the same as the beliefs described by Gagnon et al.

After having classified each belief in a category, marked it as positive or negative, and given it a label, we used the options in Excel to count the frequency of mentions of each belief. Within the three belief categories, we counted the total number of times each belief was reported by participants. Using Excel, we then ordered the beliefs from the most to the least frequently mentioned and assigned each belief a rank according to its position on this list. To identify the 75% most frequently mentioned beliefs for each category (behavioral, normative, and control), we divided the cumulative total number of mentions of each belief by the total number of mentions of all beliefs in that category and retained the top three-quarters as the salient beliefs for that category as per theory of planned behavior methodology [63]. If it was impossible to segregate precisely the top 75% of beliefs because certain beliefs occurred with the same frequency, we included all borderline beliefs (even if that meant retaining more than 75%) in order to represent participants' beliefs comprehensively. We also retained less frequently reported beliefs that we felt could have an important influence on health care professionals' use of wiki-based reminders. For the purpose of this paper, we translated each belief from French into English. As for the transcripts, we translated only those excerpts selected for publication.

XSL•FO
RenderX

To determine whether our participants' baseline demographic characteristics were statistically different from those of the general population of health care professionals from which we had recruited our sample, we performed simple univariate statistical analyses. We used a 2-tailed Fisher exact test for dichotomous variables (gender) and a 2-tailed Student *t* test for continuous variables (age and years of experience). We used the free online statistical calculator GraphPad [64] to perform all statistical analyses.

Results

Participants' Characteristics

The three trauma centers comprised 66 eligible EPs and 444 eligible AHPs. To attain our target of 25 professionals per group, we invited 55 EPs and 39 AHPs to participate. Of these, 38% (25/66) of EPs and 6% (25/444) of AHPs agreed to take part. This translates to a response rate of 46% (25/55) for EPs and 64% (25/39) for AHPs. Of participating AHPs, 60% (15/25) were nurses, 28% (7/25) were respiratory therapists, and 12% (3/25) were pharmacists. These proportions are comparable with the distribution of eligible AHPs, of whom 57.7% (256/444) were nurses, 32.9% (146/444) were respiratory therapists, and 10% (42/444) were pharmacists. Our sample of EPs was composed of 10 EPs from a level I center, 10 from a level II center, and 5 from a level III center. Our sample of AHPs reproduced this distribution. Figure 2 illustrates the flow of participants in the study.

Compared with the 66 eligible EPs, the EPs who participated in this survey were similar in mean age (42 vs 43 years; P = .43), in mean years of experience (14 vs 16; P = .52), and in gender distribution (23/25, 92% vs 56/66, 85%). Compared with the 444 eligible AHPs, the AHPs who participated in the survey were also similar in mean age (38 vs 35 years; P = .19) and in gender distribution (18/25, 72% vs 372/444, 83.8%; P = .16). The only notable difference was that AHP participants had more clinical experience than average AHPs (14 vs 11 years; P = .04).

As shown in Table 1, which presents the participants' characteristics, the EPs in our study constituted a diverse group of general practitioners and specialists in emergency medicine. The sample also covered a wide range of age groups and levels of clinical experience. The sample of AHPs was also composed of a wide range of professions, age groups, and levels of experience, with nurses constituting the largest number of professionals. Among the AHPs, 3 did not work in an emergency department, but either held responsibilities on the local trauma committee (1 nurse) or taught clinics to AHPs caring for patients with traumatic brain injury (1 nurse and 1 respiratory therapist). Our sample also included important decision makers who sat on the local trauma committee (4 EPs and 4 AHPs). All three trauma centers had Internet access in their emergency department and their resuscitation room.

Table 2 and Table 3 present the salient beliefs of EPs and AHPs, respectively. The tables contain verbatim examples for each belief. Tables 4 (Multimedia Appendix 7) and 5 (Multimedia Appendix 8) present the nonsalient beliefs.

Figure 3, Figure 4, and Figure 5 display the percentages of EPs who had mentioned each belief (both salient and nonsalient) in each category, starting with the most frequently reported belief. Figure 6, Figure 7, and Figure 8 do likewise for AHPs.

XSL•FO
RenderX

Table 1. Characteristics of participating emergency physicians (EPs) and allied health professionals (AHPs).

Variable	EPs (n = 25)	AHPs (n = 25)
Age (years)		
Mean (SD)	42 (9)	38 (10)
Median (IQR)[a]	38 (35–49)	35 (29–44)
Born between 1977 and 1997, n (%)	4 (16%)	10 (40%)
Clinical experience (years)		
Mean (SD)	14 (10)	14 (9)
Median (IQR)	11 (6–23)	11 (9–18)
Gender, n (%)		
Male	23 (92%)	7 (28%)
Emergency medicine certification, n (%)		Not applicable
College of Family Physicians (without emergency medicine certification)	9 (36%)	
College of Family Physicians (with emergency medicine certification)	4 (16%)	
Royal College of Physicians of Canada or Collège des médecins du Québec	8 (32%)	
Profession, n (%)	Not applicable	
Nursing		15 (60%)
Respiratory therapist		7 (28%)
Pharmacist		3 (12%)
Work environment, n (%)		
Emergency department	25 (100%)	22 (88%)
Intensive care unit	2 (8%)	9 (36%)
Member of a local or regional trauma committee	4 (16%)	4 (16%)
Previous use of a wiki[b], n (%)	20 (80%)	15 (60%)
Previous use of Wikipedia[b], n (%)	14 (56%)	8 (32%)
Previous editing of a wiki[b], n (%)	1 (4%)	1 (4%)

[a] Interquartile range.

[b] We did not ask whether the respondent had used wikis for personal or for professional reasons.

XSL•FO
RenderX

Table 2. Emergency physicians' salient beliefs about using a wiki-based reminder.

Rank[a]	Salient belief	n (%)[b]	Verbatim example
Behavioral belief (n = 11)			
	Perceived advantage		
1	Refreshes the memory	14 (20%)	"good revision"
2	Gives access to evidence-based data	9 (13%)	"see the best data"
3	Allows information to be shared	9 (13%)	"creates a collaborative space between hospitals"
4	Standardizes practices	8 (11%)	"consensus on the approach"
5	Centralizes information and protocols	7 (10%)	"prevents searching in different places"
6	Reduces errors	6 (8%)	"commit fewer mistakes"
7	Gives access to expert opinions	6 (8%)	"written by leaders in the field"
	Perceived disadvantage		
10	Adds stress[c]	2 (3%)	"stress is added by having to search information while your patient is there"
	Total	61/71 (86%)	
Normative belief (n = 19)			
	Referents perceived as favorable		
1	Nurses	16 (13%)	"nurses"
2	Physicians	16 (13%)	"physicians"
3	Isolated/less-exposed centers	15 (13%)	"centers less familiar with severe head injury"
4	The younger generation	14 (12%)	"the young"
7	Respiratory therapists	8 (7%)	"respiratory therapists"
8	The trauma team	7 (6%)	"the emergency team"
10	Administration[c]	4 (3%)	"the department heads"
11	The respondent's patients[c]	3(3%)	"patients"
12	Specialists (surgeons, intensivists)[c]	3 (3%)	"specialties other than emergency"
	Referents perceived as unfavorable		
5	People resistant to standardized care	8 (7%)	"some people think that protocols are for robots"
6	People less comfortable with computers	8 (7%)	"people not comfortable using computers"
	Total	102/119 (86%)	
Control belief (n = 31)			
	Perceived facilitating factor		
1	Ease of use[d]	19 (8%)	"if it is user friendly, easy to navigate"
2	Having a bedside computer	18 (8%)	"must be easy to access directly in the resuscitation room"
3	Peer-reviewed high-quality scientific information	18 (8%)	"control over the quality of the information"
5	Rapid access to protocols	17 (7%)	"access should not take more than 3 clicks"
6	Absence of institutional control	14 (6%)	"having 18 passwords"
7	Compatibility with work processes[d]	14 (6%)	"integrated into daily work tools"
8	Access by handheld devices (eg, an iPhone)	11 (5%)	"available on handheld computers"
9	Locally adaptable	8 (4%)	"able to adapt it to the local flavor"
10	Trialability[d]	8 (4%)	"you have to use it often to become familiar"
11	Having Internet access	7 (3%)	"accessible from all locations by Internet"

XSL•FO
RenderX

Rank[a]	Salient belief	n (%)[b]	Verbatim example
12	Quality of visual design	7 (3%)	“the attractiveness of the site”
	Perceived barrier		
4	Not being updated regularly	18 (8%)	“if the protocol dates back and I know there are new data”
13	Time constraints[d]	7(3%)	“Not having the time, having to decide on the spot”
14	Frequently changing information	7 (3%)	“wiki always changing”
15	Authors not being identified[c]	6 (3%)	“be able to know who edited”
18	Undetermined legal responsibility[c]	4 (2%)	“who is ultimately legally responsible”
	Total	183/227 (81%)	

[a] The rank number corresponds to the position held in the ranking of all beliefs. The most frequently mentioned belief is ranked first. The ranking numbers do not necessarily follow each other in this table, since we grouped them as advantages, disadvantages, favorable referents, unfavorable referents, barriers, and facilitators. These rank numbers correspond to their position in Figures 3 to 8.

[b] n = the number of participants who reported the belief during their interview, and % = the number of times the belief was reported in all interviews divided by the number of times all beliefs in that category (behavioral, normative, and control beliefs) were reported in all interviews.

[c] This belief was not mentioned in the top 75% most frequently reported but was retained nonetheless.

[d] The label for this belief was taken from the Gagnon et al framework [62].

XSL•FO
RenderX

Table 3. Allied health professionals' salient beliefs about using a wiki-based reminder.

Rank[a]	Salient beliefs	n (%)[b]	Verbatim example
Behavioral belief (n = 15)			
	Perceived advantage		
1	Gives rapid access to protocols	16 (16%)	"immediately available"
2	Improves quality of care	15 (15%)	"enhances the quality of care"
3	Gives access to a regularly updated protocol	12 (12%)	"always up-to-date"
4	Standardizes practices	9 (9%)	"everyone uses the same procedure"
5	Promotes team work	8 (8%)	"enables a multidisciplinary approach"
6	Centralizes information and protocols	6 (6%)	"able to consolidate the information"
7	Gives access to evidence-based data	6 (6%)	"based on evidence"
8	Provides a new tool for teaching	6 (6%)	"facilitates education"
	Perceived disadvantage		
	None perceived		
	Total	78/101 (77%)	
Normative belief (n = 17)			
	Referents perceived as favorable		
1	Physicians	19 (14%)	"physicians"
2	Respiratory therapists	18 (13%)	"respiratory therapists"
3	Nurses	16 (12%)	"nurses"
4	The younger generation	13 (9%)	"young people"
7	The trauma team	9 (7%)	"any professional working in the trauma bay with a [traumatic brain injury]"
8	Quality-of-care promoters	9 (7%)	"clinical coordinator"
10	Administration[c]	7(5%)	"general management"
	Referents perceived as unfavorable		
5	People less comfortable with computers	11 (8%)	"those with less computer skills"
6	People resistant to change	11 (8%)	"people less favorable to change"
	Total	113/137 (82%)	
Control belief (n = 31)			
	Perceived facilitating factor		
1	Having a bedside computer	20 (12%)	"have the computer close at hand"
2	Peer-reviewed high-quality scientific information	13 (8%)	"who ensures that the information is good"
3	Trialability[d]	12 (7%)	"must have training"
4	Ease of use[d]	11 (7%)	"simple, instinctive system"
8	Publicity about the wiki	7 (4%)	"should be publicized"
9	Secure website	7 (4%)	"secure system"
12	Having a workstation for every profession	5 (3%)	"each having a workstation"
14	Quality of visual design	5 (3%)	"simple presentation"
	Perceived barrier		
5	Undetermined legal responsibility	10 (6%)	"must know if the hospital endorses it"
6	Time constraints[d]	10 (6%)	"we must act, no time to go look"
7	System reliability	7 (4%)	"if the computer crashes"

XSL•FO
RenderX

Rank[a]	Salient beliefs	n (%)[b]	Verbatim example
10	The whole team not being up-to-date	6 (4%)	"if people are not up-to-date, could be difficult to apply it"
11	Cost of computers	6 (4%)	"the budget"
13	Mandatory use	5 (3%)	"it's not because one center does it that way, that everybody should adopt that practice"
	Total	124/162 (77%)	

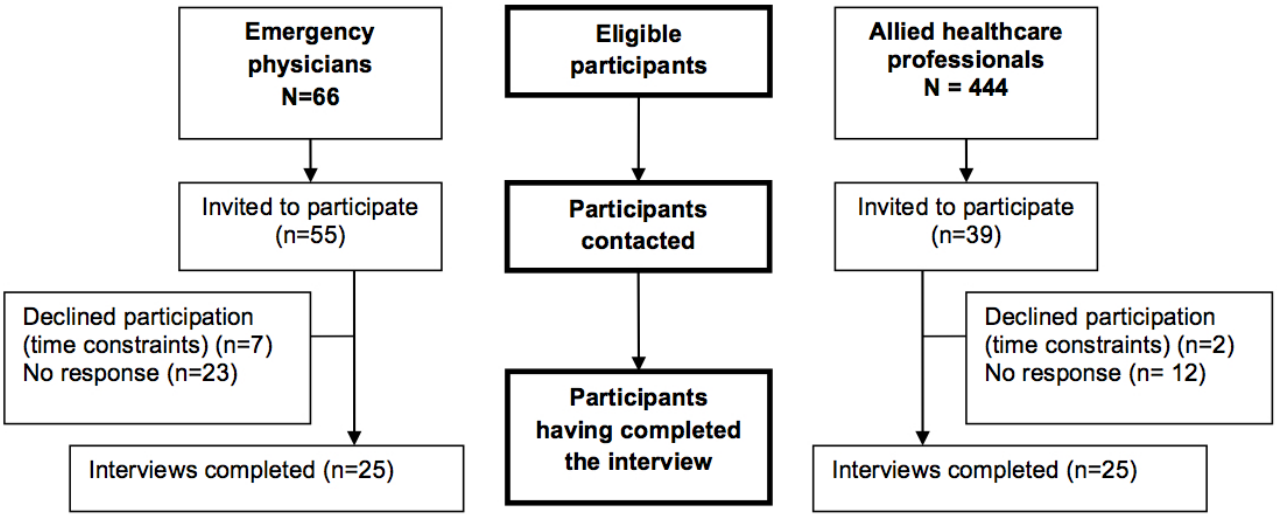
[a] The rank number corresponds to the position held in the ranking of all beliefs. The most frequently mentioned belief is ranked first. The ranking numbers do not necessarily follow each other in this table, since we grouped them as advantages, disadvantages, favorable referents, unfavorable referents, barriers, and facilitators. These rank numbers correspond to their position in Figures 3 to 8.

[b] n = the number of participants who reported the belief during their interview, and % = the number of times the belief was reported in all interviews divided by the number of times all beliefs in that category (behavioral, normative, and control beliefs) were reported in all interviews.

[c] This belief was not mentioned in the top 75% most frequently reported but was retained nonetheless.

[d] The label for this belief was taken from the Gagnon et al framework [62].

Figure 2. Flow of participants through study.



XSL•FO
RenderX

Figure 3. Proportion of emergency physicians who mentioned each behavioral belief (both salient and nonsalient).

