

Review

# Digital Lifestyle Interventions to Support Healthy Gestational Weight Gain: Scoping Review

Renée A Otte<sup>1</sup>, PhD, MA; Lucie Duracher<sup>1</sup>, PhD; Ozge Demir<sup>2</sup>, MSc; Hanne A A Spelt<sup>1</sup>, PhD

<sup>1</sup>Research and Advanced Development, Philips Mother & Child Care and Women's Health, Eindhoven, The Netherlands

<sup>2</sup>Clinical Affairs Personal Health, Philips Mother & Child Care and Women's Health, Eindhoven, The Netherlands

**Corresponding Author:**

Renée A Otte, PhD, MA

Research and Advanced Development, Philips Mother & Child Care and Women's Health

High Tech Campus 37

Eindhoven 5656AE

The Netherlands

Phone: 31 402730404

Email: [renee.otte@philips.com](mailto:renee.otte@philips.com)

## Abstract

**Background:** Digital lifestyle interventions hold promise in supporting healthy gestational weight gain (GWG) during pregnancy. However, clarity on their key design and implementation features remains limited. The prevalence of excessive GWG and its associated maternal and infant health risks makes understanding the landscape of digital intervention characteristics critical.

**Objective:** This scoping review aimed to map current literature on digital lifestyle interventions designed to promote healthy GWG and to identify intervention characteristics, including behavior change techniques (BCTs), used across these interventions, with particular attention to patterns in design and implementation features across studies reporting positive outcomes.

**Methods:** We systematically searched PubMed, Embase, Cochrane, and Web of Science for peer-reviewed studies published between 2014 and 2024. Studies were included if they described interventions with at least 1 digital component targeting GWG. Studies on high-risk pregnancies, nonhuman participants, protocols without results, abstracts, gray literature, and non-English publications were excluded. Data extraction covered study characteristics, theoretical frameworks, timing, duration, frequency, delivery modes, and BCTs applied. The landscape of intervention characteristics was mapped, including descriptive analysis of features that appeared across different study outcomes.

**Results:** A total of 44 studies met the inclusion criteria: 23 primary data articles (pilot studies, randomized controlled trials, etc) and 21 secondary data articles (meta-analyses, systematic reviews, etc). Primary studies showed that interventions were more likely to achieve intended outcomes when they started earlier, lasted longer, and combined digital and in-person components. Five BCTs were commonly present across interventions achieving positive outcomes: goal setting (outcome; 71%), discrepancy between current behavior and goal (43%), self-monitoring of behavior (86%), social support (unspecified; 71%), and credible source (71%). Secondary studies supported these findings, identifying several helpful features: starting before midpregnancy, long duration with high intensity, in-person contact, and BCTs related to goal setting, action planning, feedback on, and monitoring of behavior. However, primary studies showed gaps in reporting practices, with many details lacking about design and implementation features, such as BCTs. This converged with secondary studies reporting insufficient detail in the reviewed primary literature, limiting interpretation and replication potential.

**Conclusions:** This scoping review maps digital interventions for GWG and identifies key patterns in intervention design and implementation. Evidence suggests that interventions may be more promising when combining digital delivery with in-person components and incorporating BCTs related to goal setting, self-monitoring, and social support. This review provides a comprehensive mapping of BCT usage and other intervention features, highlighting approaches associated with positive outcomes. However, significant gaps in reporting practices limit evidence synthesis. The findings can inform the design of digital interventions for managing GWG by identifying potentially successful design and implementation features. Future research should prioritize standardized reporting practices and evaluate interventions in underserved populations, including health care desert communities, to enhance the evidence base.

**Keywords:** pregnancy; gestational weight gain; digital lifestyle interventions; behavioral change techniques; scoping review; mobile phone

## Introduction

### Background

Pregnancy represents a critical window of opportunity for improving health outcomes for both mother and child. This transformative period catalyzes significant changes in a woman's conception of self and social roles, fundamentally altering her capabilities, opportunities, and motivations for health behavior modification [1-3]. Throughout this paper, we use the term "woman" to refer to individuals assigned female at birth, while acknowledging and respecting all gender identities. As a stage of transition, pregnancy presents an optimal time for encouraging healthy lifestyles, including weight management, with benefits that may persist well beyond pregnancy [4,5].

Current recognized medical guidelines, such as those by the Institute of Medicine (IOM), emphasize the importance of appropriate gestational weight gain (GWG) depending on prepregnancy BMI (ie, underweight BMI <18.5 kg/m<sup>2</sup>: 12.5-18 kg; normal weight BMI 18.5-24.9 kg/m<sup>2</sup>: 11.5-16 kg; overweight BMI 25-29.9 kg/m<sup>2</sup>: 7-11.5 kg; and obese BMI ≥30 kg/m<sup>2</sup>: 5-9 kg) for improved maternal and fetal outcomes [6,7]. Deviation from these recommendations – either excessive or insufficient GWG – has been associated with adverse outcomes. For women, these include increased risk of gestational diabetes, hypertensive disorders of pregnancy, cesarean delivery, and postpartum weight retention. For infants, risks encompass preterm birth, inappropriate birth weight, macrosomia, and increased likelihood of childhood obesity [8-10].

Despite the well-documented health implications, achieving recommended GWG remains a challenge for many women. Globally, 18%-30% of pregnant women gain insufficient weight, while 37%-51% exceed recommendations [8,11]. This challenge stems from multiple factors: many women are unaware that healthy weight gain targets differ per individual and depend on their preconception BMI [12,13], and even if women are acquainted with recommendations, they may not know how to operationalize them [14]. For example, the majority of pregnant women fail to meet dietary recommendations, such as those for vegetables, fats, and grains [13,15,16], and fall short of achieving the recommended 150 minutes of moderate-intensity aerobic activity per week [17-19]. In addition, common pregnancy symptoms such as nausea, fatigue, and pain, along with lack of knowledge and limited access to information, form additional barriers to maintaining healthy lifestyle practices [14,20-22].

Therefore, pregnant women require support in following healthy lifestyles and achieving healthy GWG. While health care professionals are ideally positioned to deliver this support through prenatal visits [3], they often face significant implementation barriers despite their motivation to

address these guidelines [23,24]. For example, they may lack time, access to quality resources, training, and organizational support and perceive their efforts as being ineffective [23-25]. Consequently, many pregnant women report receiving either insufficient or inaccurate counseling on these topics, while they may desire it [6,14,26].

This issue is further exacerbated in maternity care deserts, where many women receive minimal or no prenatal care [27-29]. For example, between 2017 and 2023, in several low- and middle-income countries, less than 60% of pregnant women received at least 4 antenatal care visits while the World Health Organization recommends a minimum of 8 [3,30]. The problem extends to high-income countries, for example, the United States, where over 2.3 million women live in areas without obstetric services, with an additional 3 million having limited access to maternity care [27].

### Digital Lifestyle Interventions for Managing Healthy GWG

Digital lifestyle interventions have emerged as a promising solution to the challenges of supporting healthy GWG. Several studies have shown the potential of using digital lifestyle programs in a pregnant population. For example, Redman et al [31] reported that their eHealth intervention combining digital and nondigital components positively impacted healthy GWG, while Feng et al [32] found reduced GWG in participants using a smartphone-based intervention compared with matched controls. However, some interventions have not achieved their intended outcomes [33,34], while others have shown differential effects depending on prepregnancy BMI classifications [35,36]. Despite these mixed outcomes, digital lifestyle interventions offer unique advantages in transcending geographical and social barriers, offering cost-effective, scalable support on top of usual care [28,37-39].

Literature reveals considerable variability in how digital lifestyle interventions are designed and implemented, which contributes to the inconsistent results observed across studies. Whether digital behavior change interventions achieve their intended outcomes depends on multiple factors working in concert, necessitating mapping of intervention characteristics, theoretical foundations, and reported findings to better understand the current landscape of approaches. Even among interventions that have shown promise, uncertainty persists regarding which specific design components and implementation features may contribute to their success.

Some studies suggest there are no clear optimal specifications for implementation features of GWG management interventions, such as duration, contact frequency, intensity of use, delivery format (group vs individual), or dietary approach [40]. Conversely, other research indicates that factors like the timing of intervention initiation, delivery modes (digital-only vs digital-mixed), and the type and

frequency of digital components may influence outcomes [37,41]. A possible explanation for these mixed findings is how behavior change interventions are described: variation in reporting practices impedes our understanding of intervention mechanisms, evidence synthesis, and the development of more effective interventions [42].

## ***Design and Implementation of Digital Lifestyle Interventions***

Understanding the specific components that contribute to intervention success requires examination of both design and implementation features. Digital lifestyle interventions are a form of behavior change interventions, defined as programs that aim to change behavior with a clear objective and target group [43]. When designing interventions to change behavior, researchers draw on established theories to understand which components are most likely to produce change and what contextual factors might strengthen or weaken the intervention's impact. The design of these interventions incorporates multiple behavior change techniques (BCTs), which represent the smallest active ingredients of an intervention capable of inducing behavior change [43-45]. BCTs are typically implemented based on theory, and understanding their proposed mechanisms of action may illuminate the processes by which BCTs influence behavior [46]. For example, the BCT "goal setting (behavior)" – defined as setting or agreeing on a goal defined in terms of the behavior achieved, such as agreeing on a 3-mile daily walking goal – works through increasing behavioral self-regulation.

To come to standardized reporting, researchers created a standardized classification system called the Behavior Change Technique Taxonomy to systematically identify and classify the techniques used to change behavior and better understand what makes behavior change interventions effective. Systematically identifying and quantifying BCTs used across interventions can help characterize intervention intensity to some degree, identify common patterns or clusters, and validate theory-based concepts [44,45]. This approach has proven value in previous reviews of interventions targeting smoking cessation [47] and physical activity (PA) [48].

The extent to which a BCT can achieve its intended purpose may vary depending on the target population, the specific behavior being addressed, and how the intervention is implemented [43]. As previously noted, implementation features such as timing, duration, frequency, and delivery modalities are critical as they represent the practical aspects of how interventions are delivered in real-world settings. It is therefore important to further explore how these features interact with BCTs to influence outcomes.

For healthy GWG interventions, implementation features are particularly important given the time-sensitive nature of pregnancy and the need to accommodate evolving physiological and psychological states. Research indicates that key implementation features influencing outcome include the timing of initiation (preconception, early pregnancy, or later stages), intervention duration (spanning the entire pregnancy or focusing on specific trimesters), frequency of

delivery (daily contact vs weekly check-ins), and delivery modes (digital-only platforms vs hybrid approaches combining digital and face-to-face elements). The choice of a digital platform itself introduces additional implementation considerations (eg, user interface design, accessibility across devices, integration with existing health care systems, and the level of personalization offered) which are beyond the scope of this paper.

The relationship between these design and implementation features and positive outcomes for healthy GWG remains unclear without a systematic evaluation of existing evidence. Understanding which BCTs are most used, how they are typically implemented, and whether certain implementation approaches are associated with better outcomes requires a comprehensive mapping of the current intervention landscape.

## ***Goal of This Study***

To address the knowledge gap surrounding the characteristics and implementation of digital lifestyle interventions for healthy GWG, we conducted a scoping review focusing on interventions developed between 2014 and 2024. Our objectives were to systematically map intervention characteristics and identify design and implementation features that appear to be associated with positive outcomes. We examined theoretical foundations, intervention timing, duration, frequency, delivery modes, and the BCTs used across studies.

We addressed 2 primary research questions. First, what is the scope and nature of evidence on digital lifestyle interventions for healthy GWG? Second, what design and implementation features characterize digital interventions that report positive outcomes?

By addressing these questions, we aim to synthesize existing knowledge about intervention components and provide insights that may inform future research and development of digital interventions for supporting healthy GWG in addition to usual care. This paper presents a descriptive and narrative analysis of our findings.

## **Methods**

### ***Overview***

We used a scoping review methodology to map the breadth of existing evidence and identify patterns in the design and implementation of digital lifestyle interventions. This methodology is particularly well-suited for exploring the extent of existing literature, mapping and summarizing evidence, identifying key characteristics, and informing future research directions [49]. This approach was most appropriate given the heterogeneity in digital intervention designs and reporting practices in this field, where the goal was to map evidence patterns rather than to conduct a quantitative synthesis for clinical decision-making.

Our review was guided by Chapter 10 of the Manual for Evidence Synthesis from the Joanna Briggs Institute, specifically the section on scoping reviews [49]. For

drafting this paper, we followed the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension guidelines for scoping reviews) [50] (Checklist 1). A review protocol was developed for internal use but was not registered.

## Eligibility Criteria

To define eligibility criteria, we used the Population, Concept, and Context framework [49], with population being “pregnant women” and concept “digital lifestyle interventions for managing gestational weight gain.” With “digital” interventions, we refer to those with at least 1 digital component (eg, app, SMS text message, and website), potentially in addition to nondigital components (eg, paper booklets and in-person sessions). The context was left unspecified to allow for the inclusion of studies conducted across diverse health care settings and populations.

Both articles on primary data (eg, pilot studies and randomized controlled trials [RCTs]) and on secondary data (eg, reviews and meta-analyses) were eligible. To ensure relevance to current digital health practices, the search was limited to articles published within the last 10 years. A preliminary scan of literature before 2014 indicated that earlier studies either did not fit our inclusion criteria or lacked sufficient focus on digital components. Given the rapid evolution of digital health technologies, we considered this time frame appropriate for capturing the most relevant and applicable evidence. Articles were excluded from our selection if they were not available in full in English; were not based on human participant data (eg, computer-generated data); were study protocols without results; were not related to pregnancy; did not include GWG as a primary or secondary outcome; were not peer-reviewed publications; did not investigate digital lifestyle interventions; or focused on high-risk pregnancies, such as placenta previa and gestational diabetes (to maintain focus on general GWG management rather than condition-specific interventions). A complete list of inclusion and exclusion criteria is provided in [Multimedia Appendix 1](#).