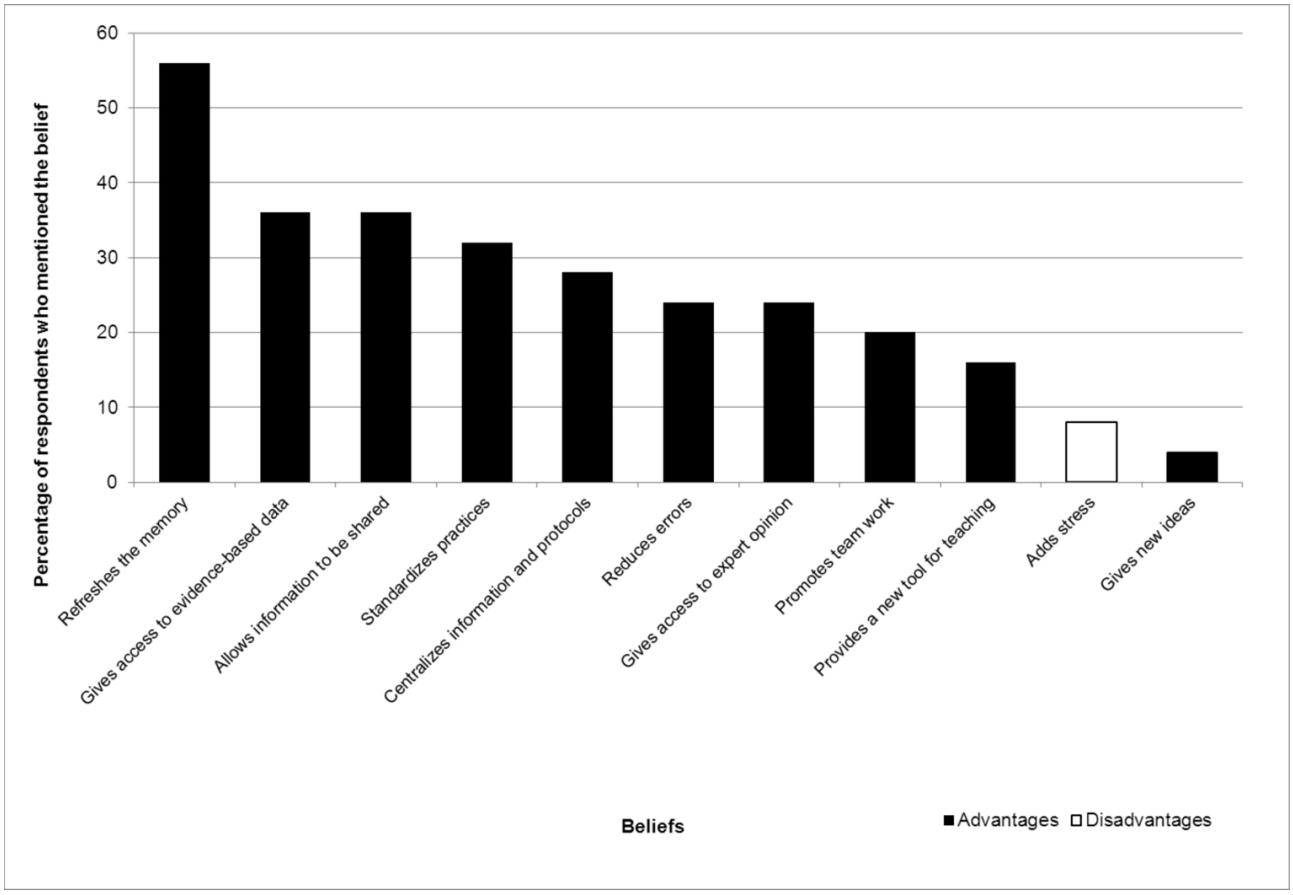
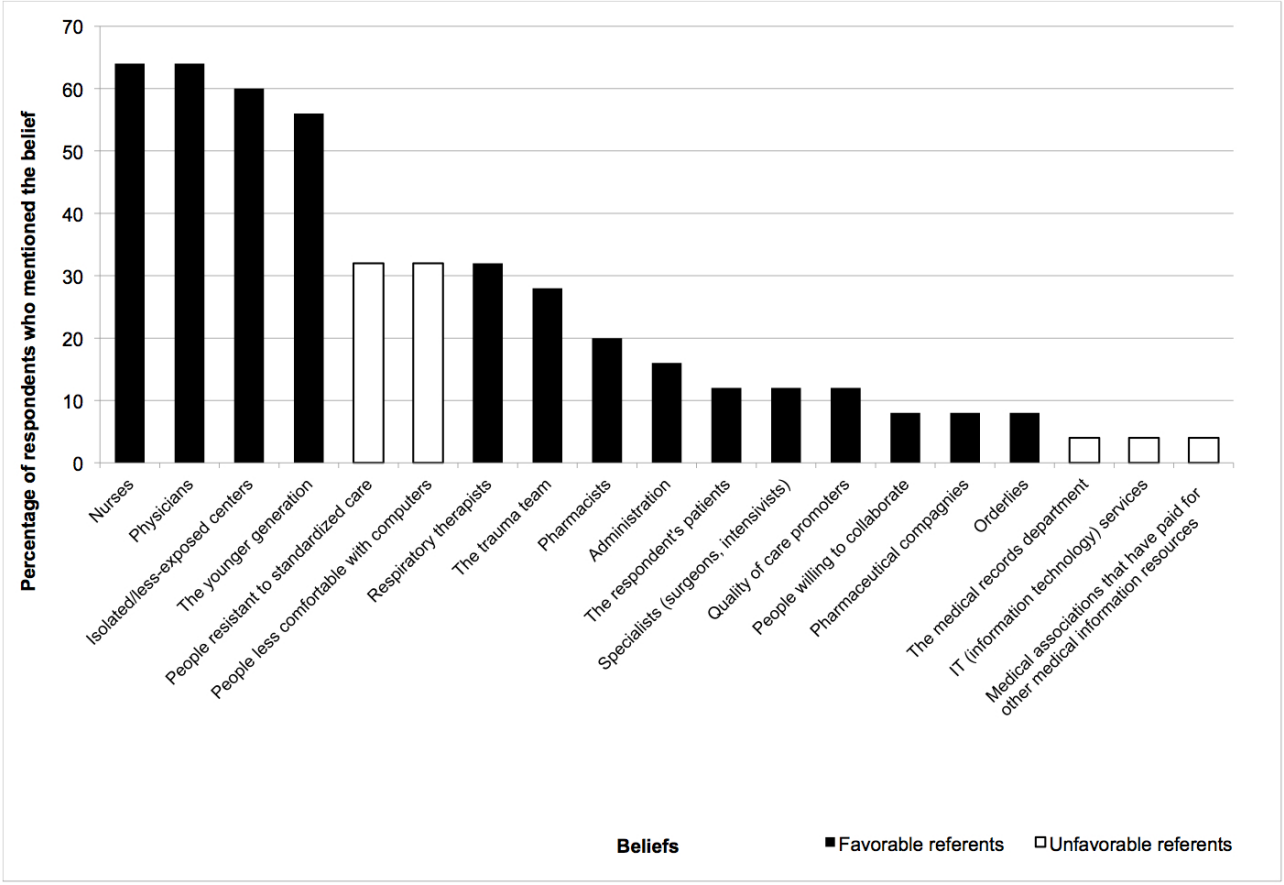


Figure 4. Proportion of emergency physicians who mentioned each normative belief (both salient and nonsalient).



XSL•FO
RenderX

Figure 5. Proportion of emergency physicians who mentioned each control belief (both salient and nonsalient).

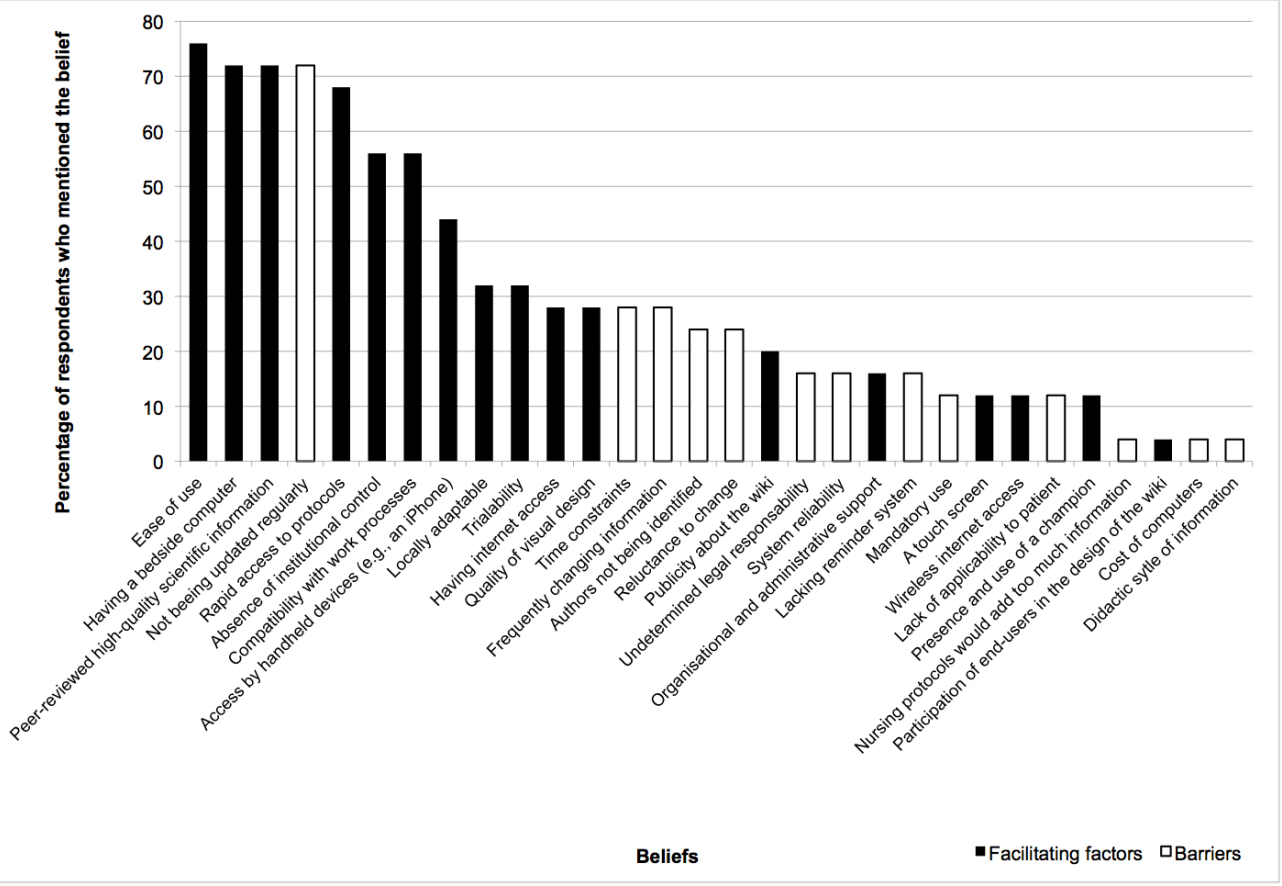
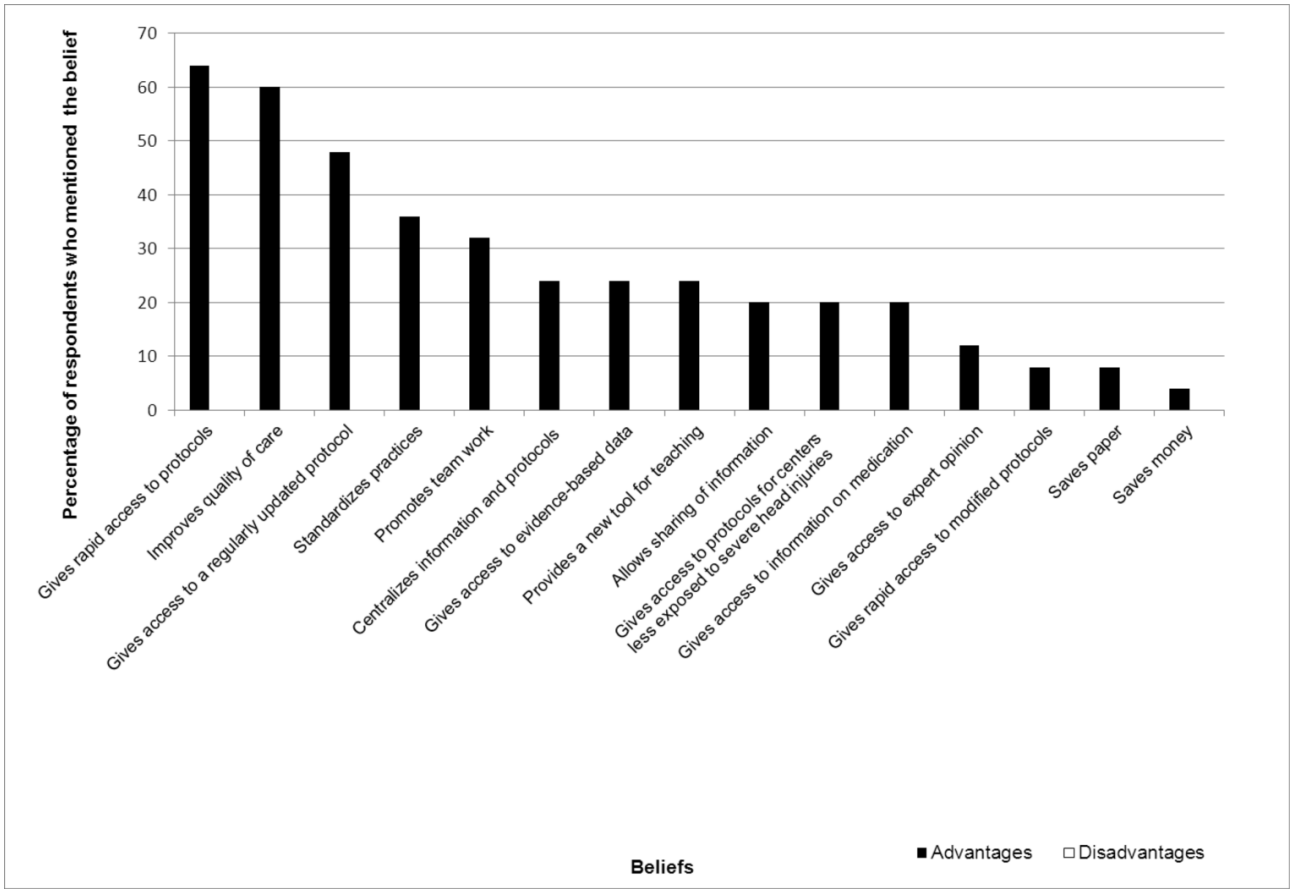


Figure 6. Proportion of allied health professionals who mentioned each behavioral belief (both salient and nonsalient).



XSL•FO
RenderX

Figure 7. Proportion of allied health professionals who mentioned each normative belief (both salient and nonsalient).

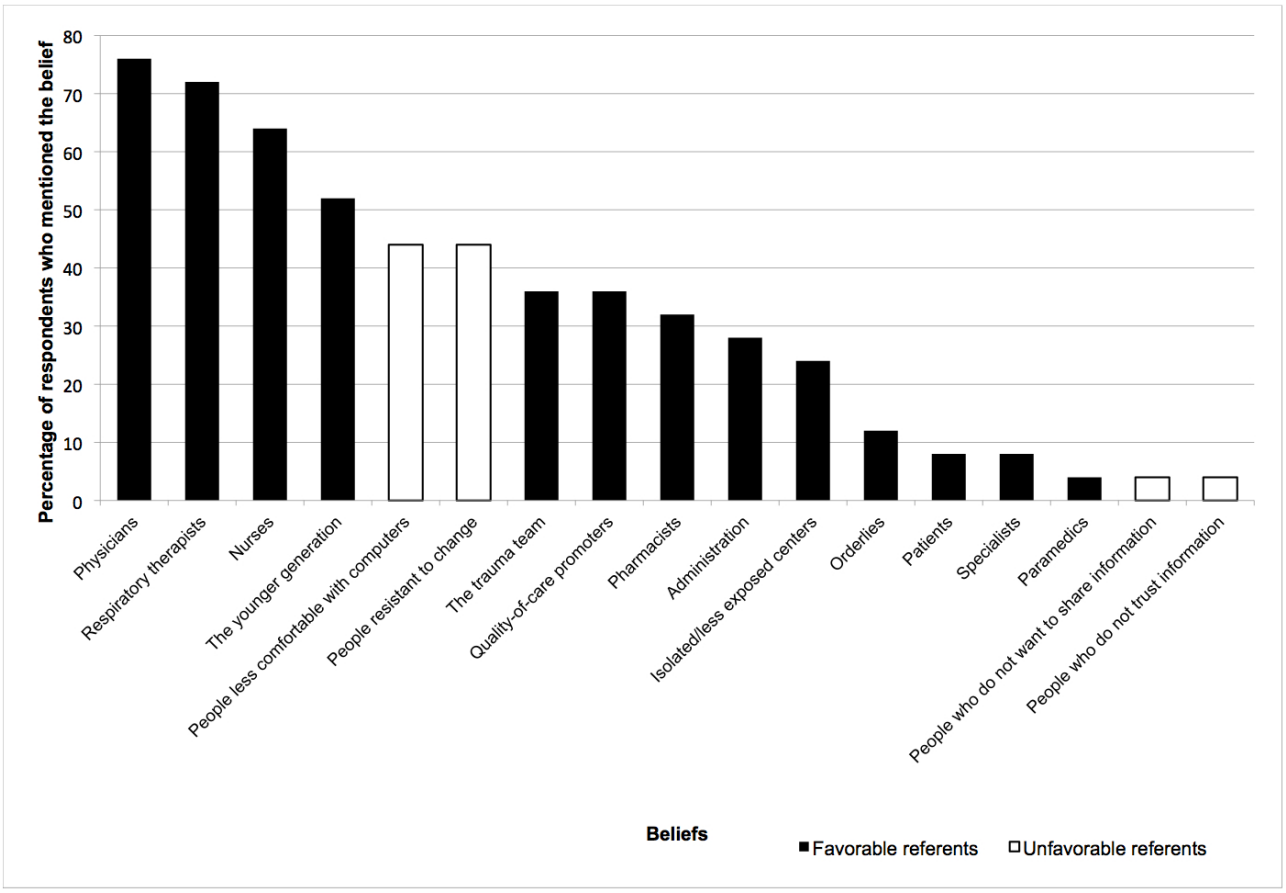
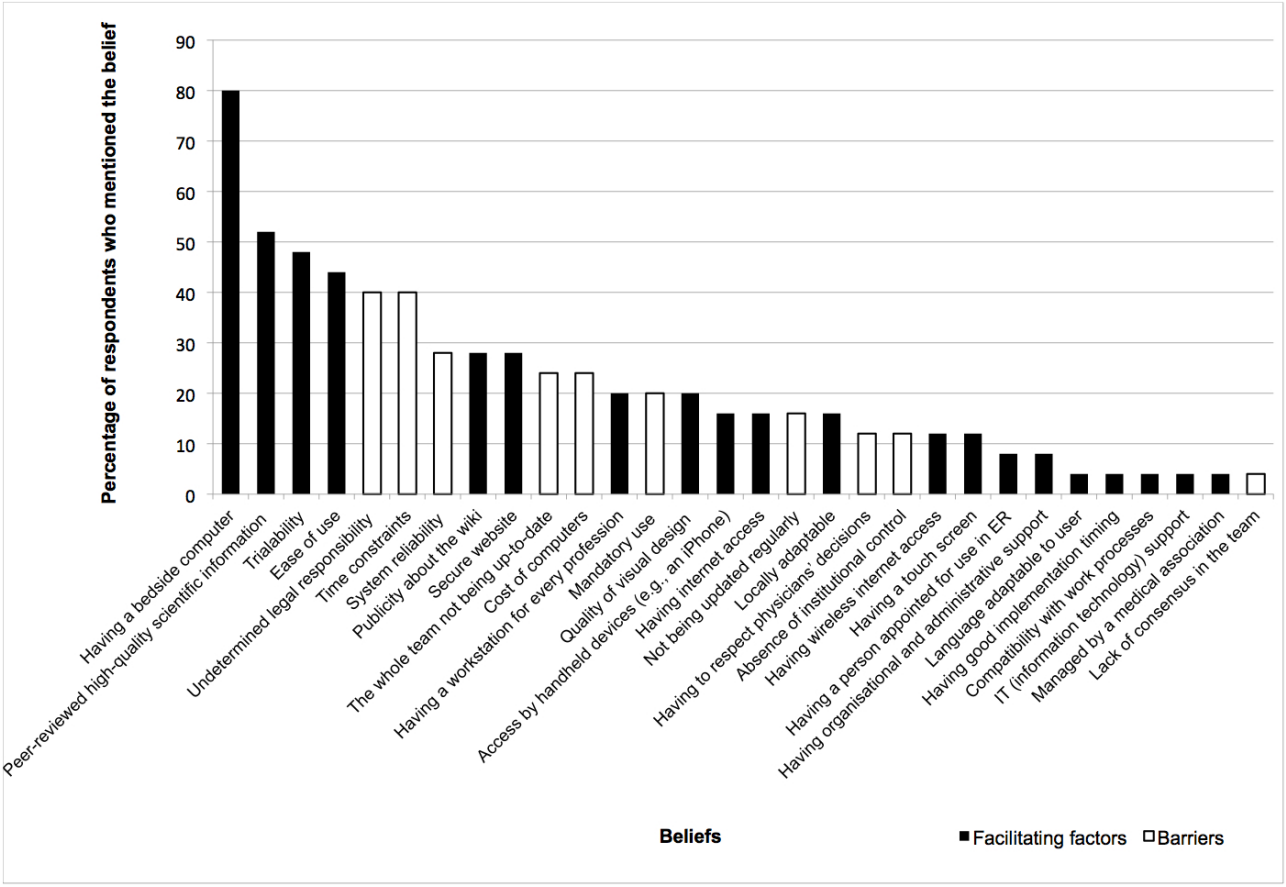


Figure 8. Proportion of allied health professionals who mentioned each control belief (both salient and nonsalient).



XSL•FO
RenderX

Behavioral Beliefs: Advantages and Disadvantages

The three behavioral beliefs about using a wiki-based reminder that EPs mentioned most frequently were, in order of frequency, that if refreshes the memory, gives access to evidence-based data, and allows information to be shared. No disadvantages figured in the top 75% of beliefs, and only one disadvantage was reported at all, with 2 EPs opining that a wiki-based reminder system would add the stress of having to look for information while the patient was there in front of them (Table 2). We retained this belief as salient because it was the only disadvantage reported. The three behavioral beliefs about using a wiki-based reminder that AHPs mentioned most frequently were that it gives the user rapid access to protocols, improves the quality of care, and gives the user access to a regularly updated protocol. AHPs reported no salient disadvantages (Table 3).

Normative Beliefs: Positive and Negative Referents

The three referents most cited by EPs as likely to approve or disapprove of the behavior were nursing personnel, physicians, and isolated or less-exposed trauma centers. All were seen as favorable to the respondent's adopting the behavior (Table 2). The three referents most often mentioned by AHPs were physicians, respiratory therapists, and nurses, all of whom were also considered to approve of the behavior. For EPs, we retained as salient two beliefs pertaining to referents who would disapprove of the behavior: people resistant to standardized care and people less comfortable with computers. AHPs also stated that people less comfortable with computers would not approve. In addition, AHPs feared that people resistant to change would not approve (Table 3). We also retained three beliefs not mentioned in the top 75% for EPs—namely, the respondent's patients, the administration, and specialists—because we consider that these referents play an important role in implementing reminders promoting best practices in trauma care [65-67] and in implementing information and communication technology (ICT) [62,68-70]. We also retained administration for AHPs for the same reasons.

Control Beliefs: Facilitating Factors and Barriers

EPs indicated that the three top facilitators were ease of use, having a computer at the bedside, and accessing information that was peer reviewed and of high scientific quality (Table 2). The most frequently reported barrier was the wiki-based reminder not being regularly updated; the next most frequently reported barriers were time constraints and frequently changing information. We selected as salient beliefs two barriers that were not reported in the top 75%: authors not being identified and undetermined legal responsibility. We also selected these beliefs because they have been frequently reported by other authors [32,36,39,71].

Among AHPs, the three most frequently mentioned facilitators were having a computer at the bedside, accessing information that was peer reviewed and of high scientific quality, and trialability (how easy it is to experiment with the tool) (Table 3). The three most frequently mentioned barriers reported by AHPs were the undetermined legal responsibility of using a wiki, time constraints, and an unreliable information system.

Discussion

This study identified EPs' and AHPs' beliefs about using a wiki-based reminder to promote best practices in caring for patients with a severe traumatic brain injury. Based on the theory of planned behavior, we categorized these beliefs as behavioral, normative, and control beliefs. After analyzing the beliefs and ranking them in order of frequency of mention, we labeled the 75% most-reported beliefs as salient. We also labeled salient certain beliefs that were not among the 75% most reported. This post hoc decision was based on our knowledge of the literature (eg, "administration" as a normative belief), our experience in implementing care protocols for trauma (eg, "specialists" as a normative belief), or our fear of excluding important negative beliefs (eg, "adds stress" as a behavioral belief).

EPs and AHPs saw many of the same advantages to using a wiki-based reminder: namely, that a reminder gives access to evidence-based data, that it standardizes practices, and that it centralizes protocols. EPs and AHPs also shared similar normative beliefs about parties favorable to the use of a wiki-based reminder (nurses, physicians, respiratory therapists, the trauma team, and the younger generation), and both groups mentioned people less comfortable with computers as a negative referent. Many facilitating factors were common to EPs and AHPs: having a computer at the bedside, accessing information that was peer reviewed and of high scientific quality, ease of use, trialability, and an attractive visual design. The groups also had two obstacles in common: time constraints and undetermined legal responsibility.

Our two groups of respondents also differed in the perceived advantages to using a wiki-based reminder. While both saw the centralization of information and protocols as an advantage, only EPs saw the sharing of information as an advantage and only AHPs saw the promotion of teamwork as an advantage. Similarly, both groups saw easy access to a wiki-based reminder (eg, having a bedside computer) as a characteristic that would make using the reminder simple to use, but only EPs saw rapid access to protocols ("fewer than three clicks") as a simplifying feature, and only AHPs saw having a workstation for every professional as such a feature. The apparent contradiction between the AHPs' concern about having a secure website and the EPs' desire to avoid passwords is worth exploring. Finally, AHPs felt it important to publicize and otherwise promote the wiki-based reminder to make it more visible (or in Rogers's terms, which we explain below, "observable"). AHPs saw this as important to the innovation's uptake, recognizing that the more people observe others using a wiki, the more likely they are to use it too.

We noted other differences. Significantly, AHPs named mandatory use as a dominant barrier. At the same time, AHPs often referred to EPs, quality-of-care promoters, and hospital administrators as important decision makers in the care of patients with a severe traumatic brain injury. Thus, if EPs, quality-of-care promoters, and hospital administrators make it mandatory to use a wiki-based reminder, the importance of this barrier might decrease. Research suggests that individuals are more likely to comply with referents' expectations when the

XSL•FO
RenderX

referents in question can reward or punish nonbehavior, as is often the case in a mandatory setting [72,73]. Future work will have to measure and compare the relative importance of these beliefs. These measurements will be used to determine whether implementation strategies should be adapted to different groups of professionals.

Many of the findings in our study confirm the findings of authors who have studied the adoption of other ICTs and of innovations in general. For instance, our participants reported compatibility with work process and trialability as important beliefs. In the diffusion of innovation theory, Rogers identifies these two characteristics in addition to three others—the innovation's relative advantage, its complexity or simplicity, and its observability (the degree to which it is visible to users and potential users)—as influencing an individual's decision to adopt or reject an innovation [74]. Authors besides Rogers have also associated an ICT's lack of compatibility with work process and its poor trialability with the innovation's unsuccessful implementation [32,39,75,76]. Because wiki-based reminders are designed to facilitate changes and edits by all users, they can be modified to fit different work processes [32,36,39]. Likewise, wikis' free and open access could facilitate their trialability [41,42,71]. Hence, these seem like important advantages whose influence will need to be measured in future studies. Our participants reported the other three diffusion of innovation characteristics indirectly.

The findings of this survey are also consistent with the factors proposed by Davis [77] as determinants of the adoption of technology in his Technology Acceptance Model. In Davis's model, the system's perceived ease of use and its perceived usefulness were among the most frequently mentioned beliefs. Similarly, ease of use was the EPs' top control belief and the AHPs' fourth most frequently mentioned belief. As for usefulness, salient beliefs not yet mentioned in this discussion included that a reminder reduces errors (EPs), that it gives users rapid access to protocols (AHPs), that it gives users access to regularly updated protocols (AHPs), and that it is a new teaching tool (AHPs). Prospective measurement of the influence of these beliefs will be important, as high perceptions of system usefulness and ease of use have been associated with cases of ICT adoption [62].

Our study identified additional beliefs (aside from those similar to the beliefs identified by Rogers and by Davis) that were identical to the barriers and facilitators found in a recent systematic review of factors influencing health care professionals' adoption of ICTs [62]. The beliefs in question were the presence and use of a champion, the participation of end users, and time constraints. Time constraints in particular have been identified as an important control belief in studies on ICT adoption [32,41,62,71,78] and in other contexts as well [79]. This is why we considered it salient, even though it ranked only 13th for EPs and sixth for AHPs. Other salient beliefs concerned the speed with which the user could access the reminder (the fifth-ranked control belief for EPs) and the rapidity with which the reminder gave the user access to protocols (the top-ranked behavioral belief for AHPs). Other control beliefs identified in our study were also similar to those identified in the systematic review mentioned above [62]: the quality of the visual design (salient for both groups), the absence of institutional control (salient for EPs, nonsalient for AHPs), the reminder's reliance on peer-reviewed information of high scientific quality (salient for both groups), the mandatory use of the reminder (salient for AHPs, nonsalient for EPs), the lack of a reminder to use the wiki (nonsalient for EPs), having a computer at the bedside (salient for both groups), adding stress (salient for EPs), and use by people less comfortable with computers (salient for both groups).

We also found similarities to studies on the adoption of a computerized decision support system. In these studies, clinicians most wanted such a system to remind them of what they already intended to do [19,34,80,81]. Similarly, the EPs' most frequently reported behavioral belief was that using a wiki-based reminder would refresh their memory. Centralized information (the EPs' fifth-ranked salient behavioral belief) and access from different areas of the hospital have also been described in the literature as important factors in using a computerized decision support system [38,39]. Respondents also perceived these systems as improving patient care [80]: this is similar to the EPs' belief that a wiki-based reminder would help reduce errors (sixth salient behavioral belief).

Our study of wikis also confirmed several barriers described in studies of health care professionals' beliefs about using social media [32,36,39,41-43,78]: concern about the quality of information (EPs and AHPs), undetermined legal responsibilities [36,39,71] (EPs and AHPs), and lack of author identification [32,36] (EPs only). Measuring professionals' perceptions of the importance of these barriers in our questionnaire will be essential to determine how these barriers might influence the use of a wiki-based reminder.

This overlap between study findings, notwithstanding our rigorous use of a theoretical framework, allowed us to identify new beliefs specific to our target population and related to the adoption of wiki-based reminders, beliefs that studies of the adoption of social media in health care had not identified. The importance of these new beliefs will also be important to measure in a future questionnaire. In terms of behavioral beliefs, both EPs and AHPs reported that using a wiki-based reminder could help standardize practices, promote teamwork (salient only for AHPs), and give users access to regularly updated protocols. EPs did not perceive this last factor as an advantage, but stated that having a system that was updated regularly would be a facilitating factor. Surprisingly, EPs also stated that frequently changing information would be a barrier. The importance of these apparently conflicting beliefs will be important to measure because reminders contained within a wiki could indeed change quite frequently if the literature changes frequently or if an edit war should occur. An edit war arises when a user repeatedly re-edits, undoes, or reverses a prior user's edits in an attempt to keep visible his or her preferred version of a page [82].

We also identified many influential groups of people who would be favorable to health care professionals' use of a wiki-based reminder, with EPs and AHPs naming each other as their main influence. So far, interpretations of the role of social influence on the adoption of ICTs have varied. Some authors have argued

XSL•FO
RenderX

for the inclusion of normative beliefs (sources of social influence) in models of adoption and use [83,84], while others have excluded them [77]. Furthermore, some work has found that social influence is significant only under certain circumstances: in settings where ICT use is mandatory [71,85], among women in the early stages of their experience [86,87], and among older workers [88]. However this may be, we believe our study to be the first to have rigorously identified health care professionals' salient normative beliefs concerning the use of any form of social media in health care. This is significant, because understanding the influence of normative beliefs on health professionals' intentions to use social media such as wikis will be of the essence: social media are hypothesized to operate based on social networking, participation, collaboration, apomediation, and openness between peers [89]—all elements related to social influence.

Although age had been noted as a moderating factor in predicting the adoption of ICTs [87], past studies have not described the "younger generation" as an influential referent group, as AHPs and EPs did in our study. This finding is significant, since members of generation Y (people born between 1977 and 1997) will soon constitute a major part of the health care workforce and have been described as being comfortable with technology [90].

Some EPs working in the level I trauma center expressed another important normative belief. They suggested that clinicians in level II and III centers would be more likely to use a wiki-based reminder for the care of patients with a severe traumatic brain injury than would experienced clinicians working in level I centers, who would not need to refer to a reminder. This suggestion reflects the fact that many clinicians working in level I trauma centers view themselves as leaders and champions who help less-experienced clinicians better manage traumatic brain injuries. The influence of this belief must be measured quantitatively. If the experts do not intend to use wiki-based reminders themselves, future exploration must verify whether they intend to contribute their expertise to a wiki in order to help staff at level II and III centers improve their practices. It seems not unlikely that when recognized experts and strong leaders in a field add material to a wiki of evidence-based reminders promoting best practices, other health care professionals are motivated to take up the material in question. Further exploration of the intention to contribute medical information to a wiki will be particularly important because it seems that the level of sharing of medical information through social media is lower than expected for health care professionals [28,43,78].

In spite of its rigorous methods, our study has limitations. First, we did not perform member checking, even though member checking would have made our results more credible. However, two independent research professionals experienced with using the theory of planned behavior analyzed the contents of the interview transcripts rigorously to interpret our respondents' beliefs as trustworthily as possible and resolved disagreements by referring scrupulously to the transcripts. Furthermore, to make it possible for readers to interpret the results for themselves, we have presented a sample transcript for each salient belief.