## Search Strategy

The search strategy was developed collaboratively by all 4 authors. To retrieve a comprehensive set of relevant studies, we translated our main research question into 3 broad search terms: “smartphone application,” “mHealth,” and “gestational weight gain.” These terms were used to search 4 electronic databases: PubMed, Embase, Cochrane, and Web of Science. These databases were selected for their extensive coverage of biomedical and life science literature. Our search strategy confirmed the appropriateness of this selection: while each additional database yielded some unique records, few of these met our inclusion criteria, suggesting that our chosen approach achieved near-saturation of the relevant literature.

The search strings were adapted to meet the syntax requirements of each database. Refer to [Multimedia Appendix 2](#) for the exact strings used per database. The searches in PubMed, Embase, and Cochrane were carried out on March 8, 2024, and the search in Web of Science was completed

on March 25, 2024. To match eligibility criteria, the searches were limited to articles published in English between 2014 and 2024 and within the defined population and context scope. Search results from each database were exported as .csv files and merged into a single Microsoft Excel file for screening and deduplication.

## Article Selection

First, duplicates were removed using a custom Python script. It recoded each article’s title to an ID by removing all punctuation marks, turning all capitals into lowercase, and removing all spaces. These IDs were used to identify and delete duplicate entries. The remaining, nonduplicate articles were imported and stored in a Zotero library (Corporation for Digital Scholarship) for further screening.

Then, each article was screened independently by different pairs of the 4 authors using the eligibility checklist, examining titles, abstracts, and results sections. Ineligible articles were assigned exclusion criterion codes to ensure traceability. Any disagreements between reviewers were resolved through structured discussion, with a third author consulted when consensus could not be reached.

To enhance comprehensiveness, we also searched the internet for follow-up publications of excluded study protocols and hand-searched the reference lists of all included articles. Any additional articles identified through these methods underwent the same rigorous screening and selection process.

## Data Extraction

Selected articles were read in full by at least 2 of the 4 authors in various combinations, and relevant information was extracted. If an article was deemed ineligible at this stage, it was assigned an exclusion criterion code and removed from the database. All exclusion decisions were discussed and agreed upon by at least 2 authors to ensure consistency and transparency.

Extracted data items included study type, study goal, population details, sample size, theoretical foundation, timing, duration, frequency, delivery mode, BCTs used, and results. The full list of data items and their definitions, along with the methodology for handling assumptions and simplifications for certain data items to ensure consistency across studies, is provided in [Multimedia Appendix 3](#).

## Data Synthesis

Data synthesis was conducted through a multistage descriptive and narrative analysis led by RAO, with support from the other authors. First, for primary and secondary data articles, we analyzed extracted study characteristics (publication year, country, study design, and so on) to map the scope and distribution of the evidence base. These findings were visualized using frequency tables.

Second, for primary data articles, we analyzed intervention characteristics including theoretical foundations, timing of initiation, duration, frequency, delivery mode, and BCTs. Third, for nonpilot primary data articles and secondary

analysis of RCT data and meta-analyses, we categorized reported study outcomes as successful in achieving intended outcomes (yes or no) based on the study authors' conclusions. We compared intervention characteristics across these outcome categories to identify patterns and potential distinguishing features. Throughout this data synthesis process, we used constant comparison methods to identify patterns, contradictions, and gaps in the evidence base.

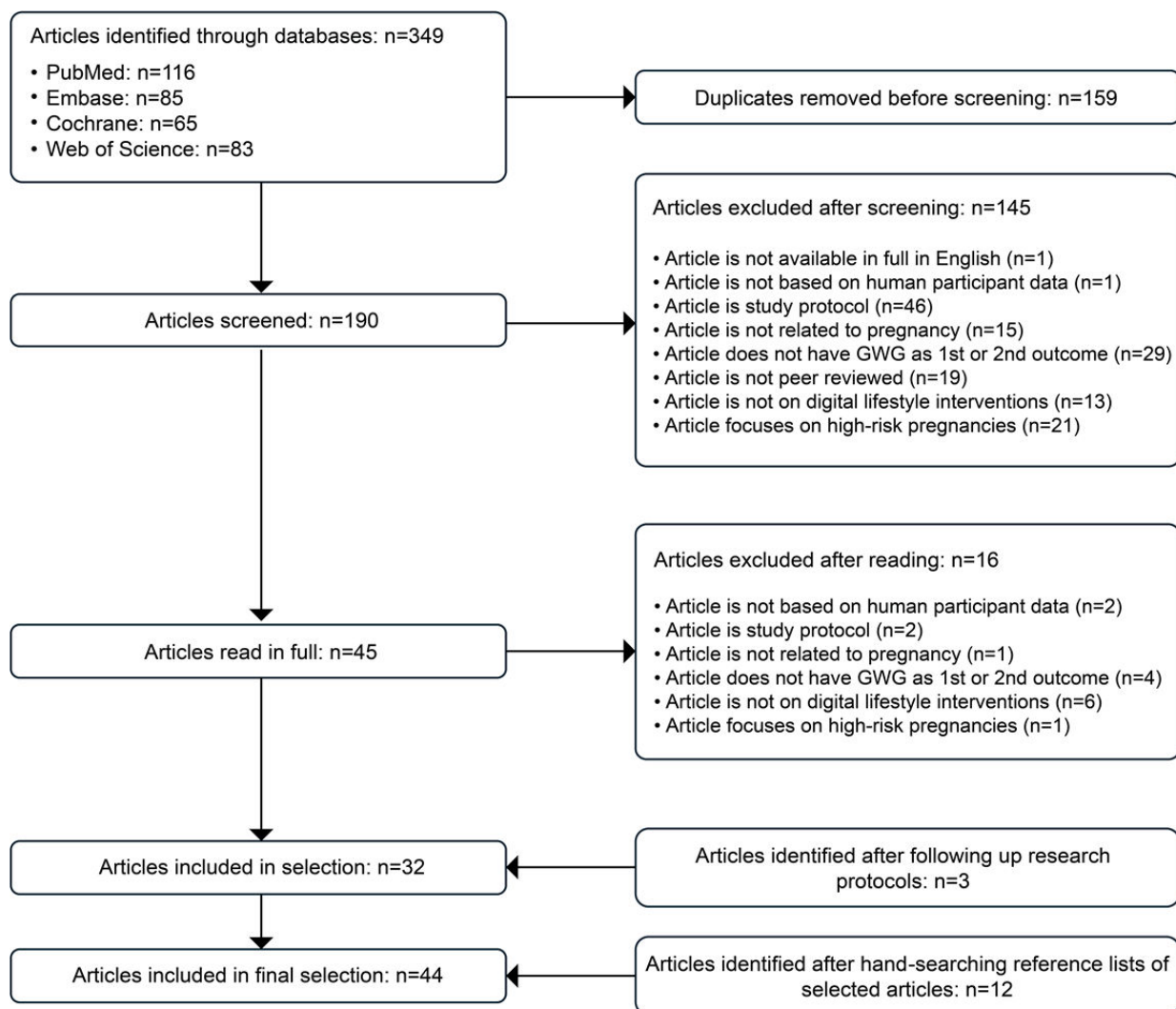
through research protocols (n=3) and hand-searching reference lists (n=12). Following full-text screening, 44 articles met the eligibility criteria: 23 primary data articles and 21 secondary data articles (meta-analyses, systematic reviews, and scoping reviews that included articles on digital lifestyle interventions). [Figure 1](#) shows the article identification and selection flow. The complete data extraction file can be found in [Multimedia Appendix 4](#).

## Results

### Overview

We identified 349 potentially eligible articles through database searches, with an additional 15 articles found

**Figure 1.** Flow diagram of identification and selection of articles. GWG: gestational weight gain.



### Descriptives of Primary and Secondary Data Articles

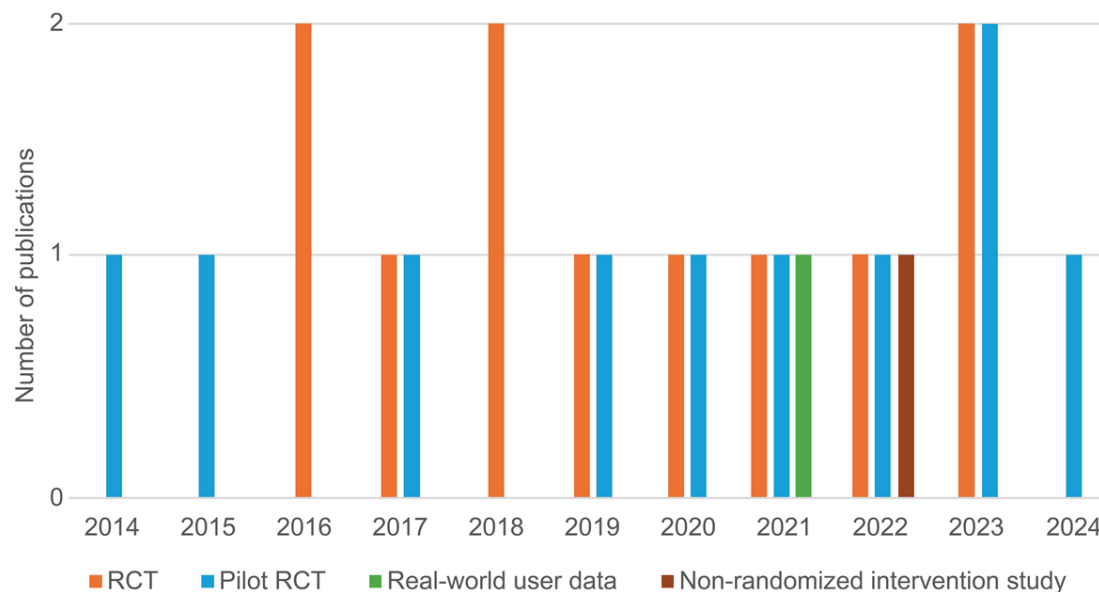
#### Primary Data Articles

The 23 primary data articles included 10 pilot RCTs (43%) [33,51-59], 11 full RCTs (48%) [9,31,32,34,35,60-65], 1 real-world user data study (4%) [66], and 1 nonrandomized

intervention study (4%) [67]. These studies reported on data gathered between 2011 and 2022, with 6 studies (26%) collecting data (partially) during the COVID-19 pandemic [32,35,59,64,65,67]. As illustrated in [Figure 2](#), pilot RCTs were conducted in most years except 2016 and 2018. From 2016 onwards, full RCTs were also conducted yearly, although these were not follow-ups of the pilot studies. A notable peak in RCTs occurred between 2016 and 2019,

potentially reflecting increased interest and funding in digital health interventions during that period.

**Figure 2.** Distribution of the different types of the 23 primary data studies per year since 2014. RCT: randomized controlled trial.



Studies were conducted in 10 different countries: United States (n=13, 57%) [9,31,34,51,56-63,66], Australia (n=2, 9%) [53,55], Canada (n=1, 4%) [67], China (n=1, 4%) [32], Finland (n=1, 4%) [33], Singapore (n=1, 4%) [54], Spain (n=1, 4%) [64], Sweden (n=1, 4%) [35], Taiwan (n=1, 4%) [65], and the United Kingdom (n=1, 4%) [52]. Sample sizes

ranged from 12 to 15,468 participants (median 68, average 916). One study using commercial app data from over 15,000 women drove the high mean [66]. Table 1 summarizes the 23 primary data articles, with complete details in Multimedia Appendix 4.

**Table 1.** Summary of the included primary data articles.

Study	Study type	Sample size	Intervention	Timing <sup>a</sup> (in gestational age)	Delivery medium	Results <sup>b</sup>
Digital-mixed interventions						
Soltani et al [52]	Pilot RCT <sup>c</sup>	14	IG <sup>d</sup> and CG <sup>e</sup> . IG received the MOMTech intervention, including 2 daily SMS text messages, 4 appointments with a healthy lifestyle midwife, goal setting for diet and PA <sup>f</sup> , and use of self-monitoring diaries.	14-16	SMS text message, face-to-face	<ol style="list-style-type: none"> <li>1. IG had lower mean GWG<sup>g</sup> than CG (mean 5.65, SD 4.6 kg vs mean 9.74, SD 7.2 kg; not tested statistically).</li> <li>2. Fewer women in IG exceeded IOM<sup>h</sup> guidelines (4, 28% vs 6, 50%; not tested statistically).</li> </ol>
Smith et al [61]	RCT	51	IG and CG. All participants had access to a website on which CG could view general recommendations on diet and PA. IG had additional access to PA goal-setting modules, problem-solving tools, journal, calendar, and community forum.	10-14	Website, pen-and-paper	<ol style="list-style-type: none"> <li>1. Compared with CG, IG significantly increased sustained PA (+54 min on average; <i>P</i>&lt;.05).</li> <li>2. IG had higher mean GWG than CG (mean 13.6, SD 5.6 kg vs mean 11.2, SD 5.1 kg, Cohen <i>d</i>=0.45).</li> <li>3. The amount of activity performed by women in IG was not sufficient to prevent eGWG<sup>i</sup>.</li> </ol>

Study	Study type	Sample size	Intervention	Timing <sup>a</sup> (in gestational age)	Delivery medium	Results <sup>b</sup>
Redman et al [31]	RCT	54	CG, IG remote, and IG in-person. IG app included personalized dietary intake prescription, weight self-monitoring, activity tracking with a pedometer, receipt of health information, and continuous personalized feedback from counselors.	10-13	App, face-to-face	<ol style="list-style-type: none"> <li>Both IGs together had lower overall GWG than CG (mean 9.2, SD 0.9 kg vs mean 12.8, SD 1.5 kg; <math>P=.04</math>).</li> <li>In-person IG gained less overall weight compared with CG (mean 8.0, SD 1.3 kg vs mean 12.8, SD 1.5 kg; <math>P=.04</math>).</li> <li>Remote IG gained less overall weight compared with CG, but this was only a trend (mean 10, SD 1.3 kg vs mean 12.8, SD 1.5 kg; <math>P=.07</math>).</li> <li>Rate of GWG was lower in in-person IG compared with CG (0.31 kg/wk vs 0.49 kg/wk; <math>P=.04</math>), and comparable with remote IG.</li> <li>Proportion of women with excess GWG was significantly lower in both IGs compared with CG (10/18, 56%, <math>P=.03</math> and 11/19, 58%, <math>P=.04</math> vs 11/13, 86.4%, respectively; OR<sup>j</sup> 0.25, 95% CI 0.04-1.45).</li> </ol>
Willcox et al [53]	Pilot RCT	91	IG and CG. Both received CAU <sup>k</sup> , including brochures with advice on diet and PA. IG also received tailored SMS text messages, access to a website, video messages, chat room interaction, and guidance from trained researcher who educated them on nutrition, PA, and GWG goals, and helped them track weight and set goals.	13-17	SMS text messages, social media, pen-and-paper, face-to-face	There was a significant difference in GWG between groups, with IG participants gaining an average 7.8 (SD 4.7) kg and CG average 9.7 (SD 3.9) kg ( $P=.04$ ).
Van Horn et al [62]	RCT	280	IG and CG. CG received biweekly newsletters and links to publicly available maternity websites. IG received DASH <sup>l</sup> diet and PA coaching. A commercially available app was used for self-monitoring of diet and PA, with additional support provided through telephone, SMS text message, and email.	15	App, face-to-face, mHealth <sup>m</sup> tools	<ol style="list-style-type: none"> <li>IG gained significantly less weight than CG (mean 10, SD 6 kg vs mean 12, SD 6 kg, <math>P=.02</math>; Cohen <math>d=0.33</math>).</li> <li>Fewer women in IG exceeded IOM guidelines (96/140, 67% vs 119/141, 84%, <math>P=.004</math>).</li> </ol>
Altazan et al [63] <sup>n</sup>	RCT	54	CG, IG remote, and IG in-person. IG app included	10-13	App, face-to-face	<ol style="list-style-type: none"> <li>Proportion of women exceeding GWG</li> </ol>

Study	Study type	Sample size	Intervention	Timing <sup>a</sup> (in gestational age)	Delivery medium	Results <sup>b</sup>
			personalized dietary intake prescription, weight self-monitoring, activity tracking with a pedometer, receipt of health information, and continuous personalized feedback from counselors.			guidelines was 56.3% (18/32) in IG and 81.8% (9/11) in CG ( $P=.17$ ). 2. Women in IG had less overall GWG as compared with CG (mean 8.7, SD 0.9 kg vs mean 12.8, SD 1.5 kg; $P=.03$ ; Cohen $d=3.33$ ).
Darvall et al [55]	Pilot RCT	27	CG, app IG, and app+coach IG. All participants wore pedometers. In CG, the pedometer display was obscured and could not be synced. Participants in both IGs had a pedometer synced to their personal smartphone. They also received a 4-session behavioral change program.	13-19	App, face-to-face, telephone, mHealth tools	There was no significant difference between groups in GWG: app IG: mean $-5.46$ , SD $2.8$ kg, $P=.07$ ; app-coach IG: mean $-0.40$ , SD $2.8$ kg, $P=.89$ , both compared with CG.
Ferrara et al [9]	RCT	394	IG and CG. CG received CAU. IG received a program to improve GWG, diet, PA, and stress management, including in-person and telephone sessions.	8-15	Pen-and-paper, face-to-face, telephone	1. IG had significantly lower GWG than CG (mean $10.21$ , SD $5.6$ kg vs mean $12.36$ , SD $5.3$ kg, $P\leq.001$ ; Cohen $d=0.39$ ). 2. Women in IG had significantly lower rates of GWG per week than women in CG (mean between-group difference $-0.07$ kg per wk, 95% CI $-0.09$ to $-0.04$ , $P<.001$ ). 3. Proportion of women exceeding guidelines for weekly GWG rate and total GWG was significantly lower in IG than in CG (96/199, 48% vs 134/195, 69%, RR <sup>o</sup> $0.70$ , 95% CI $0.59-0.83$ , $P<.001$ and 80/199, 41% vs 128/195, 66%, RR $0.62$ , 95% CI $0.51-0.76$ , $P<.001$ , respectively). 4. Proportion of women meeting IOM guidelines for weekly GWG rate and total GWG was significantly higher in IG than in CG (65/199, 33% vs 46/195, 24%, RR $1.38$ , 95% CI $1.00-1.90$ , $P=.049$ and 69/199, 36% vs 42/195, 22%, RR $1.66$ , 95% CI $1.21-2.30$ , $P=.002$ , respectively). 5. Proportion of women gaining below IOM



Study	Study type	Sample size	Intervention	Timing <sup>a</sup> (in gestational age)	Delivery medium	Results <sup>b</sup>
						guidelines for weekly rate of GWG and total GWG was significantly higher in IG than CG (38/199, 19% vs 15/195, 8%, RR 2.49, 93% CI 1.44-4.31, $P<.001$ and 45/199, 23% vs 24/195, 12%, RR 1.84, 95% CI 1.17-2.87, $P=.008$ , respectively).
Downs et al [56]	Pilot RCT	24	IG and CG. All participants received CAU and monitored their GWG, PA, and dietary intake. Participants wore 1 activity monitor daily and 1 in 2-week cycles to track PA. Intake was recorded via app on 2 weekdays and 1 weekend day. In addition, the IG received weekly dietitian meetings, individualized caloric goals, and educational booklets on diet and PA. Intervention dosage was reviewed and adjusted every 3-4 weeks as needed.	8-12	App, email, pen-and-paper, face-to-face, mHealth tools	<ol style="list-style-type: none"> <li>1. IG gained 1.9 kg less than CG, but this was not significant (<math>P=.43</math>, 95% CI -6.6 to 2.9).</li> <li>2. In IG PA from pre- to posttest increased, while in CG it decreased. This difference was not significant (<math>P=.48</math>).</li> <li>3. Energy intake increased less from pre- to posttest for IG compared with CG (<math>P=.02</math>).</li> </ol>
Thomas et al [57]	Pilot RCT	68	IG and CG. All participants received CAU. IG also set PA goals working up to 150 active minutes/week, wore accelerometer, and weighed themselves daily. They received monthly calls to review and reset goals, access to a website with collected data and GWG resources, and personal messages.	10-12	SMS, email, website, pen-and-paper, telephone, mHealth tools	<ol style="list-style-type: none"> <li>1. Participants in IG and CG had the same total GWG (+1.14 kg, 95% CI -0.71 to 3.00).</li> <li>2. Participants in IG and CG had the same rate of GWG (+0.03 kg, 95% CI -0.02 to 0.09).</li> </ol>
Digital-only interventions						
Pollak et al [51]	Pilot RCT	33	Txt4Baby IG and PregCHAT IG. Txt4Baby IG received general pregnancy-related SMS text message 3 days/week. PregChat IG received personalized feedback through SMS text messages 3 days/week based on intake of sweetened beverages, fruits and vegetables, fast food, daily step count, and weight.	16	SMS text messages	Participants in IG gained 6 pounds less than those in CG, but this was not statistically significant ( $P=.24$ , 95% CI -15.9 to 4.0).
Herring et al [60]	RCT	66	IG and CG. All participants received CAU. IG additionally received guidance through personalized health coach calls, texts, and feedback; pedometer; and DVD; on energy intake, PA, and weight. Also, participants received education and	8-17	SMS text message, social media, telephone	<ol style="list-style-type: none"> <li>1. IG was significantly less likely to exceed IOM guidelines than CG (10/27, 37% vs 19/29, 66%; <math>P=.03</math>).</li> <li>2. IG gained less weight in pregnancy than CG (mean 8.7, SD 6.6 kg vs mean</li> </ol>

Study	Study type	Sample size	Intervention	Timing <sup>a</sup> (in gestational age)	Delivery medium	Results <sup>b</sup>
Olson et al [34]	RCT	1689	shared updates in a Facebook (Meta) group. Placebo, pregnancy IG and postpartum CG, and pregnancy and postpartum IG. All participants received CAU and behavioral change tools on a website and app platform, but the placebo group did not receive weight gain tracker, diet and PA goal setting, and self-monitoring tool.	12-20	App, email, website, mHealth tools	12.3, SD 6.4 kg; $P=.046$ ; Cohen $d=0.55$ ). Authors reported no significant difference in proportion of women with excessive GWG in IG versus CG (542/1126, 48% vs 260/563, 46%, RR 1.09, 95% CI 0.98-1.20, $P=.12$ ).
Li et al [54]	Pilot RCT	26	IG and CG. All participants received standard dietary guidance for pregnancy during recruitment. IG also received 8 weeks of real-time food coaching via app. They could upload images of meals, drinks, or desserts and receive feedback and guidance from professional dietitians.	18-20	App	<ol style="list-style-type: none"> <li>1. More participants met guidelines in IG than in CG (4-wk follow-up: 7/12, 58% vs 8/15, 53%; 8 wk follow-up: 8/12, 67% vs 5/14, 36%; not tested statistically).</li> <li>2. Although not significant, IG had less GWG than CG at both 4- and 8-week follow-up (<math>-0.15</math> kg, 95% CI <math>-1.51</math> to <math>1.21</math>, <math>P=.83</math> and <math>-0.08</math> kg, 95% CI <math>-1.80</math> to <math>1.63</math>; <math>P=.92</math>, respectively).</li> </ol>
Litman et al [66]	Real-world user data	15,468	BabyScripts IG. App is provided through HCP <sup>P</sup> to track GWG. Participants could enter weight manually or via a connected scale. App gives targeted, gestational-age-specific educational materials.	<20	App	<ol style="list-style-type: none"> <li>1. Highly engaged participants had increased adherence to IOM guidelines (762/2555, 29.8% vs 302/3209, 9.4%, <math>P&lt;.001</math>).</li> <li>2. A larger proportion of highly engaged participants adhered to IOM guidelines for rate of GWG in trims 2 and 3, compared with lowest engaged patients (325/2555, 12.7% vs 219/3209, 6.8%, <math>P&lt;.001</math>).</li> </ol>
Sandborg et al [35]	RCT	305	IG and CG. All participants received CAU. IG received a 6-month app program, encouraging healthy diet and PA. This included push notifications 4 times/week for information, support, strategies, guidance, encouraging information, and reminders.	13-14	App, mHealth tools	<ol style="list-style-type: none"> <li>1. No statistically significant effect on GWG between IG and CG (<math>-0.2</math> kg, <math>P=.62</math>; Cohen <math>d=0.28</math>).</li> <li>2. No statistical difference in adherence to recommendations between IG and CG (67/134, 50% vs 68/137, 50%, <math>P=.32</math>).</li> <li>3. Results differed per BMI group: for women with BMI <math>\geq 25</math>, GWG in IG was</li> </ol>

Study	Study type	Sample size	Intervention	Timing <sup>a</sup> (in gestational age)	Delivery medium	Results <sup>b</sup>
Gonzalez-Plaza et al [64]	RCT	120	IG and CG. All participants received CAU. IG used a smartband-connected app to monitor PA and for communication with midwife, who provided personalized health guidance.	12-28	App, SMS text messages, mHealth tools	<p>lower than for those in CG (-1.67 kg, <math>P=.03</math>).</p> <p>4. IG had better diet quality than CG (<math>\beta</math>-coefficient=0.27; <math>P=.02</math>).</p> <p>1. Median GWG in IG was significantly lower than in CG (median 7.0, IQR 4-11 kg vs median 9.3, IQR 5.9-13.3 kg, <math>P=.04</math>; Cohen <math>d=0.42</math>).</p> <p>2. Adjusted mean GWG per week was significantly lower in IG than in CG (0.3 kg/wk vs 0.5 kg/wk, <math>P=.008</math>).</p> <p>3. IG had higher mean PA than the CG (1980 vs 1386 MET<sup>4</sup> min/wk, respectively, <math>P=.01</math>).</p>
Souza et al [67]	Nonrandomized intervention study	27	IG only divided into higher or lower app usage group that got access to SmartMoms Canada app, Google Fitbit, and Withings scale. App provided real-time feedback on nutrition, PA, sleep, and GWG. Participants were encouraged to use it daily.	12-20	App, mHealth tools	<p>1. Higher vs lower app usage group better adhered to GWG guidelines, but this was not statistically significant (Cramer <math>V=0.21</math>, <math>P=.54</math>).</p> <p>2. Higher vs lower app usage group had more moderate PA (mean difference 8.41, 95% CI 1.05-15.77, <math>P&lt;.05</math>) and MVPA<sup>†</sup> (mean difference 17.84, 95% CI 2.44-33.25, <math>P&lt;.05</math>).</p>
Chen et al [65]	RCT	80	IG and CG. All participants received CAU. IG used app and a wearable activity tracker. App features included prenatal history, goal setting, chart history, records, prenatal information, rewards, reminders, and prenatal tools.	17	App, SMS text messages, mHealth tools	<p>1. Proportion of participants exceeding total GWG was not significantly different between CG and IG (8/37, 22% vs 14/43, 33%, <math>P=.28</math>).</p> <p>2. In trimester 2, significantly lower proportion of IG exceeded weekly GWG (18/37, 45% vs 29/43, 67%, <math>P=.04</math>). For trimester 1 and 3, they performed like CG.</p> <p>3. In trimester 3, obese women in IG had less total GWG and body weight than those in the CG (-8.8 kg, <math>P=.04</math> and -5.4 kg, <math>P=.02</math>, respectively). This did not hold for trimesters 1 and 2.</p>