A second limitation is that our survey was conducted with a small group of EPs and AHPs who were recruited from a single region of the province of Quebec. Even though Godin and Kok [50] suggest that a sample of 25 participants is sufficient to elicit salient beliefs, we cannot assume that our results are transferable to all clinicians, especially in the case of AHPs, where no one professional group (nurses, respiratory therapists, or pharmacists) was sufficiently represented. Nonetheless, even if we surveyed only 6% (25/444) of all AHPs, the proportion of each professional group within our sample was very similar to the proportion of those groups within the total population of eligible AHPs in the three trauma centers from which we drew the sample. Finally, we made every attempt to elicit various beliefs by purposefully sampling participants from three levels of trauma centers, with varying levels of experience, and by including clinicians known to be reluctant to use computers and ICTs. We believe that this sampling method resulted in our recruiting AHPs who were more experienced than the norm. Even though it is difficult to predict the influence of this selection bias, we deliberately chose to have more experienced clinicians take part in this survey, as they are known to have more negative views about adopting new technologies [88]. In predicting the adoption of wiki reminders, measuring negative views is just as important as measuring positive ones.

Third, the video we produced to describe the behavior of study portrayed wikis positively and could have influenced interviewees' beliefs positively as well. Using a mix of animation and actors, the 6-minute video presented wikis as a new and effective way of communicating and collaborating. We produced this video because we needed to demonstrate in a short time how a wiki-based reminder could be used to improve the care of trauma patients and because the use of a wiki-based reminder to promote best practices in trauma remains theoretical for most health care professionals. It also involves many smaller lead-in behaviors (eg, connecting to the Internet, reading the reminder, and applying its suggestions) that are hard to explain during an interview. This said, after realizing that most of the beliefs expressed by participants after viewing the video were positive, we compensated for this possible bias by including negative beliefs that did not meet our 75% most frequently mentioned criteria in our list of salient beliefs.

Finally, our behavior of study was only the use of a wiki-based reminder, not the creation and editing of the reminder. The last two behaviors are important to study in order to understand how a wiki can fulfill its potential to turn a traditionally passive consumer of knowledge into an active producer of knowledge (or *prosumer*, in Eysenbach's terms) [89].

A major strength of this study was its rigorous application of the methods proposed by the authors of the theory of planned behavior to assess our target population's perceived behavioral, normative, and control beliefs related to using a wiki-based reminder. These beliefs will be used to construct a theory-based intervention to increase the use of a wiki-based reminder by EPs and AHPs. Using this theory facilitated our comparison with similar studies and contributed to our elaboration of a theoretical basis for understanding the decision making leading to this behavior. It will also allow researchers to carry out a systematic review in this area. Furthermore, the steps taken to

XSL•FO
RenderX

analyze the content of beliefs are rarely described in detail. Our detailed and rigorous description of the content analysis makes it possible for other researchers to reproduce this approach to exploring health care professionals' salient beliefs about the use of other social media in health care.

Conclusion

This theory-based study has systematically identified the beliefs underlying EPs' and AHPs' intention to use information from a wiki when caring for patients with a traumatic brain injury. It is the first step in our attempt to understand EPs' and AHPs' intentions to use such a reminder, and will help us construct a validated questionnaire that will survey a broader population of EPs and AHPs about their intention to use wiki-based reminders promoting evidence-based traumatic brain injury care. By identifying the most important determinants of EPs' and AHPs' intention to use a wiki-based reminder, we will better understand how wikis could act as knowledge translation interventions to increase evidence-based practices in this area.

Acknowledgments

Funding for this project was provided by a CADRE program (reference number: PDA 1850) (supported by a partnership between the Canadian Health Services Research Foundation and the Canadian Institutes of Health Research). KT Canada, the Département de médecine familiale et médecine d'urgence at Université Laval and CSSS Alphonse-Desjardins (CHAU de Lévis) also contributed funding. The funding agencies and organizations did not influence the content of the manuscript. France Légaré holds the Canada Research Chair in Implementation of Shared Decision Making in Primary Care and is a member of KT Canada. Marie-Pierre Gagnon holds the Tier 2 Canada Research Chair in Technologies and Practices in Health and is a KT Canada member. We thank Jennifer Petrela for editing the manuscript, Yves Lessard for drawing the cartoons for the video, Alain Audet for filming the video, and Amélie Bourassa for sharing parts of a video she produced. We also thank Lee LeFever and Common Craft for permitting us to adapt the original *Wikis in Plain English* video for our study. We thank all the actors in the video: Isabelle Bertrand, Marie-Maude Couture, Renée Turgeon, Amélie Bourassa, Mathieu Simon, Robert Doucet, and André Villeneuve. We also thank Jean-François Rancourt, Luc Génier, Marcel Émond, Alexis Turgeon, Natalie Lesage, Manon Vallières, Caroline Boutin, and Cynthia Fournier for their help in organizing this project. We are also very grateful to all the emergency physicians, nurses, respiratory therapists, and pharmacists who volunteered to answer our survey.

Conflicts of Interest

PA, AB, MPG, KA, AL, JL, JP, MPD, and FL declare that they have no competing interests. Sylvain Croteau is president of Solution Doc 2.0 Inc., a company that is developing a commercial clinical decision support system containing a wiki-based decision support tool.

Authors' Contributions

The principal investigator (PA) wrote a first draft of the manuscript. FL, MPG, AB, AL, JL, JP, KA, SC, and MPD reviewed and modified different versions of this manuscript and approved its final version. AB performed all the interviews. AB and KA performed the content analysis. PA, AB, KA, FL, and MPG reviewed the results. SC, MPD, and PA conceived the idea of the wiki. PA, SC, and MPD developed the script for the video. PA produced the video.

Multimedia Appendix 1

Description of services offered at each level of trauma center.

[PDF File (Adobe PDF File), 29KB - jmir_v14i2e49_app1.pdf]

Multimedia Appendix 2

Video for emergency physicians.

[M4V File, 77MB - jmir_v14i2e49_app2.m4v]

Multimedia Appendix 3

Video for nursing personnel.

[M4V File, 71MB - jmir_v14i2e49_app3.m4v]

Multimedia Appendix 4

Video for respiratory therapists.

[M4V File, 71MB - jmir_v14i2e49_app4.m4v]

XSL•FO
RenderX

Multimedia Appendix 5

Video for pharmacists.

[M4V File, 72MB - jmir_v14i2e49_app5.m4v]

Multimedia Appendix 6

Clinical vignette and semistructured questionnaire.

[PDF File (Adobe PDF File), 69KB - jmir_v14i2e49_app6.pdf]

Multimedia Appendix 7

Table 4. Emergency physicians' nonsalient beliefs about using a wiki-based reminder.

[PDF File (Adobe PDF File), 85KB - jmir_v14i2e49_app7.pdf]

Multimedia Appendix 8

Table 5. Allied health professionals' nonsalient beliefs about using a wiki-based reminder.

[PDF File (Adobe PDF File), 86KB - jmir_v14i2e49_app8.pdf]

References

1. Rhodes M, Sacco W, Smith S, Boorse D. Cost effectiveness of trauma quality assurance audit filters. J Trauma 1990 Jun;30(6):724-727. [Medline: 2112614]
2. Nayduch D, Moylan J, Snyder BL, Andrews L, Rutledge R, Cunningham P. American College of Surgeons trauma quality indicators: an analysis of outcome in a statewide trauma registry. J Trauma 1994 Oct;37(4):565-73; discussion 573. [Medline: 7932886]
3. Copes WS, Staz CF, Konvolinka CW, Sacco WJ. American College of Surgeons audit filters: associations with patient outcome and resource utilization. J Trauma 1995 Mar;38(3):432-438. [Medline: 7897733]
4. Cryer HG, Hiatt JR, Fleming AW, Gruen JP, Sterling J. Continuous use of standard process audit filters has limited value in an established trauma system. J Trauma 1996 Sep;41(3):389-94; discussion 394. [Medline: 8810954]
5. O'Keefe GE, Jurkovich GJ, Maier RV. Defining excess resource utilization and identifying associated factors for trauma victims. J Trauma 1999 Mar;46(3):473-478. [Medline: 10088854]
6. Gruen RL, Jurkovich GJ, McIntyre LK, Foy HM, Maier RV. Patterns of errors contributing to trauma mortality: lessons learned from 2,594 deaths. Ann Surg 2006 Sep;244(3):371-380. [doi: 10.1097/01.sla.0000234655.83517.56] [Medline: 16926563]
7. McDermott FT, Cordner SM, Tremayne AB, Consultative Committee on Road traffic Fatalities. Road traffic fatalities in Victoria, Australia and changes to the trauma care system. Br J Surg 2001 Aug;88(8):1099-1104. [doi: 10.1046/j.0007-1323.2001.01835.x] [Medline: 11488796]
8. McDonald CJ. Protocol-based computer reminders, the quality of care and the non-perfectability of man. N Engl J Med 1976 Dec 9;295(24):1351-1355. [doi: 10.1056/NEJM197612092952405] [Medline: 988482]
9. Croskerry P, Nimmo GR. Better clinical decision making and reducing diagnostic error. J R Coll Physicians Edinb 2011 Jun;41(2):155-162. [doi: 10.4997/JRCPE.2011.208] [Medline: 21677922]
10. Balas EA, Weingarten S, Garb CT, Blumenthal D, Boren SA, Brown GD. Improving preventive care by prompting physicians. Arch Intern Med 2000 Feb 14;160(3):301-308 [FREE Full text] [Medline: 10668831]
11. Buntinx F, Winkens R, Grol R, Knottnerus JA. Influencing diagnostic and preventive performance in ambulatory care by feedback and reminders. A review. Fam Pract 1993 Jun;10(2):219-228. [Medline: 8359615]
12. Wensing M, Grol R. Single and combined strategies for implementing changes in primary care: a literature review. Int J Qual Health Care 1994 Jun;6(2):115-132. [Medline: 7953212]
13. Mandelblatt J, Kanetsky PA. Effectiveness of interventions to enhance physician screening for breast cancer. J Fam Pract 1995 Feb;40(2):162-171. [Medline: 7654272]
14. Garg AX, Adhikari NK, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. JAMA 2005 Mar 9;293(10):1223-1238 [FREE Full text] [doi: 10.1001/jama.293.10.1223] [Medline: 15755945]
15. Hunt DL, Haynes RB, Hanna SE, Smith K. Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review. JAMA 1998 Oct 21;280(15):1339-1346 [FREE Full text] [Medline: 9794315]

XSL•FO
RenderX

16. Johnston ME, Langton KB, Haynes RB, Mathieu A. Effects of computer-based clinical decision support systems on clinician performance and patient outcome. A critical appraisal of research. Ann Intern Med 1994 Jan 15;120(2):135-142. [Medline: 8256973]
17. Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. BMJ 2005 Apr 2;330(7494):765. [doi: 10.1136/bmj.38398.500764.8F] [Medline: 15767266]
18. Shojania KG, Jennings A, Mayhew A, Ramsay CR, Eccles MP, Grimshaw J. The effects of on-screen, point of care computer reminders on processes and outcomes of care. Cochrane Database Syst Rev 2009(3):CD001096. [doi: 10.1002/14651858.CD001096.pub2] [Medline: 19588323]
19. Berner ES. Agency for Healthcare Research and Quality. 2009 Jun. Clinical Decision Support Systems: State of the Art URL: http://healthit.ahrq.gov/images/jun09cdsreview/09_0069_ef.html [accessed 2011-09-03] [WebCite Cache ID 618PJ2PH7]
20. Sahota N, Lloyd R, Ramakrishna A, Mackay JA, Prorok JC, Weise-Kelly L, CCDSS Systematic Review Team. Computerized clinical decision support systems for acute care management: a decision-maker-researcher partnership systematic review of effects on process of care and patient outcomes. Implement Sci 2011;6:91 [FREE Full text] [doi: 10.1186/1748-5908-6-91] [Medline: 21824385]
21. Boulos MN, Maramba I, Wheeler S. Wikis, blogs and podcasts: a new generation of Web-based tools for virtual collaborative clinical practice and education. BMC Med Educ 2006;6:41 [FREE Full text] [doi: 10.1186/1472-6920-6-41] [Medline: 16911779]
22. Kaplan AM, Haenlein M. Users of the world, unite! The challenges and opportunities of social media. Bus Horiz 2010;53(1):59-68. [doi: 10.1016/j.bushor.2009.09.003]
23. Hoffmann R. A wiki for the life sciences where authorship matters. Nat Genet 2008 Sep;40(9):1047-1051. [doi: 10.1038/ng.f.217] [Medline: 18728691]
24. Barwick MA, Peters J, Boydell K. Getting to uptake: do communities of practice support the implementation of evidence-based practice? J Can Acad Child Adolesc Psychiatry 2009 Feb;18(1):16-29. [Medline: 19270845]
25. Dijkstra R, Wensing M, Thomas R, Akkermans R, Braspenning J, Grimshaw J, et al. The relationship between organisational characteristics and the effects of clinical guidelines on medical performance in hospitals, a meta-analysis. BMC Health Serv Res 2006;6:53 [FREE Full text] [doi: 10.1186/1472-6963-6-53] [Medline: 16646968]
26. Deshpande A, Khoja S, Lorca J, McKibbon A, Rizo C, Husereau D, et al. Asynchronous telehealth: a scoping review of analytic studies. Open Med 2009;3(2):e69-e91. [Medline: 19946396]
27. Mavergames C. The Cochrane Collaboration. 2009 Jun 02. Web 2.0 and the Cochrane Collaboration: A Case Study URL: http://www.slideshare.net/mavergames/web-20-and-the-cochrane-collaboration-a-case-study [accessed 2011-08-22] [WebCite Cache ID 618RvAJ37]
28. Heilman JM, Kemmann E, Bonert M, Chatterjee A, Ragar B, Beards GM, et al. Wikipedia: a key tool for global public health promotion. J Med Internet Res 2011;13(1):e14 [FREE Full text] [doi: 10.2196/jmir.1589] [Medline: 21282098]
29. Graham ID, Tetroe J, KT Theories Research Group. Some theoretical underpinnings of knowledge translation. Acad Emerg Med 2007 Nov;14(11):936-941. [doi: 10.1197/j.aem.2007.07.004] [Medline: 17967955]
30. Gupta S, Wan FT, Newton D, Bhattacharyya OK, Chignell MH, Straus SE. WikiBuild: a new online collaboration process for multistakeholder tool development and consensus building. J Med Internet Res 2011;13(4):e108 [FREE Full text] [doi: 10.2196/jmir.1833] [Medline: 22155694]
31. Van De Belt TH, Faber MJ, Knijnenburg J, Nelen WL, Am Kremer J. Wikis as an opportunity to improve patient participation in developing information leaflets: a demonstration project in infertility patients. 2011 Sep 03 Presented at: Medicine 2.0; Sep 17-18, 2011; Stanford, CA, USA URL: http://www.medicine20congress.com/ocs/index.php/med/med2011/paper/view/582
32. Eichner J, Das M. Agency for Healthcare Research and Quality. 2010 Mar. Challenges and Barriers to Clinical Decision Support (CDS) Design and Implementation Experienced in the Agency for Healthcare Research and Quality CDS Demonstrations URL: http://healthit.ahrq.gov/portal/server.pt/gateway/PTARGS_0_11699_911566_0_0_18/CDS_challenges_and_barriers.pdf [accessed 2011-08-23] [WebCite Cache ID 619zYEjOR]
33. Overhage JM, Tierney WM, Zhou XH, McDonald CJ. A randomized trial of "corollary orders" to prevent errors of omission. J Am Med Inform Assoc 1997;4(5):364-375 [FREE Full text] [Medline: 9292842]
34. Tierney WM, Overhage JM, Murray MD, Harris LE, Zhou XH, Eckert GJ, et al. Effects of computerized guidelines for managing heart disease in primary care. J Gen Intern Med 2003 Dec;18(12):967-976. [Medline: 14687254]
35. Weingart SN, Toth M, Sands DZ, Aronson MD, Davis RB, Phillips RS. Physicians' decisions to override computerized drug alerts in primary care. Arch Intern Med 2003 Nov 24;163(21):2625-2631 [FREE Full text] [doi: 10.1001/archinte.163.21.2625] [Medline: 14638563]
36. Wright A, Bates DW, Middleton B, Hongsermeier T, Kashyap V, Thomas SM, et al. Creating and sharing clinical decision support content with Web 2.0: issues and examples. J Biomed Inform 2009 Apr;42(2):334-346. [doi: 10.1016/j.jbi.2008.09.003] [Medline: 18935982]