Study	Study type	Sample size	Intervention	Timing <sup>a</sup> (in gestational age)	Delivery medium	Results <sup>b</sup>
Feng et al [32]	RCT	268	CG and IG. All participants received CAU. IG monitored weight, diet, and PA with an app. App contained sections for weight management (through weighing, diet, and PA), daily recordings (with feedback), data trends, reminders, and pregnancy education per gestational week.	6-7	App	Overall median GWG in IG was significantly lower than that in CG (median 8.5, IQR 5.5-11 kg vs median 10.0, IQR 6-14 kg; $P=.008$ ; Cohen $d=0.42$ ).
Koivuniemi et al [33]	Pilot RCT	1038	Standard-app IG and enhanced-app IG. All participants recorded lifestyle habits (PA and diet), monitored changes by viewing graphs of their recordings, and received reminders for recording information via app. Enhanced-app IG received additional, nonpersonalized, motivating information on health-promoting lifestyle during pregnancy.	9-20	App	<ol style="list-style-type: none"> <li>1. Authors reported no significant differences in GWG or in changes in IDQ<sup>s</sup> scores or MET scores.</li> <li>2. In IG, the proportion of women with regular eating frequency was lower in late as compared with early pregnancy (OR 0.47, 95% CI 0.22-0.98, <math>P=.045</math>). In CG, there was no such difference (OR 1.44, 95% CI 0.69-3.01, <math>P=.33</math>).</li> <li>3. Proportion of women with high and moderate activity decreased more in app nonusers than in frequent app users (OR 0.61, 95% CI 0.40-0.94, <math>P=.03</math>) and occasional app users (OR 0.55, 95% CI 0.32-0.97, <math>P=.04</math>).</li> </ol>
Waring et al [58]	Pilot RCT	12	IG. Participants used a website to track diet, PA, and GWG, and an open community. Participants were encouraged to check their feed daily, post regularly themselves, track diet and PA, and weigh themselves weekly. Researchers posted messages daily and interacted asynchronously with participants.	14-18	Website	The authors reported that 70% (7/10) of participants had eGWG, 10% (1/10) had inadequate GWG, and 20% (2/10) gained within the recommended ranges.
Mattson and Barger [59]	Pilot RCT	22	Historical CG, self-weighing IG (WA), and self-weighing+counseling IG (WC). WA and WC groups were asked to weigh themselves weekly. WC group also received 6x30 min online counseling on healthy diet.	10-25	Telehealth system, mHealth tools	<ol style="list-style-type: none"> <li>1. Participants from WC and WA combined gained less weight than those in CG, but this effect was not significant (<math>-0.7</math> lb, <math>P=.72</math>).</li> <li>2. Participants in WC gained less than those in the WA, but this effect was not significant (<math>-1.5</math> lb, <math>P=.52</math>).</li> </ol>

Study	Study type	Sample size	Intervention	Timing <sup>a</sup> (in gestational age)	Delivery medium	Results <sup>b</sup>
						3. Participants from WC and WA combined who weighed themselves $\geq 6$ times/wk gained less than those who weighed $< 6$ times/wk, but this effect was not significant ( $-2.7$ lb, $P=.99$ )

<sup>a</sup>Timing of initiation of intervention.

<sup>b</sup>For nonpilot studies with a control group, effect sizes for differences in mean gestational weight gain are reported.

<sup>c</sup>RCT: randomized controlled trial.

<sup>d</sup>IG: intervention group.

<sup>e</sup>CG: control group.

<sup>f</sup>PA: physical activity.

<sup>g</sup>GWG: gestational weight gain.

<sup>h</sup>IOM: Institute of Medicine.

<sup>i</sup>eGWG: excessive gestational weight gain.

<sup>j</sup>OR: odds ratio.

<sup>k</sup>CAU: care as usual.

<sup>l</sup>DASH: dietitian-led dietary approaches to stop hypertension.

<sup>m</sup>mHealth: mobile health.

<sup>n</sup>This paper belongs to a series of papers reporting on the same study as the one by Redman et al [31]. Hence, it describes the same interventions.

<sup>o</sup>RR: relative risk.

<sup>p</sup>HCP: health care professional.

<sup>q</sup>MET: metabolic equivalent of task.

<sup>r</sup>MVPA: moderate-to-vigorous physical activity.

<sup>s</sup>IDQ: Index of Diet Quality.

## Secondary Data Articles

The 21 secondary data articles included 9 meta-analyses (43%) [37,38,40,68-73], 5 systematic reviews (24%) [74-78], 3 scoping reviews (14%) [41,79,80], and 4 secondary analyses of RCT data (19%) [36,81-83]. Of the 9 meta-analyses, 4 (44%) investigated lifestyle interventions in general, while the other 5 (56%) specifically focused on digital lifestyle interventions. All systematic reviews targeted digital lifestyle interventions exclusively. Of the 3 scoping reviews, 2 (67%) addressed general lifestyle interventions and 1 (33%) examined digital interventions specifically [1]. Figure 3 illustrates the temporal trend in research methodologies used in the secondary data articles. Meta-analyses, the most prevalent approach, peaked in 2017 with 3 publications. Notably, 2 meta-analyses published in 2017 [38,69] specifically addressed the effectiveness of digital interventions for managing GWG, despite a limited number of RCTs on the topic at that time (Table 1). Systematic reviews maintained consistent usage throughout the search period. Scoping reviews were published less frequently overall but showed an increase after 2021, which roughly coincides with the publication of the PRISMA Extension for Scoping Reviews in 2018 [50]. Secondary analyses of RCT data were typically published 1-4 years following the original data collection.

The secondary data articles synthesized studies published between 1992 and 2022, incorporating 36 publications on

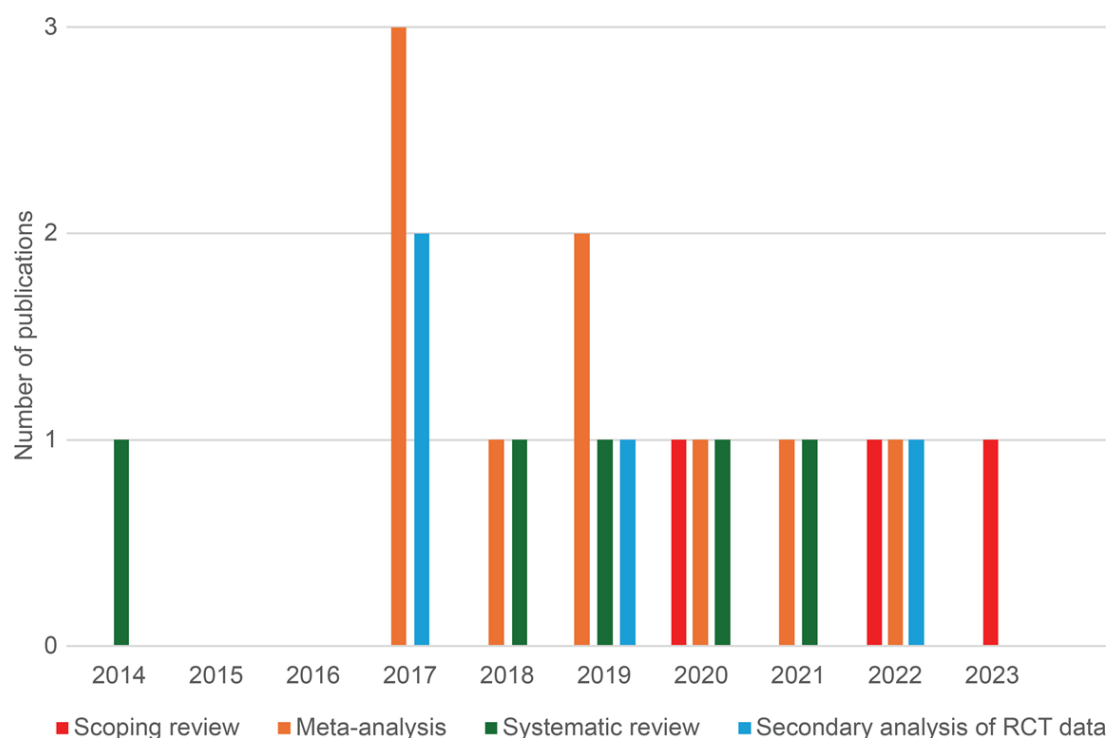
average (range 7-97, median 21), with an average sample size of 526 participants per article (range 53-2833, median 89). Overlap with our primary data articles varied across the secondary data article types: meta-analyses shared an average of 3 articles (range 2-6), systematic reviews 2.2 articles (range 0-5), and scoping reviews 3 articles (range 1-13) with our selection of 23 primary studies.

In terms of inclusion criteria, the majority of the secondary data articles primarily included RCTs or quasi-RCTs examining healthy lifestyles in pregnant women and GWG management, although systematic reviews allowed for wider inclusion criteria encompassing observational and qualitative studies.

The target populations were predominantly pregnant women in general, with exceptions including 3 articles (14%) focusing specifically on women with overweight or obesity [41,69,70], 1 article (5%) included both healthy women and those with (gestational) diabetes [71], and 1 article (5%) targeting users of pregnancy-related mobile phone interventions [78].

A summary of all included secondary data articles can be found in Table 2, with detailed data extraction available in Multimedia Appendix 4.

**Figure 3.** Distribution of the different research methodologies used in the 21 secondary data articles on (digital) interventions for gestational weight gain management since 2014.



**Table 2.** Summary of the included secondary data articles.

Study	Study type	Target group	Overlap primary articles/number of articles included (%)	Results
O'Brien et al [74]	Systematic review	All healthy pregnant women (without pregnancy-related conditions)	0/7 (0)	<ol style="list-style-type: none"> <li>1. Technology-supported lifestyle interventions in pregnancy hold potential as safe and sustainable adjunct to traditional health care models.</li> <li>2. Quality and quantity of published evidence to support use of such interventions is low.</li> <li>3. Findings raise the issue of uptake levels and sociocultural acceptance of such lifestyle interventions.</li> </ol>
Graham et al [81]	Secondary analysis RCT <sup>a</sup> data	Normal weight to moderately obese pregnant women	— <sup>b</sup>	<ol style="list-style-type: none"> <li>1. CG<sup>c</sup>: 3 different types of patterns of app usage. IG<sup>d</sup>: 5 patterns.</li> <li>2. In CG, GWG<sup>e</sup> outcomes did not differ by usage pattern. In IG, GWG outcomes did differ by usage pattern. <ul style="list-style-type: none"> <li>• In the lower income-normal BMI group, “almost consistent” or inconsistent trackers had a risk of eGWG,<sup>f</sup> and “inconsistent” trackers gained more than “nonuser” usage pattern.</li> <li>• In the higher income-normal BMI group, “consistent” trackers had lower risk of eGWG rate than “nonusers.”</li> <li>• In the higher income-high BMI group, “consistent” trackers gained less than “nonusers.”</li> </ul> </li> <li>3. Compared with participants with lower usage patterns, participants in higher usage patterns and higher income gained less, both in normal and high BMI subgroups (total mean GWG -1.83 kg, 95% CI -3.58 to -0.54). For participants with lower income, no such difference.</li> </ol>
The International Weight Management in Pregnancy (i-WIP)	Meta-analysis	All pregnant women except those with GDM <sup>g</sup>	2/81 (2)	<ol style="list-style-type: none"> <li>1. Based on IPD<sup>h</sup> data, diet- and PA<sup>i</sup>-based IGs resulted in significantly less GWG compared with CG (mean GWG -0.70 kg, 95% CI -0.92 to -0.48).</li> </ol>

Study	Study type	Target group	Overlap primary articles/number of articles included (%)	Results
Collaborative Group [72]				<ol style="list-style-type: none"> <li>When supplementing IPD data with non-IPD data, the difference between IG and CG increased (mean GWG <math>-1.1</math> kg, 95% CI <math>-1.46</math> to <math>-0.74</math>), but so did heterogeneity.</li> <li>No evidence for differential intervention effects across subgroups.</li> </ol>
Lau et al [69]	Meta-analysis	Overweight and obese pregnant women	2/17 (12)	<ol style="list-style-type: none"> <li>Participants in IG had lower GWG than CG (GWG <math>-0.63</math>kg, 95% CI <math>-1.07</math> to <math>-0.20</math>, <math>P=.004</math>).</li> <li>Electronic-based lifestyle interventions with in-person, phone, or combination of those formats were found effective for reducing GWG (<math>P=.004</math> for all 3). No such effect for solely electronic-based platforms (<math>P=.27</math>). No significant effects for subgroup differences.</li> </ol>
Olson et al [82]	Secondary analysis RCT data	Normal weight to moderately obese pregnant women	—	<ol style="list-style-type: none"> <li>Of the total, 16.5% (58/351) of low-income women and 34.2% (187/547) of not-low-income women consistently tracked GWG.</li> <li>More highly educated, older, and White women were more likely to be consistent GWG trackers.</li> <li>Among not-low-income women, consistent GWG tracking was associated with 2.35 kg less GWG (95% CI <math>-3.23</math> to <math>-1.46</math>, <math>P&lt;.001</math>) and reduced risk of eGWG (RR<sup>J</sup> 0.73, 95% CI 0.59-0.89, <math>P=.002</math>).</li> </ol>
Sherifali et al [38]	Meta-analysis	All pregnant women	4/10 (40)	<ol style="list-style-type: none"> <li>Meta-analysis on 6 studies showed nonsignificant reduction in GWG (mean GWG <math>-1.62</math> kg, 95% CI <math>-3.57</math> to <math>0.33</math>, <math>P=.10</math>) after exposure to the intervention.</li> </ol>
Overdijkink et al [76]	Systematic review	All pregnant women	3/29 (10)	<ol style="list-style-type: none"> <li>mHealth<sup>k</sup> lifestyle apps and mHealth medical apps seem feasible and acceptable.</li> <li>Evidence of effectiveness is limited because of small sample sizes.</li> <li>Formal guidelines for quality certification of apps need to be developed.</li> </ol>
Walker et al [40]	Meta-analysis	All pregnant women except those with diabetes or GDM	4/89 (5)	<ol style="list-style-type: none"> <li>Women in dietary IGs gained less than those in CG (mean GWG <math>-3.27</math> kg, 95% CI <math>-4.96</math> to <math>-1.58</math>, <math>P&lt;.001</math>).</li> <li>Women in PA IGs gained less than those in CG (mean GWG <math>-1.02</math> kg, 95% CI <math>-1.56</math> to <math>-0.49</math>, <math>P&lt;.001</math>).</li> <li>Women in lifestyle IG (diet and PA combined) gained less than those in CG (mean GWG <math>-0.73</math> kg, 95% CI <math>-1.17</math> to <math>-0.29</math>, <math>P&lt;.001</math>).</li> <li>Women in eHealth IGs gained less than those in the CG (mean GWG <math>-2.26</math> kg, 95% CI <math>-3.84</math> to <math>-0.69</math>, <math>P&lt;.001</math>).</li> <li>Interventions in groups with group components were effective more often (effective 62.5%, ineffective 37.35%; <math>P=.02</math>) than those delivered individually (effective 33.3%, ineffective 66.7%; <math>P=.04</math>).</li> <li>The study did not find optimal duration, frequency, intensity, delivery method, or diet for preventing eGWG.</li> </ol>
Chan and Chen [73]	Meta-analysis	All pregnant women	3/16 (19)	<ol style="list-style-type: none"> <li>Moderate effect in maternal weight control and maintaining optimal body composition by promoting lifestyle change and self-monitoring via mHealth apps and social media (Cohen <math>d=0.45</math>)</li> </ol>
Mertens et al [77]	Systematic review	All healthy pregnant women	2/11 (18)	<ol style="list-style-type: none"> <li>Technology-supported lifestyle interventions might affect GWG and PPWR<sup>l</sup>, but more research is needed for examining their effectiveness, usability, and critical features.</li> </ol>

Study	Study type	Target group	Overlap primary articles/number of articles included (%)	Results
Olson et al [36]	Secondary analysis RCT data	Normal weight to moderately obese pregnant women	—	<ol style="list-style-type: none"> <li>Interventions positively influence GWG and PPWL,<sup>m</sup> but results are not always significant. Furthermore, effects on PA and healthy eating are inconsistent.</li> <li>Among women with normal BMI, setting <math>\geq 2</math> goals+engaging in self-monitoring was associated with less GWG (<math>P=.03</math>). Also, risk for eGWG reduced (<math>P=.04</math>).</li> <li>Among women with higher BMI, setting <math>\geq 2</math> goals was associated with greater GWG (<math>P=.01</math>), and with significantly increased risk for eGWG (<math>P=.03</math>).</li> </ol>
Vincze et al [71]	Meta-analysis	Pregnant women with (gestational) diabetes	2/48 (4)	<ol style="list-style-type: none"> <li>A total of 12 out of 25 studies (48%) reported significant reductions in GWG.</li> <li>Despite heterogeneity, pregnant women in IGs gained less weight than those in CGs (mean GWG <math>-1.25</math> kg, 95% CI <math>-2.10</math> to <math>-0.40</math>, <math>P=.004</math>).</li> </ol>
Hussain et al [78]	Systematic review	All pregnant women who used pregnancy-related mobile phone interventions	5/28 (18)	<ol style="list-style-type: none"> <li>In high-income countries, use of mobile phone-based health behavior interventions in pregnancy demonstrates correlation with positive beliefs, behaviors, and health outcomes.</li> <li>More effective interventions are multimodal in terms of features and tend to focus on healthy GWG.</li> </ol>
Hutchesson et al [80]	Scoping review	All pregnant women	4/90 (4)	<ol style="list-style-type: none"> <li>Majority of research on behavioral interventions for women of childbearing age focused on weight management during or after pregnancy.</li> <li>Research gap to support weight management in young adult females in preconception and unrelated to pregnancy to improve chronic disease health trajectories.</li> <li>Future research to examine delivery modes and mediums, optimal intervention duration and intensity, involvement of health care providers, and involvement of underrepresented populations should be considered for effectiveness and scalability.</li> </ol>
Rhodes et al [68]	Meta-analysis	All pregnant women, except with issues that would preclude them from participating in diet- or PA-based intervention	5/11 (50)	<ol style="list-style-type: none"> <li>No significant benefit of intervention on total GWG for either ITT<sup>n</sup> (<math>-0.28</math> kg, 95% CI <math>-1.43</math> to <math>0.87</math>, <math>P=.63</math>) data or PPD<sup>o</sup> (<math>-0.65</math> kg, 95% CI <math>-1.89</math> to <math>0.67</math>, <math>P=.34</math>).</li> <li>7 BCTs<sup>p</sup> were common to all effective interventions.</li> <li>Effective interventions averaged over twice as many BCTs from goals and planning, and feedback and monitoring domains as ineffective ones.</li> <li>Positive association between high engagement with key BCTs and greater intervention success.</li> <li>Interventions using proactive messaging and feedback appeared to have more engagement.</li> </ol>
Iyawa et al [75]	Systematic review	All pregnant women	1/18 (6)	<ol style="list-style-type: none"> <li>Use of mobile apps during pregnancy points toward positive impact on pregnancy and health service delivery.</li> <li>Mobile apps can facilitate communication between pregnant women and HCPs<sup>q</sup> despite distance, making them a suitable option for patients in areas with less access to HCPs and medical facilities.</li> </ol>
Leonard et al [37]	Meta-analysis	All pregnant women	6/21 (29)	<ol style="list-style-type: none"> <li>Women in technology-supported IG had significantly lower mean GWG than CG (mean GWG <math>-1.18</math>, Cohen <math>d=0.23</math>).</li> <li>Relatively small effects may be improved by intervention characteristics such as delivery mode, type of technology, and frequency prescribed.</li> </ol>
Barroso et al [41]	Scoping review	Overweight & obese pregnant women	1/8 (13)	<ol style="list-style-type: none"> <li>Out of 8 identified trials, 4 had lifestyle interventions that were effective in improving GWG.</li> </ol>



Study	Study type	Target group	Overlap primary articles/number of articles included (%)	Results
Henriksson et al [83]	Secondary analysis RCT data	All healthy pregnant women	—	<ol style="list-style-type: none"> <li>2. Effective interventions were intensive, included in-person sessions, started early-to-mid pregnancy, and lasted remaining pregnancy duration.</li> <li>3. Lifestyle coaches trained in behavior change and motivational interviewing can facilitate in-person sessions, helping set small goals and use self-monitoring strategies, and providing feedback.</li> </ol>
Wu et al [70]	Meta-analysis	Overweight and obese pregnant women	2/23 (9)	<ol style="list-style-type: none"> <li>1. Greater number of registrations within app was associated with lower GWG and improved diet quality. Results were mainly attributable to the number of PA registrations.</li> <li>2. Number of app sessions and page views were not associated with GWG, diet quality, and PA.</li> </ol>
Raab et al [79]	Scoping review	All pregnant women	13/97 (13)	<ol style="list-style-type: none"> <li>1. Compared with CAU<sup>f</sup>, women with PA, diet, and combined diet+PA interventions all gained less during pregnancy (mean GWG -1.98kg, 95% CI -3.50 to -0.47), -1.95 kg (95% CI -3.19 to -0.71), and -1.21 kg (95% CI -1.92 to -0.50), respectively).</li> <li>2. In 7 of 18 included (pilot) RCTs, rates of eGWG or total GWG could be reduced by intervention.</li> <li>3. Effectiveness and implementability of app-supported interventions have yet to be determined.</li> <li>3. Identifying most beneficial app features and intervention components is challenging. Consistent and comprehensive intervention and outcome reporting is needed.</li> </ol>

<sup>a</sup>RCT: randomized controlled trial.

<sup>b</sup>Not applicable.

<sup>c</sup>CG: control group.

<sup>d</sup>IG: intervention group.

<sup>e</sup>GWG: gestational weight gain.

<sup>f</sup>eGWG: excessive gestational weight gain.

<sup>g</sup>GDM: gestational diabetes mellitus.

<sup>h</sup>IPD: individual participant data

<sup>i</sup>PA: physical activity.

<sup>j</sup>RR: relative risk.

<sup>k</sup>mHealth: mobile health.

<sup>l</sup>PPWR: postpartum weight retention.

<sup>m</sup>PPWL: postpartum weight loss.

<sup>n</sup>ITT: intention-to-treat.

<sup>o</sup>PPD: per-protocol data.

<sup>p</sup>BCT: behavior change technique.

<sup>q</sup>HCP: health care professional.

<sup>r</sup>CAU: care as usual.

## Intervention Characteristics of Primary Data Articles

The 23 primary data articles analyzed 22 distinct interventions on which we focus in this section. In general, studies often provided insufficient detail in intervention descriptions, representing a gap in reporting practices that complicated data extraction and interpretation of successful design and implementation features. Despite this, we were able to extract the following information.

Most interventions targeted pregnant women in their first or second trimester who were overweight or obese, had singleton pregnancies, and no medical conditions or pregnancy complications that could affect metabolism or body weight. Exceptions included 2 studies (9%) that also

included women with normal weight [34,67], 1 (5%) focusing on sedentary women [61], and 1 (5%) targeting women who had entered their weight gain in a specific app [66].

Recruitment was mostly done through prenatal clinics (n=9), followed by (university) hospital obstetric units (n=6), maternity units (n=3), and social media platforms (n=4). Most interventions used the 2009 IOM GWG guidelines (n=20, 91%). Regarding lifestyle, most interventions targeted both PA and diet (n=18, 82%), while 2 interventions (9%) focused solely on PA [55,57], and 2 (9%) on diet only [54,59].

## Theoretical Foundation

Interventions were underpinned by a myriad of behavioral and social theories (Table 3), with social cognitive theory

being most prevalent (n=11, 50%). Notably, 4 interventions (18%) used more than 1 theory [9,34,57,60], while 5 interventions (23%) provided no identifiable theoretical basis.

**Table 3.** Theoretical foundations of the interventions.

Theory	Number of studies	Study reference
Social cognitive theory	11	Ferrara et al [9], Koivuniemi et al [33], Sandborg et al [35], Pollak et al [51], Willcox et al [53], Thomas et al [57], Waring et al [58], Herring et al [60], Smith et al [61], Gonzalez-Plaza et al [64], Chen et al [65]
Control theory	1	Soltani et al [52]
Social ecological model	1	Herring et al [60]
Integrative model of behavior prediction	1	Olson et al [34]
Behavior model for persuasive design	1	Olson et al [34]
Theory of planned behavior	1	Downs et al [56]
Transtheoretical model of change	4	Ferrara et al [9], Redman et al [31], Thomas et al [57], Souza et al [67]
Self-determination theory	1	Darvall et al [55]
No theory mentioned	5	Feng et al [32], Li et al [54], Mattson et al [59], Van Horn et al [62], Litman et al [66]

### Timing

Intervention timing was relatively consistent across studies, with most starting between gestational weeks 10 and 16 on average. Specifically, 4 interventions started before 14 weeks of gestation (range 6-13, 18%) [31,32,56,57]; 13 interventions started before 28 weeks of gestation (range 8-28, 59%) [9,33-35,53,55,59-61,64-67]; and 5 interventions started between 14 and 28 weeks of gestation (range 14-20, 23%) [51,52,54,58,62].

### Duration

The average intervention duration was 21.1 (SD 7.3, range 6-29, median 24) weeks. Interventions starting in trimester 1 (<14 wk gestation) lasted about 7 weeks longer (average 28, SD 1.0 wk) than those starting in either trimester 1 or 2 combined (<28 wk gestation; average 21, SD 6.9 wk) and about 11 week longer than those starting in trimester 2 (≥14 wk and <28 wk gestation; average 16 wk, SD 1.5 wk).

### Frequency

Frequency patterns varied considerably across studies, ranging from on-demand content access to structured daily

check-ins combined with in-person sessions and some interventions combining multiple formats (detailed descriptions in [Multimedia Appendix 4](#)).

### Delivery Mode

Most interventions were digital-only (n=13, 59%) [32-35, 51,54,58-60,64-67], with 7 incorporating mobile health (mHealth) tools, such as smart watches, smart scales, or pedometers [34,35,59,64-67]. The other 9 interventions used digital-mixed formats (41%) [9,31,52,53,55-57,61,62], of which 3 also used mHealth tools [55-57].

### BCTs

Across all interventions, a total of 227 BCTs were identified, averaging 9 BCTs per intervention (range 3-18). The majority of BCTs originated from the clusters “goals and planning,” “feedback and monitoring,” and “social support.” The 3 most common individual BCTs were “self-monitoring of behavior” (code 2.3), “goal setting (behavior)” (code 1.1), and “self-monitoring of outcome(s) of behavior” (code 2.4). A full taxonomy of BCTs and their frequency is presented in [Table 4](#).

**Table 4.** Frequency of BCTs<sup>a</sup> across the 22 interventions, with proportions expressed as percentages in parentheses.