XSL•FO
RenderX

37. Black AD, Car J, Pagliari C, Anandan C, Cresswell K, Bokun T, et al. The impact of eHealth on the quality and safety of health care: a systematic overview. PLoS Med 2011;8(1):e1000387 [FREE Full text] [doi: 10.1371/journal.pmed.1000387] [Medline: 21267058]
38. Sittig DF, Wright A, Simonaitis L, Carpenter JD, Allen GO, Doebbeling BN, et al. The state of the art in clinical knowledge management: an inventory of tools and techniques. Int J Med Inform 2010 Jan;79(1):44-57. [doi: 10.1016/j.ijmedinf.2009.09.003] [Medline: 19828364]
39. Cresswell KM, Bates DW, Phansalkar S, Sheikh A. Opportunities and challenges in creating an international centralised knowledge base for clinical decision support systems in ePrescribing. BMJ Qual Saf 2011 Jul;20(7):625-630. [doi: 10.1136/bmjqs.2010.048934] [Medline: 21606472]
40. Sittig DF, Wright A, Osheroff JA, Middleton B, Teich JM, Ash JS, et al. Grand challenges in clinical decision support. J Biomed Inform 2008 Apr;41(2):387-392. [doi: 10.1016/j.jbi.2007.09.003] [Medline: 18029232]
41. Sandars J, Schroter S. Web 2.0 technologies for undergraduate and postgraduate medical education: an online survey. Postgrad Med J 2007 Dec;83(986):759-762. [doi: 10.1136/pgmj.2007.063123] [Medline: 18057175]
42. Hughes B, Joshi I, Lemonde H, Wareham J. Junior physician's use of Web 2.0 for information seeking and medical education: a qualitative study. Int J Med Inform 2009 Oct;78(10):645-655. [doi: 10.1016/j.ijmedinf.2009.04.008] [Medline: 19501017]
43. Mcgowan B, Vartabedian B, Miller R, Wasko M. The 'meaningful use' of social media by physicians for learning. 2011 Sep 17 Presented at: Medicine 2.0; Sep 17-18, 2011; Stanford, CA, USA URL: http://www.medicine20congress.com/ocs/index.php/med/med2011/paper/view/764
44. Eysenbach G. The law of attrition. J Med Internet Res 2005;7(1):e11 [FREE Full text] [doi: 10.2196/jmir.7.1.e11] [Medline: 15829473]
45. Ajzen I. Attitudes, Personality and Behavior: Mapping Social Psychology. Maidenhead: Open University Press; 1988.
46. Conner M, Norman P. Predicting health behaviour: research and practice with social cognition models. Buckingham: Open University Press; 1996.
47. Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process 1991;50(2):179-211 [FREE Full text]
48. Godin G, Boyer R, Duval B, Fortin C, Nadeau D. Understanding physicians' decision to perform a clinical examination on an HIV seropositive patient. Med Care 1992 Mar;30(3):199-207. [Medline: 1538608]
49. Millstein SG. Utility of the theories of reasoned action and planned behavior for predicting physician behavior: a prospective analysis. Health Psychol 1996 Sep;15(5):398-402. [Medline: 8891719]
50. Godin G, Kok G. The theory of planned behavior: a review of its applications to health-related behaviors. Am J Health Promot 1996;11(2):87-98. [Medline: 10163601]
51. Walker AE, Grimshaw JM, Armstrong EM. Salient beliefs and intentions to prescribe antibiotics for patients with a sore throat. Br J Health Psychol 2001 Nov;6(Part 4):347-360. [doi: 10.1348/135910701169250] [Medline: 12614509]
52. Park ER, DePue JD, Goldstein MG, Niaura R, Harlow LL, Willey C, et al. Assessing the transtheoretical model of change constructs for physicians counseling smokers. Ann Behav Med 2003;25(2):120-126. [Medline: 12704014]
53. Gagnon MP, Godin G, Gagné C, Fortin JP, Lamothe L, Reinharz D, et al. An adaptation of the theory of interpersonal behaviour to the study of telemedicine adoption by physicians. Int J Med Inform 2003 Sep;71(2-3):103-115. [Medline: 14519403]
54. Liabsuetrakul T, Chongsuvivatwong V, Lumbiganon P, Lindmark G. Obstetricians' attitudes, subjective norms, perceived controls, and intentions on antibiotic prophylaxis in caesarean section. Soc Sci Med 2003 Nov;57(9):1665-1674. [Medline: 12948575]
55. Rutter D, Quine L. Social cognition models and changing health behaviours. In: Rutter D, Quine L, editors. Changing Health Behaviour: Intervention and Research with Social Cognition Models. Buckingham: Open University Press; 2002:1-27.
56. Gagnon MP, Légaré F, Labrecque M, Frémont P, Cauchon M, Desmartis M. Perceived barriers to completing an e-learning program on evidence-based medicine. Inform Prim Care 2007;15(2):83-91. [Medline: 17877870]
57. Webb TL, Joseph J, Yardley L, Michie S. Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. J Med Internet Res 2010;12(1):e4 [FREE Full text] [doi: 10.2196/jmir.1376] [Medline: 20164043]
58. Archambault PM, Légaré F, Lavoie A, Gagnon MP, Lapointe J, St-Jacques S, et al. Healthcare professionals' intentions to use wiki-based reminders to promote best practices in trauma care: a survey protocol. Implement Sci 2010;5:45 [FREE Full text] [doi: 10.1186/1748-5908-5-45] [Medline: 20540775]
59. LeFever L. Wikis in Plain English.: Commoncraft URL: http://www.commoncraft.com/video/wikis [accessed 2011-10-19] [WebCite Cache ID 62Xls3OFm]
60. Renold E. Using vignettes in qualitative research. Build Res Capacity 2002 Jul(3):3-5 [FREE Full text] [WebCite Cache ID 66lFBwWix]
61. Elo S, Kyngäs H. The qualitative content analysis process. J Adv Nurs 2008 Apr;62(1):107-115. [doi: 10.1111/j.1365-2648.2007.04569.x] [Medline: 18352969]
62. Gagnon MP, Desmartis M, Labrecque M, Car J, Pagliari C, Pluye P, et al. Systematic review of factors influencing the adoption of information and communication technologies by healthcare professionals. J Med Syst 2012 Feb;36(1):241-277. [doi: 10.1007/s10916-010-9473-4] [Medline: 20703721]

XSL•FO
RenderX

63. Francis JJ, Eccles MP, Johnston M, Walker A, Grimshaw J, Foy R, et al. Constructing Questionnaires Based on the Theory of Planned Behaviour: A Manual for Health Services Researchers. Newcastle-upon-Tyne: Centre for Health Services Research; 2004. URL: http://pages.bangor.ac.uk/~pes004/exercise_psych/downloads/tpb_manual.pdf [WebCite Cache ID 66lFkJ6ro]
64. Anonymous. QuickCalcs Online Calculators for Scientists.: GraphPad Software, Inc; 2005. URL: http://www.graphpad.com/quickcalcs/index.cfm [accessed 2011-10-19] [WebCite Cache ID 62XmKfEGU]
65. Patel HC, Menon DK, Tebbs S, Hawker R, Hutchinson PJ, Kirkpatrick PJ. Specialist neurocritical care and outcome from head injury. Intensive Care Med 2002 May;28(5):547-553. [Medline: 12029400]
66. Palmer S, Bader MK, Qureshi A, Palmer J, Shaver T, Borzatta M, et al. The impact on outcomes in a community hospital setting of using the AANS traumatic brain injury guidelines. Americans Associations for Neurologic Surgeons. J Trauma 2001 Apr;50(4):657-664. [Medline: 11303160]
67. Hesdorffer DC, Ghajar J. Marked improvement in adherence to traumatic brain injury guidelines in United States trauma centers. J Trauma 2007 Oct;63(4):841-7; discussion 847. [doi: 10.1097/TA.0b013e318123fc21] [Medline: 18090015]
68. Øvretveit J, Scott T, Rundall TG, Shortell SM, Brommels M. Improving quality through effective implementation of information technology in healthcare. Int J Qual Health Care 2007 Oct;19(5):259-266 [FREE Full text] [doi: 10.1093/intqhc/mzm031] [Medline: 17717038]
69. Verhoeven F, Steehouder MF, Hendrix RM, van Gemert-Pijnen JE. Factors affecting health care workers' adoption of a website with infection control guidelines. Int J Med Inform 2009 Oct;78(10):663-678. [doi: 10.1016/j.ijmedinf.2009.06.001] [Medline: 19577956]
70. Lapointe L, Rivard S. Getting physicians to accept new information technology: insights from case studies. CMAJ 2006 May 23;174(11):1573-1578 [FREE Full text] [doi: 10.1503/cmaj.050281] [Medline: 16717265]
71. Masters K. For what purpose and reasons do doctors use the Internet: a systematic review. Int J Med Inform 2008 Jan;77(1):4-16. [doi: 10.1016/j.ijmedinf.2006.10.002] [Medline: 17137833]
72. Hartwick J, Barki H. Explaining the role of user participation in information system use. Manag Sci 1994;40(4):440-465. [doi: 10.1287/mnsc.40.4.440]
73. Warshaw PR. A new model for predicting behavioral intentions: an alternative to Fishbein. J Marketing Res 1980;17(2):153-172. [doi: 10.2307/3150927]
74. Rogers EM. Diffusion of Innovations. 5th edition. New York, NY: Free Press; 2003.
75. Ammenwerth E, Iller C, Mahler C. IT-adoption and the interaction of task, technology and individuals: a fit framework and a case study. BMC Med Inform Decis Mak 2006;6:3 [FREE Full text] [doi: 10.1186/1472-6947-6-3] [Medline: 16401336]
76. Yusof MM, Kuljis J, Papazafeiropoulou A, Stergioulas LK. An evaluation framework for Health Information Systems: human, organization and technology-fit factors (HOT-fit). Int J Med Inform 2008 Jun;77(6):386-398. [doi: 10.1016/j.ijmedinf.2007.08.011] [Medline: 17964851]
77. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology (MISQ 89). Manag Inf Syst Q 1989;13:319-339 [FREE Full text] [WebCite Cache ID 66lA9jSKO]
78. Lupiáñez-Villanueva F, Mayer MA, Torrent J. Opportunities and challenges of Web 2.0 within the health care systems: an empirical exploration. Inform Health Soc Care 2009 Sep;34(3):117-126. [doi: 10.1080/17538150903102265] [Medline: 19670002]
79. Gravel K, Légaré F, Graham ID. Barriers and facilitators to implementing shared decision-making in clinical practice: a systematic review of health professionals' perceptions. Implement Sci 2006;1:16 [FREE Full text] [doi: 10.1186/1748-5908-1-16] [Medline: 16899124]
80. Sittig DF, Krall MA, Dykstra RH, Russell A, Chin HL. A survey of factors affecting clinician acceptance of clinical decision support. BMC Med Inform Decis Mak 2006;6:6 [FREE Full text] [doi: 10.1186/1472-6947-6-6] [Medline: 16451720]
81. Teich JM, Merchia PR, Schmiz JL, Kuperman GJ, Spurr CD, Bates DW. Effects of computerized physician order entry on prescribing practices. Arch Intern Med 2000 Oct 9;160(18):2741-2747 [FREE Full text] [Medline: 11025783]
82. Agha R. Introducing Wikisurgery.com: the blueprint for a surgical architecture of participation. Int J Surg 2006;4(3):140-143. [doi: 10.1016/j.ijsu.2006.07.002] [Medline: 17462335]
83. Taylor S, Todd PA. Understanding information technology usage: a test of competing models. Inf Syst Res 1995;6(2):144-176. [doi: 10.1287/isre.6.2.144]
84. Thompson RL, Higgins CA, Howell JM. Personal computing: toward a conceptual model of utilization. Manag Inf Syst Q 1991;15(1):125-143. [doi: 10.2307/249443]
85. Venkatesh V, Davis FD. A theoretical extension of the technology acceptance model: four longitudinal field studies. Manag Sci 2000;46(2):186-204. [doi: 10.1287/mnsc.46.2.186.11926]
86. Venkatesh V, Morris MG, Ackerman PL. A longitudinal field investigation of gender differences in individual technology adoption decision-making processes. Organ Behav Hum Decis Process 2000 Sep;83(1):33-60. [doi: 10.1006/obhd.2000.2896] [Medline: 10973782]
87. Venkatesh V, Morris MG, Gordon BD, Davis FD. User acceptance of information technology: toward a unified view. Manag Inf Syst Q 2003;27(3):425-478 [FREE Full text] [WebCite Cache ID 66lAw0HPT]

XSL•FO
RenderX

88. Morris MG, Venkatesh V. Age differences in technology adoption decisions: implications for a changing work force. Pers Psychol 2000;53(2):375-403. [doi: 10.1111/j.1744-6570.2000.tb00206.x]
89. Eysenbach G. Medicine 2.0: social networking, collaboration, participation, apomediation, and openness. J Med Internet Res 2008;10(3):e22 [FREE Full text] [doi: 10.2196/jmir.1030] [Medline: 18725354]
90. Alch ML. The echo-boom generation: a growing force in American society. Futurist 2000;34(5):42 [FREE Full text] [WebCite Cache ID 66lCOBZ2i]

Abbreviations

AHP: Allied health care professional
EP: Emergency physician
ICT: information and communication technology

Edited by G Eysenbach; submitted 03.11.11; peer-reviewed by M Kastner; comments to author 27.11.11; revised version received 19.02.12; accepted 22.02.12; published 19.04.12.

Please cite as:
Archambault PM, Bilodeau A, Gagnon MP, Aubin K, Lavoie A, Lapointe J, Poitras J, Croteau S, Pham-Dinh M, Légaré F
Health Care Professionals' Beliefs About Using Wiki-Based Reminders to Promote Best Practices in Trauma Care
J Med Internet Res 2012;14(2):e49
URL: http://www.jmir.org/2012/2/e49/
doi:10.2196/jmir.1983
PMID:22515985

©Patrick Michel Archambault, Andrea Bilodeau, Marie-Pierre Gagnon, Karine Aubin, André Lavoie, Jean Lapointe, Julien Poitras, Sylvain Croteau, Martin Pham-Dinh, France Légaré. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 19.04.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Original Paper

Development of Web-Based Computer-Tailored Advice to Promote Physical Activity Among People Older Than 50 Years

Denise A Peels[1], MSc; Maartje M van Stralen[2], PhD; Catherine Bolman[1], PhD; Rianne HJ Golsteijn[1], MSc; Hein de Vries[3,4], PhD; Aart N Mudde[1], PhD; Lilian Lechner[1], PhD

[1]Department of Psychology, Open University of the Netherlands, Heerlen, Netherlands

[2]EMGO Institute for Health and Care Research, Department of Public and Occupational Health, VU University Medical Centre, Amsterdam, Netherlands

[3]Department of Health Promotion, Maastricht University, Maastricht, Netherlands

[4]Care and Public Health Research Institute (Caphri), Maastricht University, Maastricht, Netherlands

Corresponding Author:
Denise A Peels, MSc
Department of Psychology
Open University of the Netherlands
Valkenburgerweg 177
PO Box 2960
Heerlen, 6419 AT
Netherlands
Phone: 31 45 576 22 96
Fax: 31 45 576 22 96
Email: denise.peels@ou.nl

Abstract

Background: The Active Plus project is a systematically developed theory- and evidence-based, computer-tailored intervention, which was found to be effective in changing physical activity behavior in people aged over 50 years. The process and effect outcomes of the first version of the Active Plus project were translated into an adapted intervention using the RE-AIM framework. The RE-AIM model is often used to evaluate the potential public health impact of an intervention and distinguishes five dimensions: reach, effectiveness, adoption, implementation, and maintenance.

Objective: To gain insight into the systematic translation of the first print-delivered version of the Active Plus project into an adapted (Web-based) follow-up project. The focus of this study was on the reach and effectiveness dimensions, since these dimensions are most influenced by the results from the original Active Plus project.

Methods: We optimized the potential reach and effect of the interventions by extending the delivery mode of the print-delivered intervention into an additional Web-based intervention. The interventions were adapted based on results of the process evaluation, analyses of effects within subgroups, and evaluation of the working mechanisms of the original intervention. We pretested the new intervention materials and the Web-based versions of the interventions. Subsequently, the new intervention conditions were implemented in a clustered randomized controlled trial.

Results: Adaptations resulted in four improved tailoring interventions: (1) a basic print-delivered intervention, (2) a basic Web-based intervention, (3) a print-delivered intervention with an additional environmental component, and (4) a Web-based version with an additional environmental component. Pretest results with participants showed that all new intervention materials had modest usability and relatively high appreciation, and that filling in an online questionnaire and performing the online tasks was not problematic. We used the pretest results to improve the usability of the different interventions. Implementation of the new interventions in a clustered randomized controlled trial showed that the print-delivered interventions had a higher response rate than the Web-based interventions. Participants of both low and high socioeconomic status were reached by both print-delivered and Web-based interventions.

Conclusions: Translation of the (process) evaluation of an effective intervention into an adapted intervention is challenging and rarely reported. We discuss several major lessons learned from our experience.

Trial Registration: Nederlands Trial Register (NTR): 2297; http://www.trialregister.nl/trialreg/admin/rctview.asp?TC=2297 (Archived by WebCite at http://www.webcitation.org/65TkwoESp).

XSL•FO
RenderX

(J Med Internet Res 2012;14(2):e39) doi:10.2196/jmir.1742

KEYWORDS

Computer-tailored advice; physical activity; Web-based intervention; older adults; exercise; environment; RE-AIM model

Introduction

Regular physical activity reduces the risks of multiple health problems, which often become more prevalent when people age [1-3]. An international guideline for physical activity recommends that older adults should be physically active at moderate to vigorous intensity for at least 5 days a week, for a minimum of 30 minutes a day [4,5]. Regular physical activity is also particularly important for older adults to enable them to maintain their mobility and independence; to improve muscle strength, cognitive functioning, and mental and emotional well-being; and to prevent falls [2,4-8]. Because of the aging population in the Netherlands, stimulating physical activity among people over 50 years of age is of major relevance.