Cluster and code	BCT	Count, n (%)
Goals and planning		
1.1	Goal setting (behavior)	18 (82)
1.2	Problem solving	11 (50)
1.3	Goal setting (outcome)	12 (55)
1.4	Action planning	6 (27)
1.5	Review behavior goals	8 (36)
1.6	Discrepancy between current behavior and goal	5 (23)
1.7	Review outcome goal(s)	6 (27)
1.8	Behavioral contract	0 (0)

Cluster and code	BCT	Count, n (%)
1.9	Commitment	0 (0)
Feedback and monitoring		
2.1	Monitoring of behavior by others without feedback	0 (0)
2.2	Feedback on behavior	12 (55)
2.3	Self-monitoring of behavior	19 (86)
2.4	Self-monitoring of outcomes of behavior	16 (73)
2.5	Monitoring outcome(s) of behavior by others without feedback	1 (5)
2.6	Biofeedback	1 (5)
2.7	Feedback on outcomes of behavior	10 (45)
Social support		
3.1	Social support (unspecified)	11 (50)
3.2	Social support (practical)	4 (18)
3.3	Social support (emotional)	4 (18)
Shaping knowledge		
4.1	Instruction on how to perform a behavior	15 (68)
4.2	Information about antecedents	3 (14)
4.3	Reattribution	0 (0)
4.4	Behavioral experiments	0 (0)
Natural consequences		
5.1	Information about health consequences	13 (59)
5.2	Saliency of consequences	0 (0)
5.3	Information about social and environmental consequences	0 (0)
5.4	Monitoring of emotional consequences	0 (0)
5.5	Anticipated regret	0 (0)
5.6	Information about emotional consequences	1 (5)
Comparison of behavior		
6.1	Demonstration of the behavior	4 (18)
6.2	Social comparison	3 (14)
6.3	Information about others' approval	0 (0)
Associations		
7.1	Prompts or cues	13 (59)
7.2	Cue signaling reward	0 (0)
7.3	Reduce prompts or cues	0 (0)
7.4	Remove access to the reward	0 (0)
7.5	Remove aversive stimulus	0 (0)
7.6	Satiation	0 (0)
7.7	Exposure	0 (0)
7.8	Associative learning	0 (0)
Repetition and substitution		
8.1	Behavioral practice or rehearsal	2 (9)
8.2	Behavior substitution	0 (0)
8.3	Habit formation	0 (0)
8.4	Habit reversal	0 (0)
8.5	Overcorrection	0 (0)
8.6	Generalization of a target behavior	0 (0)
8.7	Graded tasks	0 (0)
Comparison of outcomes		

Cluster and code	BCT	Count, n (%)
9.1	Credible source	13 (59)
9.2	Pros and cons	0 (0)
9.3	Comparative imagining of future outcomes	0 (0)
Reward and threat		
10.1	Material incentive (behavior)	2 (9)
10.2	Material reward (behavior)	1 (5)
10.3	Nonspecific reward	1 (5)
10.4	Social reward	3 (14)
10.5	Social incentive	0 (0)
10.6	Nonspecific incentive	0 (0)
10.7	Self-incentive	0 (0)
10.8	Incentive (outcome)	1 (5)
10.9	Self-reward	2 (9)
10.10	Reward (outcome)	1 (5)
10.11	Future punishment	0 (0)
Regulation		
11.1	Pharmacological support	0 (0)
11.2	Reduce negative emotions	0 (0)
11.3	Conserving mental resources	0 (0)
11.4	Paradoxical instructions	0 (0)
Antecedents		
12.1	Restructuring the physical environment	2 (9)
12.2	Restructuring the social environment	0 (0)
12.3	Avoidance or reducing exposure to cues for the behavior	1 (5)
12.4	Distraction	0 (0)
12.5	Adding objects to the environment	0 (0)
12.6	Body changes	0 (0)
Identity		
13.1	Identification of self as role model	0 (0)
13.2	Framing or reframing	0 (0)
13.3	Incompatible beliefs	0 (0)
13.4	Valued self-identity	0 (0)
13.5	Identity associated with changed behavior	0 (0)
Scheduled consequences		
14.1	Behavior cost	0 (0)
14.2	Punishment	0 (0)
14.3	Remove reward	0 (0)
14.4	Reward approximation	0 (0)
14.5	Rewarding completion	0 (0)
14.6	Situation-specific reward	0 (0)
14.7	Reward incompatible behavior	0 (0)
14.8	Reward alternative behavior	0 (0)
14.9	Reduce reward frequency	0 (0)
14.10	Remove punishment	0 (0)
Self-belief		
15.1	Verbal persuasion about capability	1 (5)
15.2	Mental rehearsal of successful performance	0 (0)

Cluster and code	BCT	Count, n (%)
15.3	Focus on past success	1 (5)
15.4	Self-talk	0 (0)
Covert learning		
16.1	Imaginary punishment	0 (0)
16.2	Imaginary reward	0 (0)
	16.3 Vicarious consequences	0 (0)

<sup>a</sup>BCT: behavior change techniques.

## Outcomes

Digital lifestyle interventions showed varied outcomes for healthy GWG across both primary and secondary studies, with certain design and implementation features appearing more frequently in interventions that achieved their intended outcomes. Among 12 primary data articles coded for achieving their intended outcomes, 7 (58%) reported beneficial effects of digital lifestyle interventions on healthy GWG [9,31,32,60,62,64,66]. These interventions resulted in lower total mean or median GWG (average Cohen  $d=0.42$ ; range 0.33-0.55) [9,32,60,62,64], reduced weekly rate of GWG [9,64], reduced risk for excessive GWG [66], and improved adherence to GWG guidelines [9,31,60,62]. The remaining 5 studies (42%) did not achieve their intended outcome [34,35,61,65,67]. Although the 10 pilot RCTs were underpowered for definitive conclusions and thus not coded for achieving their intended outcomes (refer to Methods section), most reported beneficial trends for healthy GWG ( $n=7$ , 70%) [51-56,59] and 2 (20%) described better adherence to IOM guidelines [52,54].

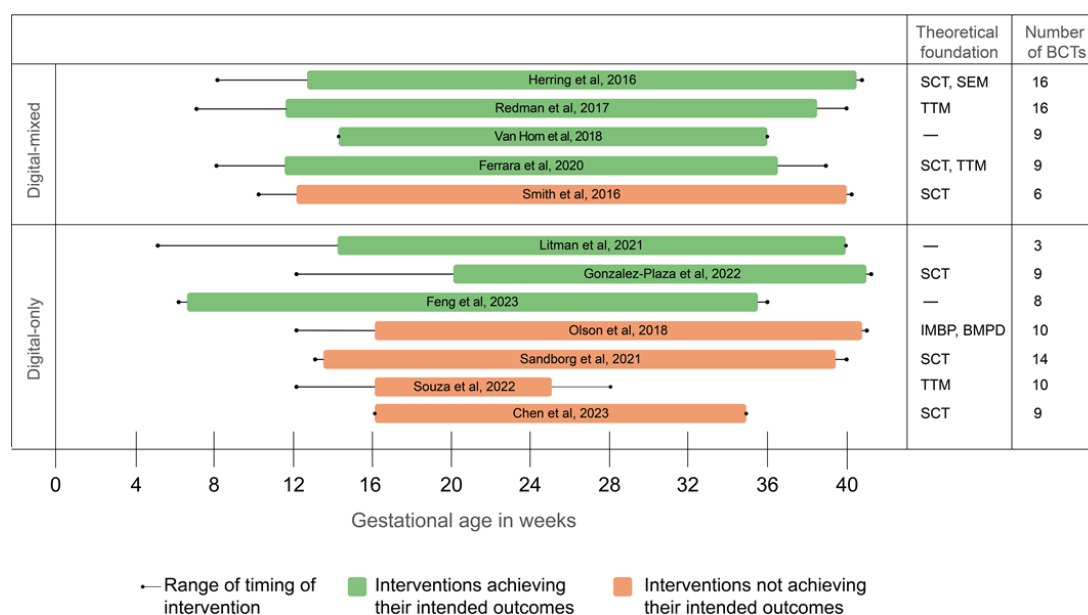
Secondary data articles reinforce these findings. Of the 9 meta-analyses, 7 (78%) found that interventions achieved

their intended outcomes [37,40,69-73], with pregnant women in intervention groups gaining an average of 1.4 (SD 0.71) kg less than control groups. All 4 secondary analyses of RCT data reported positive outcomes for digital lifestyle interventions, including effects for subgroups of participants with mid-high income who consistently used digital interventions (average  $-2.1$ , SD 0.26 kg) [81,82], associations between increased digital engagement with lower GWG [83], and differential effects by BMI status [36]. All 5 systematic reviews found digital lifestyle interventions promising for healthy GWG [74-78]. The 3 scoping reviews similarly found that approximately half of the digital interventions included improved healthy GWG outcomes [41,79,80].

## Design and Implementation Features Linked to Achieving Outcomes

Figure 4 represents a summary of design and implementation features of the 12 interventions that we coded for achieving their intended outcomes, followed by a description of the main findings per feature.

**Figure 4.** Summary overview of design and implementation features in the 12 interventions [9,31,32,34,35,60-62,64-67] coded for achieving their intended outcomes. BCT: behavior change technique; BMPD: behavior model for persuasive design; IMBP: integrative model for behavior prediction; SEM: social ecological model; SCT: social cognitive theory; TTM: transtheoretical model of change.



## Theoretical Foundation

The relationship between theoretical grounding and intervention outcomes was inconsistent across studies. In the primary data articles, social cognitive theory was the most frequently used theoretical framework, used in interventions with varying outcomes. Among the 7 interventions that achieved their stated objectives, 2 were based on 2 theories (combining the social cognitive theory and the social ecological model [60] [14%] or the transtheoretical model of change [9] [14%]). Notably, 3 interventions (43%) that met their objectives reported no explicit theoretical foundation [32,62,66]. Of the 5 interventions that did not achieve their stated goals, 3 (60%) were based on social cognitive theory [35,61,65], and 1 (20%) combined the integrative model of behavior prediction with the behavior model for persuasive design [34]. Secondary data articles did not examine theoretical foundations as determinants of intervention outcomes.

## Timing

Primary data articles showed that interventions achieving their stated objectives were initiated earlier in pregnancy (average 12, SD 4.1 wk, range 6-28 wk) compared with those that did not (average 14, SD 1.9 wk, range 10-20 wk, Figure 4). This pattern was consistent with findings from secondary data sources reporting that digital interventions meeting their outcomes typically commenced in early-to-mid pregnancy [40,41,70,79,80].

## Duration

Intervention duration varied between studies with different outcomes, with interventions that achieved their stated objectives having longer durations (mean 25.5, SD 3.3 wk, range 21-29 wk, median 27 wk) compared with those that did not (mean 21.4, SD 6.9 wk, range 9-28 wk, median 25 wk). Secondary data sources described similar patterns, with Barroso et al [41] noting that digital interventions meeting

their outcomes typically spanned the remaining pregnancy duration. Hutchesson et al [80] identified intervention duration and intensity as areas requiring further research.

## Frequency

As stated earlier, the frequency of intervention delivery showed large differences between interventions. There were no clear differences in delivery cadence between interventions that met their intended outcomes and those that did not. Secondary data articles also reported that frequency did not have a consistent impact on interventions achieving their objectives [37,38,40,71].

## Delivery Mode

Primary data articles revealed variation in outcomes between delivery modes, with 4 digital-mixed interventions (57%) achieving their intended outcomes [9,31,60,62] and 3 digital-only ones (43%) [32,64,66]. Among the interventions that did not meet their objectives, 1 was digital-mixed (20%) [61] and 4 were digital-only (80%) [34,35,65,67]. Secondary data sources corroborate these patterns, with Barroso et al [41] noting that digital interventions attaining their goals typically included frequent touch points with well-trained lifestyle coaches through in-person sessions. Hutchesson et al [80] similarly identified delivery modes in interventions and involvement of health care providers as areas for further investigation.

## BCTs

Primary data articles indicated that interventions meeting their objectives used the same number of BCTs (average 10, SD 4.3, range 3-16) compared with those that did not (average 10, SD 2.6, range 6-14). Table 5 maps the BCTs used across interventions that achieved their stated objectives and those that did not meet their goals. BCTs used commonly ( $\geq 70\%$ ) across both intervention categories were goal setting (behavior) and self-monitoring of outcome(s) of behavior.

**Table 5.** List of behavior change techniques used in interventions achieving (n=7) and not achieving (n=5) intended outcomes.

Code	BCT <sup>a</sup>	Interventions achieving intended outcomes, n (%)	Interventions not achieving intended outcomes, n (%)	Total
1.1	Goal setting (behavior)	5 (71 <sup>b</sup> )	4 (80 <sup>b</sup> )	9
1.2	Problem solving	2 (29)	3 (60 <sup>c</sup> )	5
1.3	Goal setting (outcome)	5 (71 <sup>b,c</sup> )	2 (40)	7
1.4	Action planning	1 (14)	1 (20)	2
1.5	Review behavior goal(s)	2 (29)	1 (20)	3
1.6	Discrepancy between current behavior and goal	3 (43 <sup>c</sup> )	0 (0)	3
1.7	Review outcome goal(s)	1 (14)	1 (20)	2
2.2	Feedback on behavior	3 (43)	2 (40)	5
2.3	Self-monitoring of behavior	6 (86 <sup>b,c</sup> )	3 (60)	9
2.4	Self-monitoring of outcome(s) of behavior	6 (86 <sup>b</sup> )	4 (80 <sup>b</sup> )	10
2.5	Monitoring outcome(s) of behavior by others without feedback	0 (0)	1 (20)	1
2.6	Biofeedback	0 (0)	1 (20)	1
2.7	Feedback on outcome(s) of behavior	4 (57)	3 (60)	7

Code	BCT <sup>a</sup>	Interventions achieving intended outcomes, n (%)	Interventions not achieving intended outcomes, n (%)	Total
3.1	Social support (unspecified)	5 (71 <sup>b,c</sup> )	1 (20)	6
3.2	Social support (practical)	1 (14)	1 (20)	2
3.3	Social support (emotional)	1 (14)	2 (40 <sup>c</sup> )	3
4.1	Instruction on how to perform a behavior	5 (71 <sup>b</sup> )	3 (60)	8
4.2	Information about antecedents	1 (14)	1 (20)	2
5.1	Information about health consequences	5 (71 <sup>b</sup> )	3 (60)	8
6.1	Demonstration of the behavior	1 (14)	1 (20)	2
6.2	Social comparison	1 (14)	0 (0)	1
7.1	Prompts or cues	4 (57)	4 (80 <sup>b</sup> )	8
8.1	Behavioral practice or rehearsal	0 (0)	1 (20)	1
9.1	Credible source	5 (71 <sup>b,c</sup> )	2 (40)	7
10.1	Material incentive (behavior)	0 (0)	1 (20)	1
10.10	Reward (outcome)	0 (0)	1 (20)	1
10.2	Material reward (behavior)	1 (14)	0 (0)	1
10.3	Nonspecific reward	0 (0)	1 (20)	1
10.4	Social reward	1 (14)	1 (20)	2
10.9	Self-reward	1 (14)	0 (0)	1

<sup>a</sup>BCT: behavior change technique.