The Active Plus project is a computer-tailored, theory-driven, evidence-based intervention aimed at increasing physical activity in people aged over 50 years. The intervention, consisting of print-delivered tailored advice to improve the level of physical activity, has proven to be effective in changing physical activity behavior in the short and long terms, and was effective in reaching and affecting high-risk groups such as people of low socioeconomic status (SES) [9,10]. The purpose of this study was to gain insight into the translation of the first print-delivered version of the Active Plus project into an adapted (Web-based) follow-up project based on evaluation results, by using the RE-AIM framework.

The Active Plus project consisted of two phases: (1) systematic development and evaluation of the first version of the Active Plus project, which was completed in 2009 and has proven to be effective, and (2) translation of process and effect evaluation outcomes of the first Active Plus project into an adapted project using the RE-AIM framework to further increase the reach and effect of the project and its implementation in a clustered randomized controlled trial (RCT).

In the first phase of the Active Plus project (2005–2009), interventions were systematically developed using the intervention mapping protocol [11]. Development was based on a literature review [12], a Delphi study among experts in the field [13], focus group interviews, and a review of theoretical models, such as the I-Change Model [14], the Health Action Process Approach [15], self-regulation theory [16,17], and self-determination theory [18,19], to assess the most relevant and changeable personal and environmental determinants associated with changing physical activity behavior [20]. A complete description of the development and characteristics of the first version of the Active Plus project can be found elsewhere [20]. The first version of the Active Plus project consisted of two print-delivered, tailored physical activity interventions: (1) a basic computer-tailored intervention (to raise awareness of lack of physical activity, and to stimulate initiation and maintenance of physical activity), and (2) an intervention with additional environmental components that focused on giving tailored personalized advice on local possibilities and initiatives for being physically active for people over 50 years of age. The additional environmental component was intended to positively change people's perceptions of the opportunities to be physically active in their own environment [21]. Both interventions included three tailored letters, based on the answers individuals gave in previous assessment, delivered by mail over 4 months [20]: (1) 2 weeks after the baseline assessment, (2) 2 months after the baseline assessment, and (3) 4 months after baseline assessment, based on the second assessment. The third tailored advice contained ipsative feedback about the changes in the respondents' physical activity behavior and the psychosocial determinants in the previous 4 months. This means that improvements in (determinants of) physical activity were rewarded and possible relapses were addressed appropriately with additional suggestions to increase physical activity levels again.

Both original Active Plus interventions have proven effective in changing physical activity behavior [9,10]. Results showed that participants in the intervention groups increased their physical activity by 14%, from 4.2 days per week of at least 30 minutes of physical activity at baseline to 4.9 days per week at 6 months, while the control group did not change. At 12 months, the intervention groups were still physically active for 4.7 days per week. Further, both interventions were effective in reaching low-SES groups: 48% of all participants had a low level of education. Effects on physical activity were similar among different SES groups, but the low-SES group evaluated both interventions significantly more positively than did the high-SES group [9,22]. At 3 (ie, during the intervention), 6 (ie, 2 months postintervention), and 12 months (ie, 8 months postintervention), a process evaluation, an effect evaluation, and an evaluation of the working mechanisms of the intervention (ie, analyses of mediators) and less-responsive subgroups (ie, analyses of moderators) were conducted [10,22]. The results of these evaluations were the starting point for the second phase of this project.

In the second phase of the project, we translated the process and effect outcomes of the first version of the Active Plus project into an adapted intervention using the RE-AIM framework [23-26] and implemented the new interventions in a clustered RCT. The RE-AIM model is often used to evaluate the potential public health impact of an intervention [23]. The model distinguishes five different dimensions: (1) reach: the number and representativeness of individuals willing to participate, (2) effectiveness: the impact of the intervention on target outcomes, (3) adoption: the proportion and representativeness of settings that adopt the intervention, (4) implementation: the extent to which the interventions are delivered as intended, and (5) maintenance: the extent to which individual participants maintain behavior change in the long term and the extent to which the intervention is sustained over time within the organizations that deliver the intervention [23-26].

XSL•FO
RenderX

The aim of this study was to systematically translate the results of the (process) evaluation of the first version of the Active Plus project into an adapted follow-up (Web-based) project using the RE-AIM framework. Our focus was on the reach and effectiveness dimensions, since these dimensions are most influenced by the results from the original Active Plus project. Although relevant, the adoption, implementation, and maintenance dimensions depend on evaluation of the effectiveness of the new (Web-based) interventions, and were therefore beyond the scope of this paper. Additional evaluation results and response rates of the adapted interventions will be shown.

Methods

Results of the process and effect evaluation of the original Active Plus project [10,21,22] were translated into a new (Web-based) project using the RE-AIM framework. We briefly outline the methods that we used to evaluate and adapt the Active Plus interventions according to the RE-AIM framework; we describe the actual adaptations in the Results section.

We improved the potential *reach* of the intervention by extending the delivery mode of the print-delivered intervention into an additional Web-based intervention with lower implementation costs. Furthermore, we used the process evaluation results of the original project [21] to detect how subgroups appreciated the intervention and thereby to subsequently adapt the interventions to optimize appreciation among certain groups and to increase the potential reach of the interventions.

To improve *effectiveness*, we used results of the process evaluation, analyses of effects within subgroups (ie, analyses of moderators [22]), and evaluation of the working mechanisms of the original intervention (ie, analyses of mediators [10,21]) to adapt and develop new intervention materials to eventually increase the potential effect of the intervention.

A quantitative pretest was performed using a questionnaire among 30 participants to study the appreciation and usability of all new intervention materials. Appreciation of the new intervention materials was assessed with 5 items per intervention element. Participants were asked whether they perceived the intervention materials as interesting, understandable, pleasant, advantageous, and motivating, using a 5-point Likert scale (ranging from 1, totally disagree, to 5, totally agree). We assessed usability using a 10-point Likert scale (ranging from 1, not useful, to 10, very useful). Additional in-depth open-ended questions were used to provide insight into the reasons why people gave certain ratings, and respondents were asked to write down their remarks regarding the new intervention strategies. The intervention strategies were subsequently adjusted according to the preferences of the pilot group.

A qualitative in-depth pretest (3 expert users and 7 nonexpert users) was performed to assess the usability of the new Web-based intervention as a whole. The expert users (all working in the field of health psychology) were asked to review the content of the intervention. All nonexpert participants were older than 50 years with little to average experience with Internet use, and were monitored while filling in the online questionnaire and reading the online advice. We used the results from this second pretest to further improve the Web-based intervention.

Study Design

To study the effectiveness of the new interventions, and to monitor their adoption by the target population, we implemented the adapted interventions (a basic print-delivered intervention; a print-delivered intervention with environmental information; a basic Web-based intervention; and a Web-based intervention with environmental information) in a clustered RCT, including a control group that received no advice.

The main study parameters were changes in physical activity behavior (measured using the self-administered Dutch Short Questionnaire to Assess Health-Enhancing Physical Activity [27]), and determinants of changing and maintaining physical activity behavior.

Participants and Procedure in the Clustered RCT

For the follow-up clustered RCT of the new interventions, we selected six municipal health council regions that had not participated in the first phase of the Active Plus project. To prevent participants from different intervention conditions contaminating each other (especially regarding whether they received environmental information), randomization was at the municipal health council region level, which means that each region was randomly assigned to one of the intervention conditions. This ensured that all participants were randomly assigned through their region to one of the conditions and were not able to choose the delivery mode (print delivered vs Web based) of the intervention. For each intervention condition, we selected seven (matched) neighborhoods to participate in the RCT. Neighborhoods were matched on their urbanization, percentage of people with a low SES, percentage of people with a high SES, percentage of immigrants, and percentage of people aged over 50 years. Each municipal health council provided a random sample of eligible participants living in the selected matched neighborhoods, after stratification for age. Figure 1 provides an overview of the selection of participants and of the number of participants for each intervention condition.

A power calculation (effect size = 0.4, power = 80%, intracluster correlation coefficient = .1) showed that at baseline about 420 participants were needed for each intervention condition (considering a dropout rate of 40% during the 1-year follow-up based on the original Active Plus project, and accounting for the multilevel design based on an estimate of the intracluster correlation coefficient). Because of an expected response rate of 23% (based on the previous Active Plus study [9]), our starting point was to distribute 1850 invitations in participating regions of the print-delivered intervention. Because the use of a Web-based intervention among persons aged over 50 years is less established, 2775 (50% extra) invitations were originally distributed in each Web-based intervention condition.

We recorded response rates for the different intervention conditions in SES groups.

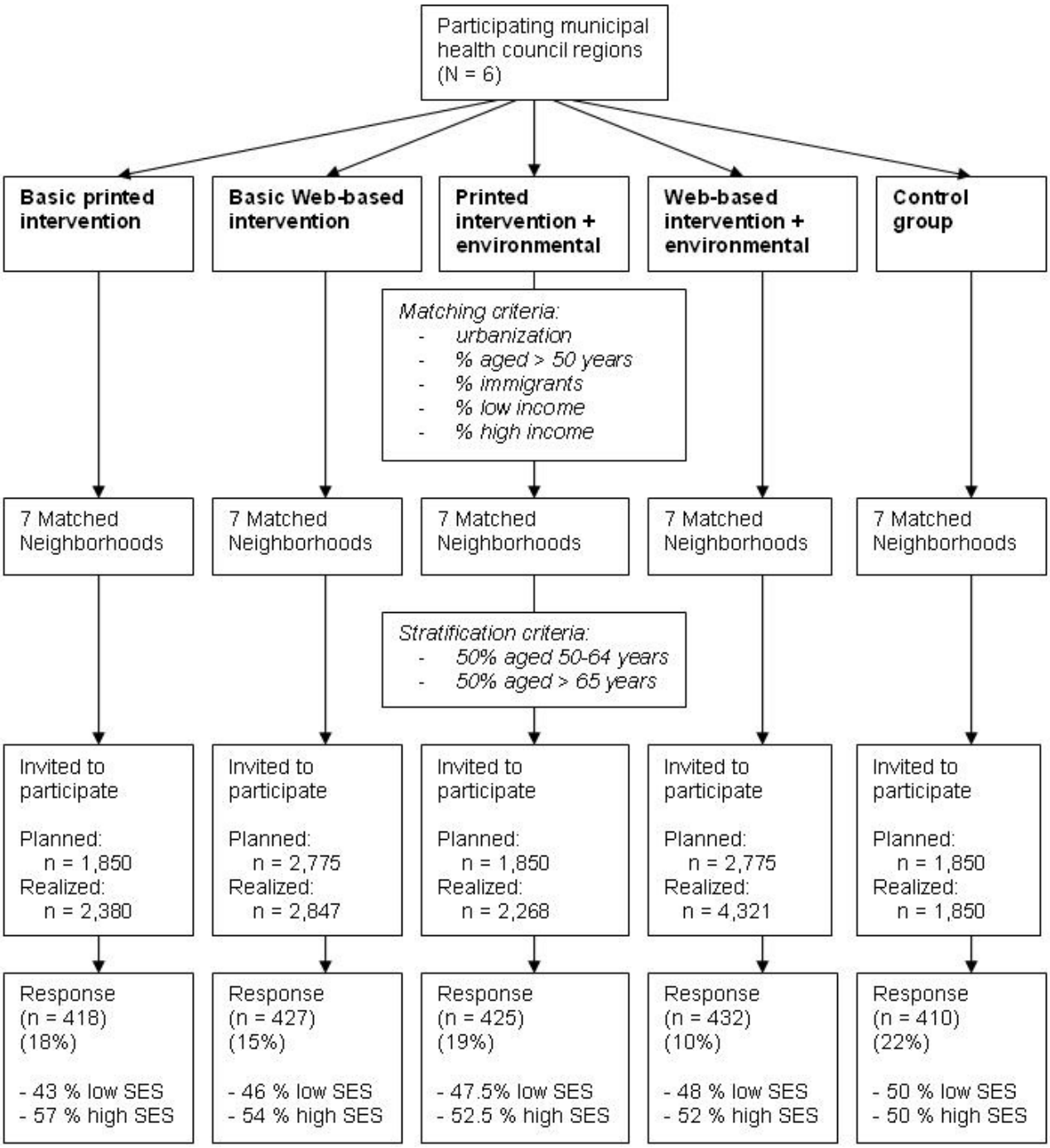
This study was in accordance with the CONSORT checklist and is approved by the Medical Ethics Committee of

XSL•FO
RenderX

Atrium–Orbis–Zuyd (METC code 10-N-36) and was registered with the Dutch Trial Register (NTR 2297).

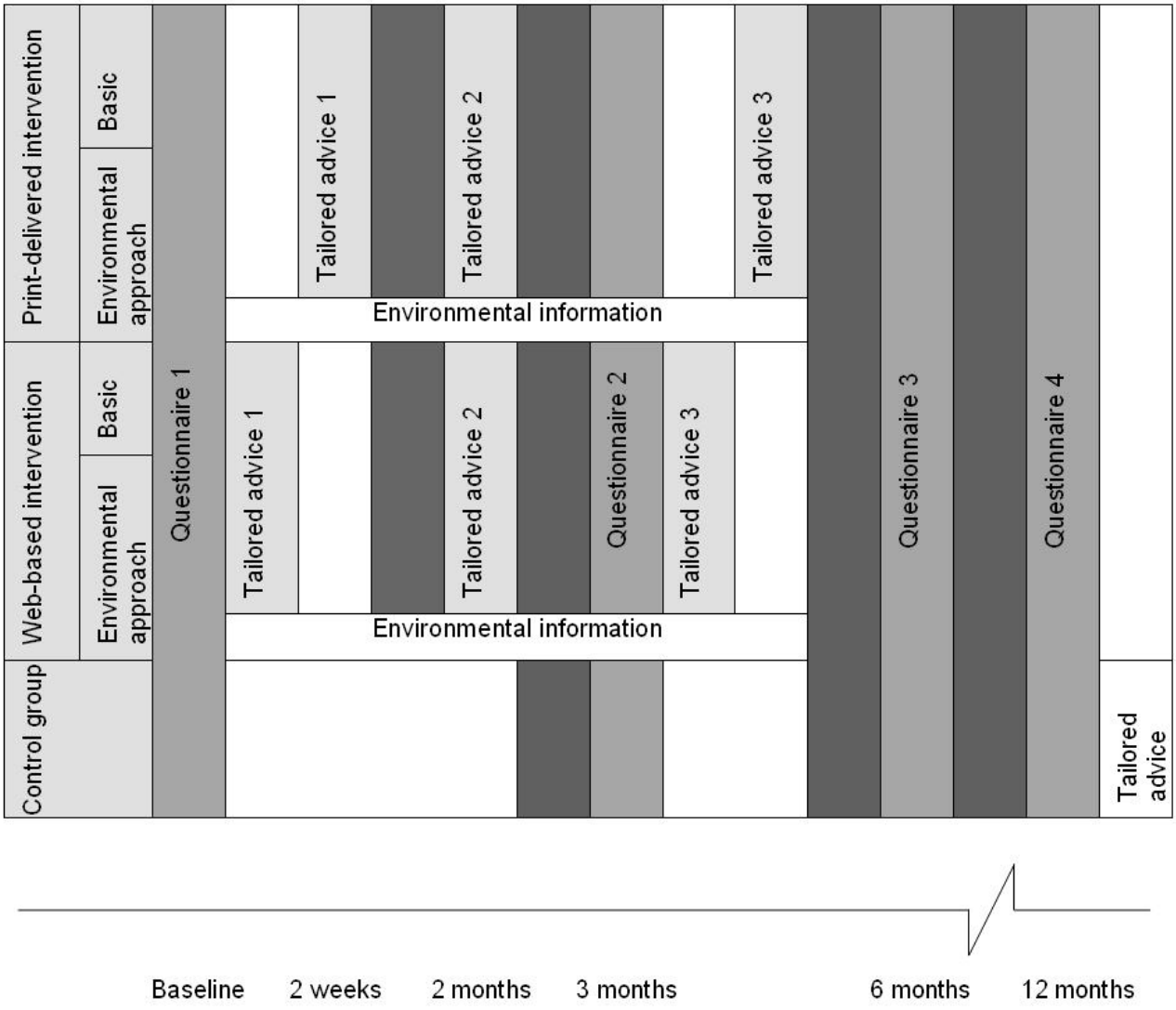
The print-delivered intervention groups received their advice by mail, within 2 weeks after they returned the questionnaire. The Web-based intervention groups received an email, with a link that directly connected them with their tailored advice, immediately after filling in the questionnaire (see Figure 2 for the timeline of this clustered RCT).

Figure 1. Flow diagram of the selection and response of participants. SES = socioeconomic status.



XSL•FO
RenderX

Figure 2. Timeline of the study.



Results

This section describes the results of (1) the evaluation of the process and effect outcomes of the first version of the Active Plus project across the reach and effectiveness dimension of the RE-AIM framework, and (2) the adaptations in the intervention and delivery mode based on this process. Table 1 provides an overview of the results. Furthermore, this section shows the pretest results and response characteristics of the Active Plus follow-up project.

XSL•FO
RenderX

Table 1. Overview of applying the RE-AIM framework in evaluating and adapting the Active Plus project.

RE-AIM dimension	Definition	Adaptation for the Active Plus project
Reach	Number and representativeness of individuals willing to participate	Extending the delivery mode to a Web-based version
		Providing additional information to reach both low- and high-socioeconomic status groups
		Providing additional information to reach participants with physical disabilities
Effectiveness	Impact of the intervention on target outcomes	Translating the print-delivered interventions into Web-based interventions
		Adding information to increase intervention effects in the subgroups that were less affected by the original intervention (persons with a normal body mass index and persons aged over 65 years)
		Improving intervention strategies
		Stimulating self-efficacy and strategic planning
		Stimulating intrinsic motivation
		Reinforcing and extending environmental information
Adoption	Proportion and representativeness of settings that adopt the intervention	Translating the print-delivered interventions into Web-based interventions. Response rates to the print-delivered interventions are higher than response rates to the Web-based interventions[a]
Implementation	Extent to which the interventions are delivered as intended	[a]
Maintenance	Extent to which individual participants maintain behavior change long term and the extent to which the intervention is sustained over time within the organizations that deliver the intervention	Improvements made to the original interventions are expected to further increase the effects on physical activity behavior[a]

[a] Further research is beyond the scope of the current study.

Reach

Several efforts were made to increase the potential reach of the intervention. The delivery mode of the intervention was extended, and tailored advice was adapted to reach both low-and high-SES participants and to reach participants with physical disabilities.

Extending the Delivery Mode

The original Active Plus interventions were print delivered, distributed through written letters. In 2005 (the start of the original project) only a limited proportion of the older age groups had access to the Internet. However, in recent years Internet use among (older) adults has increased enormously. In 2010, 94% of all Dutch adults has access to the Internet at their home [28]. Although home Internet access is still lower in the age group 65+ years, with 68% access, the age group 55–65 years increased their home Internet access substantially to 91% in 2010. Furthermore, the differences in Internet access between SES groups have become much smaller (low SES 87%, high SES 98% in the general population), indicating that Web-based interventions are no longer a barrier to reaching low-SES groups or older adults [28].

Web-based tailoring offers several advantages over print-delivered tailoring, not only within the scope of reach but also in increasing the potential effects (which is the second dimension of the RE-AIM model and described in the next section). The main advantages of Web-based tailoring are that it provides options for more interactive applications (such as Google Maps, and meeting and discussion forums) and the opportunity to use more multimedia components (eg, physical activity options illustrated by videos, which should lead to better learning effects than static pictures [29]). Further, the Internet can deliver tailored feedback immediately, eliminating a time lag between assessment and feedback. The implementation costs of Web-based interventions are much lower, and they require less intensive manual labor than print-delivered interventions. Data from the print-delivered questionnaires need to be entered, and the letters need to be printed and sent by mail, which requires postage and portage. Translating the print-delivered interventions into Web-based interventions makes the interventions less expensive and less work intensive, and the project can be made more easily available to larger populations. Web-based interventions are therefore expected to have a larger reach. Other studies also showed that Web-based interventions have the potential to reach large audiences, with low costs per participant [30].

Reaching Low- and High-SES Groups

Both original interventions were effective in reaching low-SES groups: 48% of all participants had a low level of education [9,10]. As described above, it is expected that low-SES groups can be reached by a Web-based intervention. Furthermore, the process evaluation of the first project [21] showed that high-SES participants felt the need to receive more in-depth information about the effects of physical activity on health-related aspects.

XSL•FO
RenderX

Therefore, we developed tailored messages with more in-depth information (such as the possible consequences of insufficient physical activity), especially for the more highly educated participants.

Reaching Participants With Physical Disabilities

Unpublished data from the first project showed that persons with physical disabilities had a lower appreciation of the original interventions. Because many people aged over 50 years have chronic physical disabilities (30% in the original Active Plus project), in the follow-up project we paid special attention to possible physical impairments of the participants. In the Netherlands, 38.1% of all people aged between 55 and 64 years have a chronic disease, increasing to 57.7% of all people aged above 75 years [31]. Therefore, being physically active with a chronic disease needs more attention, and the advice was tailored to certain physical disabilities. Participants with arthritis, cardiovascular diseases, depression, respiratory diseases, rheumatism, stroke, diabetes, osteoporoses, or severe back pain received additional tailored information about being physically active with their disability, since these disabilities have the highest prevalence among older persons in the Netherlands. This additional (existing) information was developed by the Dutch Institute for Sports and Movement and the Dutch Organization for Sports With Physical Impairments.

Effectiveness

To increase effectiveness, we improved the original Active Plus interventions by translating the print-delivered interventions into Web-based interventions, by targeting nonresponsive subgroups, and by improving the intervention strategies based on the results of the effect and process evaluation (see Table 1).

Web-Based Interventions

Because of several advantages, noted above, of Web-based interventions, we translated the print-delivered interventions into Web-based interventions. Research showed that Web-based interventions can be effective in changing health behaviors such as physical activity [32]. The Web-based interventions included more multimedia components. In the print-delivered Active Plus advice, a practical strategy to target modeling was to include role model statements in the letters, by using pictures of active similar others (same age and gender) combined with text describing the motivation and experiences of each person. For the Web-based version, we replaced these role model pictures and statements, as well as the traditional pictures to explain specific physical activity exercises, with short videos. Research has shown that video animations lead to better learning effects than static pictures [29].

We developed a website to provide the respondents with the opportunity to find information about physical activities in their own local surroundings, and to exchange information with other respondents. A meeting and discussion forum, an e-card facility, and Google Maps showing opportunities to be physically active in their own surroundings were developed specifically for participants in the environmental intervention conditions. We also added several hyperlinks to the website to provide participants with additional information about local physical activity possibilities. Participants in the Web-based intervention received an email with a copy (pdf format) of the personal advice they had received on the website directly after filling in the questionnaire. The advice sent by email had the same format as the print-delivered version.

Targeting Nonresponsive Subgroups

Moderation analyses showed that the interventions were not effective in persons with a healthy body mass index (<25 kg/m^2) and adults 65 years and older [22]. Therefore, we added information on the advantages of physical activity for persons with a healthy body mass index and adults older than 65 years. The importance of physical activity when having a healthy weight was emphasized, and extra information was added about the benefits of physical activity especially for older adults, such as the importance of physical activity to maintain a healthy cognitive state.

Improving Intervention Strategies

We adapted some intervention strategies based on the process evaluation of the first project [21]. Regarding some of the original intervention strategies incorporated into the tailored letters (ie, role model statements, action planning post-its, and coping planning tables), the majority of the participants had read the materials and perceived the materials as interesting. However, when intervention components asked participants to actively participate (eg, filling in an action plan or coping plan), only a minority of them actually filled in the materials [9]. In the original interventions, action plans had to be written down on post-its. For this new intervention, the post-its were replaced by large and more appealing schemes, on which participants could plan and write down their weekly physical activities, with a more extensive and more motivating explanation. These schemes were integrated into several parts of the tailored advice, and participants were actively stimulated to work with these schemes.

Strategic Planning and Self-efficacy

Mediation analyses showed that strategic planning and self-efficacy were important in changing physical activity behavior [10]. Therefore, we provided more elaborated tailored advice on strategic planning in the improved interventions. The self-efficacy advice was formulated in a more empathetic way. Furthermore, more in-depth analyses showed that for some self-efficacy concepts (age, being physically active alone, and having less money), the transition from “being able to do it” to “being sure that they were able to do it” is of great importance. In the adapted interventions, the participants therefore also receive tailored text messages for these concepts when they answered “maybe” or “being able to do it,” whereas, in the original project, participants received self-efficacy messages only when they answered that they were “not (sure about) being able to do it.” In addition, participants received a logbook with instructions to encourage them to monitor their own physical activity behavior and thereby to increase their awareness of such behavior and to stimulate maintenance of being physically active.

XSL•FO
RenderX

Intrinsic Motivation

Mediation analyses of the original Active Plus project showed that the intervention had only a minimal effect on the participants' intrinsic motivation to be physically active [10]. By integrating some concepts of the self-determination theory into the current intervention, we attempted to increase the participants' intrinsic motivation. The self-determination theory emphasizes the importance of intrinsic motivation in engaging in and maintaining health-related behaviors. Motivation is autonomous or self-determined when a person's perceived locus of causality is internal. Intrinsic motivation implies that the behavior is engaged in for enjoyment and satisfaction [33-35]. Several studies have shown the importance of intrinsic motivation as a predictor in exercise participation [36-40]. People will develop and maintain more self-determined motivation when their environment supports autonomy. This implies that people's perspective should be acknowledged, their initiatives should be supported, a choice and relevant information should be provided, and pressure and control should be minimized [33-35]. To create an autonomy-supportive environment, we adapted text messages to comply with the self-determination theory [34]. A clear rationale to adopt the behavior was provided by presenting a more elaborated knowledge component about the contingencies between behavior and health outcomes to support informed choices. Also, participants' feelings and perspectives were acknowledged more by showing more empathy. Participants were stimulated to think and write down their personal most important reasons to be sufficiently physically active. Furthermore, the participants' own initiatives were more supported. For example, on every improvement, positive feedback was given even when the physical activity behavior still did not comply with the international physical activity guidelines. Participants were also offered a choice of options giving them control over their own physical activity behavior (eg, physical activity in their daily activities, during their leisure time, or by exercising). Finally, we checked all text messages for the use of neutral language: "should" and "must" were replaced by "may" and "could."

Reinforcing and Extending Environmental Information

Previous studies have emphasized the importance of focusing on enhancing participants' perceptions of their environment [41-47]. Unfortunately, we found no overall differences in physical activity effects between the environment-based Active Plus intervention and the basic tailored intervention [10,21]. However, perceptions of the environment changed positively: participants perceived significantly more opportunities to engage in physical activity in their immediate environment. Furthermore, at 6 months the intervention additionally focusing on environmental aspects increased the amount of certain types of physical activities such as walking and cycling more than did the basic intervention [10,21]. Mediation analyses showed that the positive effect of the environmentally tailored intervention on physical activity was mediated by changes in environmental perceptions [10,21]. This emphasizes the importance of including aspects such as enhancing participants' perceptions of their environment in tailored interventions. Adding environmental information to the intervention is supposed to further increase the intervention effects. Therefore, an extended version of the environment-based intervention was developed for this follow-up project.

In the original Active Plus project, participants in the environmental intervention conditions received information on walking and cycling routes in their own neighborhoods, written examples of exercises to do at home, contact information for neighborhood sport clubs, a roadmap of their immediate neighborhood on which walking and cycling possibilities were highlighted, and access to a forum and e-buddy system on a website. In the adapted follow-up intervention, we emphasized the environmental approach, making it more personalized and extended with additional options. Information about local opportunities to be physically active was added on three levels: (1) in their own district (sport clubs or sport accommodations matching with their own preferences, existing walking and cycling routes, and options to develop their own walking and cycling routes), (2) in their immediate neighborhood (walking routes to stores within 1 km of their own house, using Google Maps), and (3) in their own home (options for being more physically active in their daily life activities and seven different home exercises).

Furthermore, we paid more attention to the participants' social environment. Although the original environmental Active Plus intervention contained an option to visit a website to contact other adults to be physically active together, little emphasis was placed on this opportunity, resulting in very low participation. In the new intervention, we put greater emphasis on opportunities to get together with others in the neighborhood to be physically active. We developed an online forum with a variety of topics, actively promoted the use of a well-known website to find a sport mate (www.beweegmaatje.nl), and developed several postcards and e-cards that the participant could use to invite someone to be physically active together. Participants also received tailored feedback about the social modeling and social support they receive from their immediate social environment.

Pretest

All of the new intervention materials were quantitatively and qualitatively evaluated for appreciation and usability. Results of the quantitative pretest showed (see Table 2) that the new strategies had modest usability (scores between 5.3 and 6.4 on a scale of 1, not useful, to 10, very useful) and relatively high appreciation (scores between 3.7 and 4.1 on a scale of 1, low appreciation, to 5, high appreciation). Based on these results and the remarks of the participants on the materials, we subsequently adjusted the intervention strategies according to the preferences of the pilot group.

The qualitative pretest assessing the usability of the Web-based intervention (see Table 3) showed that filling in an online questionnaire and performing the online tasks (such as sending e-cards, filling in pdf forms, or watching videos) was not problematic for the nonexpert users. Although filling in the questionnaire and reading the advice took a considerable amount of time, the participants did not mention this as a constraint.

XSL•FO
RenderX

Table 2. Summary of quantitative pretest results.

Determinant	Theoretical method	Intervention strategy	Intervention materials	Appreciation score (1–5)	Usability score (1–10)
Action planning	Active learning	Invite to formulate action plan	Weekly schema to write down plans to be physically active (when, what, where, with whom)	3.89	5.93
Coping planning	Active learning	Invite to formulate coping plans	Coping planning schema	3.72	5.78
Perceived social environment or having a sports partner	Linking members to networks of people	Provide the opportunity to contact others	Post card to invite someone to be physically active together	3.96	5.32
Perceived physical environment	Facilitating	Provide exercises to do at home	Physical activity exercises	4.06	6.64
Awareness	Self-monitoring	Encourage monitoring of own behavior	Logbook	3.73	5.79

Table 3. Summary of qualitative pretest results of the Web-based intervention.

General findings	Adaptations
The website address is often typed in into the Google search window instead of the website address window.	The website was made findable in the Google search results, and an information form was developed on how to enter the website.
Average duration of filling in the online questionnaire was 50 minutes. The participants did not mention this as a constraint.	No adaptations were made to the length of the questionnaire.
People perceived difficulties in how to fill in certain questions.	An information form was developed on how to fill in this questionnaire. This information was also added to the help section of the website.
People appreciated the large letter type.	The letter type size was not changed.
All people were able to use the scrolling methods, but scrolling both up and down, and to the left and to the right is too difficult.	Layout of the webpage was adapted to prevent too much scrolling.
By clicking on other website links, participants lost track of their own tailored advice.	Website links mentioned in the advice opened in a new window, to prevent participants from loosing track of their personal advice.
Some technical errors and errors in tailoring algorithms were found.	All errors were adjusted.

Adoption, Implementation, and Maintenance

To study effectiveness and to monitor adoption of the interventions by the target population, the interventions were implemented in a clustered RCT. Since the response percentages were lower than expected, in a second recruitment round we sent additional invitations to reach similar absolute numbers of respondents in all intervention groups. Figure 1 shows that the response rate to the print-delivered intervention was higher than the response rate to the Web-based intervention among people aged over 50 years. As expected, both low- and high-SES participants were reached by both print-delivered and Web-based interventions.

Changes made in the intervention strategies to increase the intervention effects (eg, stimulating intrinsic motivation) were also expected to further increase the maintenance of physical activity behavior among the target population.

Discussion

This paper describes the systematic translation of the results of the (process) evaluation of the original version of the Active Plus project into an adapted (Web-based) intervention using the RE-AIM framework. Our focus was on the reach and effectiveness dimensions of the RE-AIM framework, since these dimensions are most influenced by the results from the original Active Plus project.

We optimized the potential reach and effect of the Active Plus interventions by translating the print-delivered interventions into Web-based interventions. We also improved the potential reach of the intervention by adapting the tailored advice to reach both low- and high-SES participants and to reach participants with physical disabilities. To further increase the effectiveness of the original Active Plus interventions, we adapted them to appeal to subgroups that did not respond to the effect in the original intervention (ie, persons with a healthy body mass index and adults older the 65 years). Furthermore, several intervention strategies were improved. Because results from the original project showed that strategic planning, self-efficacy, intrinsic motivation, and the environmental component were important in changing physical activity behavior, these concepts were more strongly targeted in the new interventions. We made the adaptations based on the results of the first Active Plus project, such as the process evaluation [21], analyses of effects within subgroups (ie, analyses of moderators [22]), and evaluation of

XSL•FO
RenderX

the working mechanisms of the original interventions (ie, analyses of mediators [10,21]).

Pretest results showed that all of the new intervention materials had modest usability and relatively high appreciation, and that filling in an online questionnaire and performing the online tasks was not problematic for adults aged over 50 years. We subsequently adjusted the intervention strategies according to the preferences of the pilot group and then implemented the interventions in a clustered RCT. Our first results showed a higher response rate for the print-delivered interventions than for the Web-based interventions. However, different SES groups were equally reached.