<sup>b</sup>BCTs that were used often, that is, in  $\geq 70\%$  of interventions (also refer to [Multimedia Appendix 3](#));

<sup>c</sup>BCTs that were used more, that is,  $\geq 25\%$  in successful interventions as compared with an unsuccessful one or vice versa (also refer to [Multimedia Appendix 3](#)).

In total, 5 BCTs showed notable differences in usage patterns between intervention categories, appearing  $\geq 25\%$  more frequently in interventions that achieved their objectives: goal setting (outcome; 71% vs 40%), discrepancy between current behavior and goal (43% vs 0%), self-monitoring of behavior (86% vs 60%), social support (unspecified; 71% vs 20%), and credible source (71% vs 40%). Conversely, interventions that did not meet their objectives used problem solving (60% vs 29%) and social support (emotional; 40% vs 14%)  $\geq 25\%$  more frequently than those that achieved their goals.

Interestingly, with respect to delivery modes, we observed different patterns in the number of BCTs used in interventions meeting their objective: digital-mixed interventions (n=4, 57%) used 13 BCTs, while digital-only ones used 7 (n=3, 43%). Most commonly used BCTs in successful digital-mixed interventions were goal setting (behavior and outcome) and self-monitoring of behavior. In contrast, successful digital-only interventions primarily relied on self-monitoring of outcome(s) of behavior, information about health consequences, and a credible source.

From the secondary data articles, only the meta-analysis by Rhodes et al [68] examined BCTs in relation to intervention outcomes, reporting an average of 9 BCTs per intervention and confirming that interventions meeting their objectives used twice as many BCTs from the groups “goals and planning” and “feedback and monitoring” categories compared with interventions that did not. They identified 7 BCTs commonly present across interventions that attained their goal: goal setting (behavior), problem solving, review

of behavior goals, feedback on behavior, social support, information about health consequences, and information about emotional consequences. Notably, review of behavior goal(s) was observed exclusively in interventions achieving their objectives, with the authors concluding that interactivity is crucial for driving engagement and improving intervention success. A secondary analysis of RCT data [36] described BMI-specific patterns for goal setting, noting beneficial associations for women with normal BMI but adverse associations for those with higher BMI.

## Discussion

### *Evidence Landscape of Digital Lifestyle Interventions for Healthy GWG*

Digital lifestyle interventions alongside usual care show potential for supporting healthy lifestyles and GWG management among pregnant women. This scoping review systematically mapped existing literature to identify key design and implementation features, examining theoretical frameworks, timing, duration, frequency, delivery modes, and BCTs. Our mapping of 44 articles (23 primary and 21 secondary data) revealed diverse approaches to digital lifestyle interventions targeting GWG management and highlighted gaps in current research. These findings provide insights into identifying research priorities and informing future intervention development.

Our initial research question focused on the scope and nature of evidence regarding digital lifestyle interventions for

GWG. The primary data articles revealed diverse patterns in reported outcomes. Among the 23 primary studies reviewed [9,31-35,51-67], 12 were coded for success [9,31,32,34,35,60-62,64-67] with 7 achieving their intended outcomes [9,31,32,60,62,64,66]. In addition, 7 of the 10 pilot studies [33,51-59], although underpowered, indicated positive trends [51-56,59]. Notably, several studies that did not report improvements in GWG did document benefits such as increased PA and improved dietary quality [35,61,67]. The secondary data articles, particularly meta-analyses, commonly reported that digital interventions supported GWG, although the reported impacts were described as modest. These findings are consistent with broader literature suggesting potential benefits of digital lifestyle interventions for GWG [68].

The substantial body of secondary literature identified in this review indicates ongoing interest in synthesizing evidence on digital lifestyle interventions and their components. This is also reflected in the temporal analysis of the systematic reviews in our selection that revealed an evolving research focus and improvements in the quality of digital lifestyle interventions. Early work by O'Brien et al [74] in 2014 concluded that digital interventions hold potential for complementing traditional health care models but emphasized the low quality and quantity of the interventions available. By 2018, Overdijkink et al [76] reported that app interventions had good overall usability and efficacy, although high dropout rates for several apps persisted. Mertens et al [77] in 2019 confirmed that the quality of interventions improved, but challenges with accessibility and engagement with target populations remained. Subsequently, Hussain et al [78] reinforced the potential of digital interventions for managing healthy GWG but highlighted the continued heterogeneity of studies and their generally small sample sizes. They also called for cost-effectiveness research. In 2021, Iyawa et al [75] reported that apps could positively impact self-management, such as GWG, during pregnancy while noting gaps in longitudinal studies and research in low- and middle-income countries.

The continued heterogeneity of interventions described by Hussain et al [78] was also evident in the primary data articles we studied, with differences in study populations (such as participants from different prepregnancy BMI categories), intervention duration, intensity, and delivery modes. This diversity was explicitly acknowledged in several meta-analyses as a challenge for evidence synthesis [37,40,68,69,71]. In addition, studies used varied approaches to outcome measurement, with some focusing on adherence to IOM guidelines [9,31,60,62], others on the total average [9,31,60,62,63] or median GWG [32,64], weekly weight gain rates [9], patterns of intervention engagement in relation to weight outcomes [66], or any combination of these. This heterogeneity in both intervention design and outcome measurement approaches underscores the complexity of this research field. It points to areas where greater methodological consistency could benefit future research synthesis efforts.

## ***Patterns in Key Design and Implementation Features***

### **Overview**

Our second research question explored the key components and characteristics of digital lifestyle interventions for healthy GWG. This exploration involved mapping intervention components and examining patterns across different types of interventions to identify commonly reported features. We examined intervention theoretical foundations, timing, duration, frequency, delivery modes, and BCTs.

A significant gap emerged regarding the comprehensiveness of intervention descriptions across the reviewed articles. Many lacked sufficient detail for reliable interpretation of components and potential research replication. This finding was reinforced by our secondary data articles, which similarly identified gaps in reporting on interventions and their outcomes as a key limitation in the field. These documentation limitations align with previous research highlighting challenges in comparing interventions and synthesizing evidence about their characteristics [42,45,46,68,69,71]. Despite the publication of the Behavior Change Technique Taxonomy in 2013 [44], and the fact that included studies were published afterwards, the majority have not incorporated these standardized reporting guidelines. Despite these limitations, we identified tentative patterns between design features and intervention outcomes, discussed below in relation to existing literature.

### **Theoretical Foundations**

Regarding theoretical foundations, we found that this feature did not appear to differentiate between interventions that achieved their intended outcomes and those that did not: both types of interventions commonly drew upon social cognitive theory. Potential explanations include inappropriate selection or poor application of the theory for a given intervention context [84]. Notably, 5 interventions in our review lacked a clearly defined theoretical foundation, with 3 of these reporting achievement of their intended outcomes. This pattern is noteworthy given available literature suggesting that theory-driven interventions are more likely to be successful [84,85]. Possible explanations include that theoretical frameworks were applied but not explicitly reported, or that intervention developers focused on implementing specific BCTs rather than grounding their approach in a central theory.

### **Timing and Duration**

Earlier intervention initiation and longer duration were more commonly observed in interventions that achieved their stated objectives. This aligns with the understanding that weight gain accelerates in the second half of pregnancy, necessitating early intervention [66,86]. None of the interventions in our review commenced in the third trimester, which aligns with this rationale.



## Frequency

No clear patterns emerged between contact frequency and intervention outcomes. Interventions showed substantial heterogeneity in contact points with providers and participant control over interaction with intervention components. Reasons for these differences likely stem from theory-based choices, for example, offering more frequent but less personalized elements versus less frequent but more tailored ones.

## Delivery Mode

Digital-mixed interventions were more often associated with success than digital-only formats. As such, in-person components, especially those involving health care provider endorsement, may enhance credibility and behavior change, which is in line with existing research. However, as Rhodes et al [68] observed, methodological heterogeneity between interventions may have limited the ability to detect consistent patterns of association with intervention outcomes. Therefore, studies in which a comparison is made between delivering the same intervention through digital-mixed and digital-only means, such as that by Redman et al [31] that offers an interesting venue for future research.

## BCTs

BCTs related to the categories goals and planning, and feedback and monitoring were frequently associated with successful interventions. While previous research by Webb et al [87] and Rhodes et al [68] suggested that a higher number of BCTs may enhance effectiveness, our review did not find a consistent relationship between the number of BCTs and intervention success. This discrepancy may reflect differences in scope: whereas both Webb et al and Rhodes et al examined digital-only interventions, our review included both digital-only and digital-mixed delivery. Despite this, the average number of BCTs per intervention in our review (average 9) matched that reported by Rhodes et al [68], suggesting some consistency in usage patterns.

More importantly, our analysis highlighted that specific BCTs, rather than the total number, were more commonly associated with successful outcomes. These included: goal setting (outcome), discrepancy between current behavior and goal, self-monitoring of behavior, social support (unspecified), and a credible source. These findings are supported by broader literature on diet and PA interventions, in which interventions combining self-monitoring with at least one other technique from control theory [88] – in this case, goal setting (outcome) – were more commonly associated with achieving intended outcomes [89].

When examining delivery modes, we observed that digital-mixed interventions used more BCTs than digital-only ones. This may suggest that digital-only interventions can be effective with fewer, well-targeted BCTs – an area that warrants further research, particularly given the challenges of adapting certain BCTs to digital formats [90].

## In Summary

Summarizing, our review identified several implementation and design features that may contribute to digital lifestyle interventions for GWG in achieving their intended goals. While theoretical foundation and frequency of intervention delivery were not commonly associated with success, interventions that started earlier in pregnancy, lasted longer, and combined digital with nondigital components were more likely to achieve beneficial outcomes. In addition, the BCTs' goal setting (outcome), discrepancy between current behavior and goal, self-monitoring of behavior, social support (unspecified), and credible source were commonly present across interventions accomplishing their intended purpose.

## Limitations and Strengths

This review has several limitations. First, we excluded articles involving high-risk pregnancies. Given the greater health stakes in such populations, it is possible that digital lifestyle interventions may have different levels of impact among at-risk women. Future research should explore whether outcomes differ between normal- versus high-risk pregnancies.

A second limitation is the inability to control for variations in usual care across different localities, which can vary substantially between health care settings. This may influence women's opportunities, motivations, and capabilities to engage in healthy lifestyle behaviors. Consequently, the functional gap that a digital lifestyle intervention needs to address may differ depending on this local health care context.

Third, most included studies were conducted in high-income countries, mainly the United States. This limits the generalizability of our findings to low- and middle-income countries, where digital interventions may be especially valuable due to limited access to maternity care.

In addition, our searches included only publications in the English language and those published until March 25, 2024. This may have excluded relevant studies in other languages or published more recently.

Despite these limitations, our review has several strengths. We included both digital-only and digital-mixed interventions, enabling comparative insights. Our structured and replicable literature search strategy ensured comprehensive coverage of the literature. By focusing on healthy (normal-risk) pregnant populations, we were able to draw clearer comparisons across studies.

Finally, we conducted an extensive analysis of key intervention and design features used across the included interventions, including BCTs. This addressed a gap in the literature, as only a few previous reviews have provided a detailed breakdown of which specific BCTs are commonly used in digital lifestyle interventions with both digital-mixed and digital-only delivery modes for GWG management in pregnant women. Our analysis, therefore, provides a foundation for understanding the current landscape of BCT implementation in this field and may inform future

research directions and intervention development considerations. Therefore, we believe that despite the limitations of our review, our conclusions about the key design and implementation features contributing to interventions achieving their intended goals remain valid.

## Future Research

Based on our findings, we propose 5 key priorities for future research, which we outline below.

### Healthy Lifestyles Versus GWG

First, digital lifestyle interventions reported modest differences in GWG between interventions that met their intended goals and those that did not (average reduction of 1.4, SD 0.71 kg). This is in line with Dodd et al [91], whose meta-analysis of 78 studies on nondigital lifestyle interventions found an average decrease in GWG of 1.1 (95% CI -1.46 to -0.74) kg in pregnant intervention participants compared with controls. In combination with previous research in nonpregnant populations suggesting that more weight loss is needed before health benefits start showing [92,93] and our findings that digital lifestyle interventions can positively affect lifestyles even without successful outcomes for healthy GWG [35,61,67], future studies should explore whether these behavioral changes, rather than GWG alone, are the primary drivers of improved pregnancy outcomes.

### Engagement and Standardization

Second, more work on methodological aspects is required, such as differentiating between digital and behavioral engagement in longitudinal interventions. Digital engagement refers to users' interaction with intervention components, while behavioral engagement describes the adoption of target health behaviors. Understanding their temporal relationship is crucial: interventions typically require initial digital engagement until users establish habits, after which behavioral engagement becomes more meaningful for assessing success. Measuring one type when intending to measure the other could lead to misleading conclusions about what contributes to achieving intended outcomes. It is important to note that long-term engagement—whether digital or behavioral—may not always be necessary for intervention success [90]. Rather than pursuing maximum engagement, future research should focus on identifying “effective engagement” to achieve healthy GWG. In addition, broader use of the BCT taxonomy [44] and clearer reporting of implementation strategies would enhance comparability and replication.