We have identified several major lessons from our experience of translating the original intervention into a Web-based intervention targeted at older adults. First, it is essential to use a theoretical framework such as the RE-AIM model when evaluating and adapting an original intervention, since it ensures that all important points that can determine the impact of an intervention are systematically addressed. Second, it is of major importance to use process evaluation data, and mediation and moderation results to redesign and strengthen an effective intervention. Finally, it is imperative to thoroughly pretest the new interventions. The combination of quantitative and qualitative pretests used in this study was very useful to gain a broad insight into user experiences and preferences, and thereby to improve the usability of the intervention.

Translating the (process) evaluation of an effective intervention into an adapted intervention is very challenging and rarely reported. Evaluation studies seldom lead to adaptations in the evaluated interventions, at least not ones that are scientifically monitored and reported, which results in a gap between research insights and practice. Evidence on how to effectively facilitate this adaptation process is also limited [48]. Providing more insight into intervention evaluations and adaptations could help future research in systematically (re)evaluating and (re)designing interventions, without reinventing the wheel.

Our adaptations led to four versions of the intervention: basic or with additional environmental information, and print delivered or Web based. In future evaluations, it will be important to consider the differences in cost and effects of the different interventions as well. The potential reach of the Web-based interventions is expected to be higher than the print-delivered intervention because of the lower implementation cost. Furthermore, the effect of the Web-based intervention on behavioral change might be better due to the advantages of the Internet (eg, the possibility of immediate feedback and multimedia use). Response rates showed that both low- and high-SES participants can be reached by both print-delivered and Web-based interventions. The continuing study of the Active Plus project aims to provide more insights into the cost effectiveness of the adapted interventions.

The RE-AIM framework was perceived as a very useful guideline for evaluating the original intervention and translating it into a new intervention. We emphasized the reach and effectiveness dimensions in our study. However, gaining insight into the most relevant conditions for the adoption and implementation of an intervention is also of major importance and will be the focus of future research. The adoption, implementation, and maintenance dimensions would depend on the cost-effectiveness evaluation of the new (Web-based) interventions, and will therefore be studied in a later stage of this project. Results of the effect evaluation of the new interventions and experiences of the target population and intermediaries with the intervention may serve as input for future studies. Careful administration of all costs and time needed for the development, recruitment, and implementation of the interventions is important to enable different intermediaries to judge whether they would have the capacity to implement these interventions in a nonexperimental setting.

Future studies should also provide insight into the feasibility and relevant conditions for accepting and implementing the interventions (by the intermediaries) or for participating in the interventions (target group). Since Web-based interventions among persons aged over 50 years can be regarded as an innovation, a study to inform the adaption, implementation, and maintenance of the intervention could be guided by Rogers' theory of innovations [49], for example, by using focus group interviews or in-depth interviews.

This paper provides insight into the processes leading to future effects of the intervention and could help future researchers in systematically developing or reevaluating their intervention.

Acknowledgments

This study was funded by The Netherlands Organization for Health Research and Development (ZonMw, 200110006) and publication was supported by The Netherlands Organization for Scientific Research (NWO).

Conflicts of Interest

None declared.

References

1. Rodgers A, Vaughan P, Prentice T, Tan-Torres Edejer T, Evans D, Lowe J. World Health Organization. 2002. The World Health Report 2002: Reducing Risks, Promoting Healthy Life URL: http://www.who.int/whr/2002/en/whr02_en.pdf [accessed 2011-08-12] [WebCite Cache ID 60sWIhzdf]
2. Department of Health, Physical Activity, Health Improvement and Prevention. At Least Five a Week: Evidence on the Impact of Physical Activity and its Relationship to Health. London: Department of Health; 2004. At least five a week:

XSL•FO
RenderX

Evidence on the impact of physical activity and its relationship to health URL: http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_4080981.pdf [accessed 2012-02-21] [WebCite Cache ID 65cPwwk1s]
3. The Swedish National Institute of Public Health. Healthy Ageing: A Challenge for Europe. Stockholm: Swedish National Institute of Public Health; 2006. URL: http://ec.europa.eu/health/archive/ph_projects/2003/action1/docs/2003_1_26_sum_en.pdf
4. Nelson ME, Rejeski WJ, Blair SN, Duncan PW, Judge JO, King AC, et al. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc 2007 Aug;39(8):1435-1445. [doi: 10.1249/mss.0b013e3180616aa2] [Medline: 17762378]
5. Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, American College of Sports Medicine, American Heart Association. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation 2007 Aug 28;116(9):1081-1093 [FREE Full text] [doi: 10.1161/CIRCULATIONAHA.107.185649] [Medline: 17671237]
6. Janssen I, Jolliffe CJ. Influence of physical activity on mortality in elderly with coronary artery disease. Med Sci Sports Exerc 2006 Mar;38(3):418-417. [doi: 10.1249/01.mss.0000191185.58467.be] [Medline: 16540827]
7. Kesaniemi YK, Danforth E, Jensen MD, Kopelman PG, Lefèbvre P, Reeder BA. Dose-response issues concerning physical activity and health: an evidence-based symposium. Med Sci Sports Exerc 2001 Jun;33(6 Suppl):S351-S358. [Medline: 11427759]
8. Ooijendijk WTM, Hildebrandt VH, Hopman-Rock M. Trendrapport Bewegen en Gezondheid 2004/2005. Leiden: TNO; 2007.
9. van Stralen MM, de Vries H, Mudde AN, Bolman C, Lechner L. Efficacy of two tailored interventions promoting physical activity in older adults. Am J Prev Med 2009 Nov;37(5):405-417. [doi: 10.1016/j.amepre.2009.07.009] [Medline: 19840695]
10. van Stralen MM, de Vries H, Mudde AN, Bolman C, Lechner L. The long-term efficacy of two computer-tailored physical activity interventions for older adults: main effects and mediators. Health Psychol 2011 Jul;30(4):442-452. [doi: 10.1037/a0023579] [Medline: 21639638]
11. Barthelomew LK, Parcel GS, Kok G, Gottlieb NH. Planning Health Promotion Programs: An Intervention Mapping Approach. 2nd edition. San Francisco, CA: Jossey-Bass; 2006.
12. Van Stralen MM, De Vries H, Mudde AN, Bolman C, Lechner L. Determinants of initiation and maintenance of physical activity in older adults: a literature review. Health Psychol Rev 2009;3(2):147-207. [doi: 10.1080/17437190903229462]
13. van Stralen MM, Lechner L, Mudde AN, de Vries H, Bolman C. Determinants of awareness, initiation and maintenance of physical activity among the over-fifties: a Delphi study. Health Educ Res 2010 Apr;25(2):233-247 [FREE Full text] [doi: 10.1093/her/cyn045] [Medline: 18927443]
14. de Vries H, Mesters I, Riet JV, Willems K, Reubsaet A. Motives of Belgian adolescents for using sunscreen: the role of action plans. Cancer Epidemiol Biomarkers Prev 2006 Jul;15(7):1360-1366 [FREE Full text] [doi: 10.1158/1055-9965.EPI-05-0877] [Medline: 16835337]
15. Schwarzer R. Modeling health behavior change: how to predict and modify the adoption and maintenance of health behaviors. Appl Psychol 2008;57(1):1-29. [doi: 10.1111/j.1464-0597.2007.00325.x]
16. Baumeister RF, Vohs KD. Handbook of Self-regulation: Research, Theory, and Applications. New York, NY: Guilford Press; 2004.
17. Boekaerts M, Pintrich PR, Zeidner M. Handbook of Self-regulation. San Diego, CA: Academic Press; 2000.
18. Hagger MS, Chatzisarantis NLD. Intrinsic Motivation and Self-determination in Exercise and Sport. Champaign, IL: Human Kinetics; 2007.
19. Hagger M, Chatzisarantis N. Active human nature: self-determination theory and the promotion and maintenance of sport, exercise and health. In: Hagger MS, Chatzisarantis NLD, editors. Intrinsic Motivation and Self-determination in Exercise and Sport. Champaign, IL: Human Kinetics; 2007:1-19.
20. van Stralen MM, Kok G, de Vries H, Mudde AN, Bolman C, Lechner L. The Active plus protocol: systematic development of two theory- and evidence-based tailored physical activity interventions for the over-fifties. BMC Public Health 2008;8:399 [FREE Full text] [doi: 10.1186/1471-2458-8-399] [Medline: 19055806]
21. van Stralen MM, de Vries H, Mudde AN, Bolman C, Lechner L. The working mechanisms of an environmentally tailored physical activity intervention for older adults: a randomized controlled trial. Int J Behav Nutr Phys Act 2009;6:83 [FREE Full text] [doi: 10.1186/1479-5868-6-83] [Medline: 19995412]
22. van Stralen MM, de Vries H, Bolman C, Mudde AN, Lechner L. Exploring the efficacy and moderators of two computer-tailored physical activity interventions for older adults: a randomized controlled trial. Ann Behav Med 2010 May;39(2):139-150. [doi: 10.1007/s12160-010-9166-8] [Medline: 20182833]
23. Glasgow RE, Klesges LM, Dzewaltowski DA, Estabrooks PA, Vogt TM. Evaluating the impact of health promotion programs: using the RE-AIM framework to form summary measures for decision making involving complex issues. Health Educ Res 2006 Oct;21(5):688-694 [FREE Full text] [doi: 10.1093/her/cyl081] [Medline: 16945984]
24. Glasgow RE, Nelson CC, Strycker LA, King DK. Using RE-AIM metrics to evaluate diabetes self-management support interventions. Am J Prev Med 2006 Jan;30(1):67-73. [doi: 10.1016/j.amepre.2005.08.037] [Medline: 16414426]

XSL•FO
RenderX

25. Glasgow RE, McKay HG, Piette JD, Reynolds KD. The RE-AIM framework for evaluating interventions: what can it tell us about approaches to chronic illness management? Patient Educ Couns 2001 Aug;44(2):119-127. [Medline: 11479052]
26. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. Am J Public Health 1999 Sep;89(9):1322-1327. [Medline: 10474547]
27. Wendel-Vos GC, Schuit AJ, Saris WH, Kromhout D. Reproducibility and relative validity of the short questionnaire to assess health-enhancing physical activity. J Clin Epidemiol 2003 Dec;56(12):1163-1169. [Medline: 14680666]
28. Centraal Bureau voor de Statistiek. 2011. Statline URL: http://statline.cbs.nl/statweb/ [accessed 2011-08-12] [WebCite Cache ID 60sYl51sO]
29. Paas F. Neem Eens een Voorbeeld aan Anderen: Nieuwe Impulsen voor Onderzoek Naar Leren en Instructie. Heerlen: Open Universiteit Nederland; 2007.
30. Griffiths F, Lindenmeyer A, Powell J, Lowe P, Thorogood M. Why are health care interventions delivered over the internet? A systematic review of the published literature. J Med Internet Res 2006;8(2):e10 [FREE Full text] [doi: 10.2196/jmir.8.2.e10] [Medline: 16867965]
31. Hoeymans N, Schellevis FC, Wolters I. Rijksinstituut voor Volksgezondheid en Milieu. 2011 Jul 15. [How Many Persons Have One or More Chronic Diseases?] URL: http://www.nationaalkompas.nl/gezondheid-en-ziekte/ziekten-en-aandoeningen/chronische-ziekten-en-multimorbiditeit/hoeveel-mensen-hebben-een-of-meer-chronische-ziekten/ [accessed 2011-08-12] [WebCite Cache ID 60sWjS0XO]
32. van den Berg MH, Schoones JW, Vliet Vlieland TP. Internet-based physical activity interventions: a systematic review of the literature. J Med Internet Res 2007;9(3):e26 [FREE Full text] [doi: 10.2196/jmir.9.3.e26] [Medline: 17942388]
33. Deci EL, Ryan RM. Intrinsic Motivation and Self-determination in Human Behavior. New York, NY: Plenum; 1985.
34. Deci EL, Eghrari H, Patrick BC, Leone DR. Facilitating internalization: the self-determination theory perspective. J Pers 1994 Mar;62(1):119-142. [Medline: 8169757]
35. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol 2000 Jan;55(1):68-78. [Medline: 11392867]
36. Thøgersen-Ntoumani C, Ntoumanis N. The role of self-determined motivation in the understanding of exercise-related behaviours, cognitions and physical self-evaluations. J Sports Sci 2006 Apr;24(4):393-404. [doi: 10.1080/02640410500131670] [Medline: 16492603]
37. Wilson PM, Rodgers WM. The relationship between perceived autonomy support, exercise regulations and behavioral intentions in women. Psychol Sport Exerc 2004;5(3):229-242. [doi: 10.1016/S1469-0292(03)00003-7]
38. Rose EA, Parfitt G, Williams S. Exercise causality orientations, behavioral regulation for exercise and stage of change for exercise: exploring their relationships. Psychol Sport Exerc 2005;6(4):399-414. [doi: 10.1016/j.psychsport.2004.07.002]
39. Silva MN, Vieira PN, Coutinho SR, Minderico CS, Matos MG, Sardinha LB, et al. Using self-determination theory to promote physical activity and weight control: a randomized controlled trial in women. J Behav Med 2010 Apr;33(2):110-122. [doi: 10.1007/s10865-009-9239-y] [Medline: 20012179]
40. Silva MN, Markland D, Minderico CS, Vieira PN, Castro MM, Coutinho SR, et al. A randomized controlled trial to evaluate self-determination theory for exercise adherence and weight control: rationale and intervention description. BMC Public Health 2008;8:234 [FREE Full text] [doi: 10.1186/1471-2458-8-234] [Medline: 18613959]
41. Owen N, Humpel N, Leslie E, Bauman A, Sallis JF. Understanding environmental influences on walking; Review and research agenda. Am J Prev Med 2004 Jul;27(1):67-76. [doi: 10.1016/j.amepre.2004.03.006] [Medline: 15212778]
42. Humpel N, Owen N, Iverson D, Leslie E, Bauman A. Perceived environment attributes, residential location, and walking for particular purposes. Am J Prev Med 2004 Feb;26(2):119-125. [Medline: 14751322]
43. Sallis JF, King AC, Sirard JR, Albright CL. Perceived environmental predictors of physical activity over 6 months in adults: activity counseling trial. Health Psychol 2007 Nov;26(6):701-709. [doi: 10.1037/0278-6133.26.6.701] [Medline: 18020842]
44. Kremers SP, de Bruijn GJ, Droomers M, van Lenthe F, Brug J. Moderators of environmental intervention effects on diet and activity in youth. Am J Prev Med 2007 Feb;32(2):163-172. [doi: 10.1016/j.amepre.2006.10.006] [Medline: 17197152]
45. Humpel N, Marshall AL, Leslie E, Bauman A, Owen N. Changes in neighborhood walking are related to changes in perceptions of environmental attributes. Ann Behav Med 2004 Feb;27(1):60-67. [doi: 10.1207/s15324796abm2701_8] [Medline: 14979864]
46. Harrington DW, Elliott SJ. Weighing the importance of neighbourhood: a multilevel exploration of the determinants of overweight and obesity. Soc Sci Med 2009 Feb;68(4):593-600. [doi: 10.1016/j.socscimed.2008.11.021] [Medline: 19095339]
47. De Bourdeaudhuij I, Sallis JF, Saelens BE. Environmental correlates of physical activity in a sample of Belgian adults. Am J Health Promot 2003;18(1):83-92. [Medline: 13677966]
48. Armstrong R, Waters E, Crockett B, Keleher H. The nature of evidence resources and knowledge translation for health promotion practitioners. Health Promot Int 2007 Sep;22(3):254-260 [FREE Full text] [doi: 10.1093/heapro/dam017] [Medline: 17596543]
49. Rogers EM. Diffusion of Innovations. New York, NY: Free Press; 2003.

XSL•FO
RenderX

Abbreviations

RCT: randomized controlled trial
SES: socioeconomic status

Edited by G Eysenbach; submitted 27.01.11; peer-reviewed by I DeBourdeaudhuij; comments to author 27.07.11; revised version received 31.08.11; accepted 16.01.12; published 02.03.12.

Please cite as:
Peels DA, van Stralen MM, Bolman C, Golsteijn RHJ, de Vries H, Mudde AN, Lechner L
Development of Web-Based Computer-Tailored Advice to Promote Physical Activity Among People Older Than 50 Years
J Med Internet Res 2012;14(2):e39
URL: http://www.jmir.org/2012/2/e39/
doi:10.2196/jmir.1742
PMID:22390878

©Denise A Peels, Maartje M van Stralen, Catherine Bolman, Rianne HJ Golsteijn, Hein de Vries, Aart N Mudde, Lilian Lechner. Originally published in the Journal of Medical Internet Research (http://www.jmir.org), 02.03.2012. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on http://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX

Publisher:
JMIR Publications
130 Queens Quay East.
Toronto, ON, M5A 3Y5
Phone: (+1) 416-583-2040
Email: support@jmir.org

XSL•FO
RenderX