### Intervention Development

Third, concerning intervention development, a better understanding of individual BCTs and their implementation is needed. Our findings reveal an overlap between the most prominent BCTs in both effective and ineffective interventions, suggesting that BCT implementation methods may influence outcomes differently than the techniques themselves. For instance, social support can be delivered through forums, group settings, or peer-to-peer pairs, each with potentially different characteristics. Future research could

explore BCT implementation approaches and their underlying mechanisms of action.

Another consideration involves recent technological trends in intervention development. As most pregnancy apps are developed by private companies [94], their features reflect current technological capabilities, including comprehensive data collection, wearable integration, and algorithm-driven coaching [95,96]. While these advances may enhance accessibility and personalization, they introduce important ethical considerations [97,98]. Particularly, personalization raises concerns about user autonomy [99] and trustworthiness [100], especially as intervention rules change through usage, potentially making one-time informed consent insufficient. In addition, pregnant women may place varying levels of trust in these systems despite potentially limited understanding of their capabilities [100]. Users may end up over- or undertrusting the system, both of which come at a cost [101]. Future research could explore how ethical considerations might be integrated into intervention development from the start, with attention to meaningful and ethical personalization.

### Collaboration Between Academia and Industry

Fourth, we advocate enhanced collaboration between academia and industry in the research and development of digital lifestyle interventions for pregnant women. While our review identified many pilot RCTs, we observed a notable scarcity of follow-up studies scaling these initial findings. This gap may stem from the inherent challenges of transitioning from pilot studies to full-scale RCTs with technologically mature interventions within academic settings, where research typically progresses at a more measured pace and fewer resources for technological development are available. In contrast, industry partners operate on accelerated development cycles with direct access to emerging technologies. This difference in throughput time becomes particularly relevant given that while most published research originates from academic institutions, the majority of pregnancy-related apps in use are developed by private technology companies [94]. Strategic partnerships between these sectors could combine academia's methodological rigor with industry's technological agility, accelerating the translation of evidence-based interventions into widely accessible tools while maintaining scientific integrity, to together improve the health behavior of pregnant women and their families.

### Societal Aspects

Finally, while there is a widespread assumption among researchers and policymakers that digital interventions for pregnancy could significantly benefit health care desert communities, this hypothesis remains largely unexplored in empirical research [94,102]. This gap is particularly noteworthy because, due to their unique circumstances and limited alternative resources, individuals in health care deserts may actually demonstrate higher success rates with digital interventions in terms of increased capability and opportunity to engage with healthy behaviors. In our scoping review, only Iyawa et al [75] addressed this crucial aspect. Furthermore, the health care desert context emphasizes the importance of

conducting rigorous cost-effectiveness analyses, comparing different intervention approaches. Such economic evaluations are essential for making informed decisions about resource allocation, particularly in areas where health care resources are already scarce. This economic perspective becomes especially relevant when considering the potential scalability and sustainability of digital lifestyle interventions in underserved communities [103].

## Conclusion

This scoping review examined the landscape of digital lifestyle interventions aimed at supporting healthy (GWG), with a focus on 6 key design and implementation features: theoretical foundation, intervention timing, duration, frequency, delivery modes, and BCTs. Our findings confirm that digital interventions hold promise for promoting healthy GWG. While theoretical underpinnings and frequency of

delivery did not consistently predict success, interventions that began earlier in pregnancy and lasted longer were more likely to achieve beneficial outcomes. Digital-mixed delivery modes—those combining digital tools with in-person contact—appeared more effective than digital-only formats. Importantly, 5 BCTs emerged as more commonly used in successful interventions: goal setting (outcome), discrepancy between current behavior and goal, self-monitoring of behavior, social support (unspecified), and credible source.

These findings provide a foundation for designing more effective, evidence-based digital interventions to support maternal health. Future research should continue to refine these components, explore their implementation in diverse populations, and address gaps in reporting and standardization.

---

## Acknowledgments

We are grateful to Joyce Westerink, PhD and Sumit Raurale, PhD, for their invaluable reviews of our manuscript. In addition, we thank Dimple Bhadani, MDes, for designing the figures.

During the preparation of this manuscript, the authors made use of Philips Enterprise AI Chat (version October 2023; for use by Philips employees only) and Claude Sonnet 4 (claude-sonnet-4-20250514, provided by Anthropic). Artificial intelligence consultation initially focused on manuscript writing assistance for clarity and consistency and subsequently provided methodological guidance for scoping review conduct and advice on aligning research objectives with analytical approach. All artificial intelligence-generated content was reviewed, edited, and verified by the authors, who take full responsibility for the manuscript's content and conclusions.

---

## Authors' Contributions

Conceptualization: RAO, LD, OD, HAAS

Data curation: RAO

Formal analysis: RAO

Investigation: RAO, LD, OD, HAAS

Methodology: RAO, LD, OD, HAAS

Project administration: LD

Supervision: HAAS

Validation: HAAS

Writing – original draft: RAO

Writing – review & editing: RAO, LD, OD, HAAS

---

## Conflicts of Interest

None declared.

---

## Multimedia Appendix 1

Eligibility criteria.

[\[PDF File \(Adobe File\), 410 KB-Multimedia Appendix 1\]](#)

---

## Multimedia Appendix 2

Search strings for each of the databases searched.

[\[PDF File \(Adobe File\), 404 KB-Multimedia Appendix 2\]](#)

---

## Multimedia Appendix 3

Data items included in the Data Extraction file.

[\[PDF File \(Adobe File\), 549 KB-Multimedia Appendix 3\]](#)

---

## Multimedia Appendix 4

Data extraction table.

[\[PDF File \(Adobe File\), 972 KB-Multimedia Appendix 4\]](#)

**Checklist 1**

PRISMA-ScR checklist.

[\[PDF File \(Adobe File\), 707 KB-Checklist 1\]](#)**References**

1. Olander EK, Darwin ZJ, Atkinson L, Smith DM, Gardner B. Beyond the “teachable moment” - A conceptual analysis of women’s perinatal behaviour change. *Women Birth*. Jun 2016;29(3):e67-71. [doi: [10.1016/j.wombi.2015.11.005](https://doi.org/10.1016/j.wombi.2015.11.005)] [Medline: [26626592](https://pubmed.ncbi.nlm.nih.gov/26626592/)]
2. Phelan S. Pregnancy: a “teachable moment” for weight control and obesity prevention. *Am J Obstet Gynecol*. Feb 2010;202(2):135. [doi: [10.1016/j.ajog.2009.06.008](https://doi.org/10.1016/j.ajog.2009.06.008)] [Medline: [19683692](https://pubmed.ncbi.nlm.nih.gov/19683692/)]
3. WHO recommendations on antenatal care for a positive pregnancy experience. World Health Organization. 2016. URL: <https://www.who.int/publications/i/item/9789241549912> [Accessed 2024-01-07]
4. Rockliffe L, Peters S, Heazell AEP, Smith DM. Factors influencing health behaviour change during pregnancy: a systematic review and meta-synthesis. *Health Psychol Rev*. Dec 2021;15(4):613-632. [doi: [10.1080/17437199.2021.1938632](https://doi.org/10.1080/17437199.2021.1938632)] [Medline: [34092185](https://pubmed.ncbi.nlm.nih.gov/34092185/)]
5. Project: development of global gestational weight gain standards. World Health Organization. 2023. URL: [https://cdn.who.int/media/docs/default-source/nutrition-and-food-safety/development-of-global-gestational-weight-gain-standards/who-gestational-weight-gain-standards-background.pdf?sfvrsn=7c9a4952\\_3](https://cdn.who.int/media/docs/default-source/nutrition-and-food-safety/development-of-global-gestational-weight-gain-standards/who-gestational-weight-gain-standards-background.pdf?sfvrsn=7c9a4952_3) [Accessed 2024-01-07]
6. Institute of Medicine (U.S.). Rasmussen KM, Yaktine AL, editors. *Weight Gain during Pregnancy: Reexamining the Guidelines*. National Academies Press; 2009. ISBN: 978-0-309-13113-1
7. Davidson KW, Barry MJ, Mangione CM, et al. Behavioral counseling interventions for healthy weight and weight gain in pregnancy: US Preventive Services Task Force recommendation statement. *JAMA*. May 25, 2021;325(20):2087-2093. [doi: [10.1001/jama.2021.6949](https://doi.org/10.1001/jama.2021.6949)]
8. Goldstein RF, Abell SK, Ranasinha S, et al. Gestational weight gain across continents and ethnicity: systematic review and meta-analysis of maternal and infant outcomes in more than one million women. *BMC Med*. Aug 31, 2018;16(1):153. [doi: [10.1186/s12916-018-1128-1](https://doi.org/10.1186/s12916-018-1128-1)] [Medline: [30165842](https://pubmed.ncbi.nlm.nih.gov/30165842/)]
9. Ferrara A, Hedderson MM, Brown SD, et al. A telehealth lifestyle intervention to reduce excess gestational weight gain in pregnant women with overweight or obesity (GLOW): a randomised, parallel-group, controlled trial. *Lancet Diabetes Endocrinol*. Jun 2020;8(6):490-500. [doi: [10.1016/S2213-8587\(20\)30107-8](https://doi.org/10.1016/S2213-8587(20)30107-8)] [Medline: [32445736](https://pubmed.ncbi.nlm.nih.gov/32445736/)]
10. Champion ML, Harper LM. Gestational weight gain: update on outcomes and interventions. *Curr Diab Rep*. Feb 27, 2020;20(3):11. [doi: [10.1007/s11892-020-1296-1](https://doi.org/10.1007/s11892-020-1296-1)] [Medline: [32108283](https://pubmed.ncbi.nlm.nih.gov/32108283/)]
11. Martínez-Hortelano JA, Cavero-Redondo I, Álvarez-Bueno C, Garrido-Miguel M, Soriano-Cano A, Martínez-Vizcaíno V. Monitoring gestational weight gain and prepregnancy BMI using the 2009 IOM guidelines in the global population: a systematic review and meta-analysis. *BMC Pregnancy Childbirth*. Oct 27, 2020;20(1):649. [doi: [10.1186/s12884-020-03335-7](https://doi.org/10.1186/s12884-020-03335-7)] [Medline: [33109112](https://pubmed.ncbi.nlm.nih.gov/33109112/)]
12. Shulman R, Kottke M. Impact of maternal knowledge of recommended weight gain in pregnancy on gestational weight gain. *Am J Obstet Gynecol*. Jun 2016;214(6):754. [doi: [10.1016/j.ajog.2016.03.021](https://doi.org/10.1016/j.ajog.2016.03.021)] [Medline: [27012961](https://pubmed.ncbi.nlm.nih.gov/27012961/)]
13. Willcox JC, Ball K, Campbell KJ, Crawford DA, Wilkinson SA. Correlates of pregnant women’s gestational weight gain knowledge. *Midwifery*. Jun 2017;49:32-39. [doi: [10.1016/j.midw.2016.08.011](https://doi.org/10.1016/j.midw.2016.08.011)] [Medline: [27638343](https://pubmed.ncbi.nlm.nih.gov/27638343/)]
14. Grenier LN, Atkinson SA, Mottola MF, et al. Be healthy in pregnancy: exploring factors that impact pregnant women’s nutrition and exercise behaviours. *Matern Child Nutr*. Jan 2021;17(1):e13068. [doi: [10.1111/mcn.13068](https://doi.org/10.1111/mcn.13068)] [Medline: [32705811](https://pubmed.ncbi.nlm.nih.gov/32705811/)]
15. Caut C, Leach M, Steel A. Dietary guideline adherence during preconception and pregnancy: a systematic review. *Matern Child Nutr*. Apr 2020;16(2):e12916. [doi: [10.1111/mcn.12916](https://doi.org/10.1111/mcn.12916)] [Medline: [31793249](https://pubmed.ncbi.nlm.nih.gov/31793249/)]
16. Wilkinson SA, Schoenaker D, de Jersey S, et al. Exploring the diets of mothers and their partners during pregnancy: findings from the Queensland Family Cohort pilot study. *Nutr Diet*. Nov 2022;79(5):602-615. [doi: [10.1111/1747-0080.12733](https://doi.org/10.1111/1747-0080.12733)] [Medline: [35355379](https://pubmed.ncbi.nlm.nih.gov/35355379/)]
17. WHO Guidelines on Physical Activity and Sedentary Behavior. World Health Organization; 2020. URL: <https://www.who.int/publications/i/item/9789240015128> [Accessed 2025-11-05] ISBN: 9789240015128
18. Meander L, Lindqvist M, Mogren I, Sandlund J, West CE, Domellöf M. Physical activity and sedentary time during pregnancy and associations with maternal and fetal health outcomes: an epidemiological study. *BMC Pregnancy Childbirth*. Feb 27, 2021;21(1):166. [doi: [10.1186/s12884-021-03627-6](https://doi.org/10.1186/s12884-021-03627-6)] [Medline: [33639879](https://pubmed.ncbi.nlm.nih.gov/33639879/)]
19. Ribeiro MM, Andrade A, Nunes I. Physical exercise in pregnancy: benefits, risks and prescription. *J Perinat Med*. Jan 27, 2022;50(1):4-17. [doi: [10.1515/jpm-2021-0315](https://doi.org/10.1515/jpm-2021-0315)] [Medline: [34478617](https://pubmed.ncbi.nlm.nih.gov/34478617/)]

20. Thompson EL, Vamos CA, Daley EM. Physical activity during pregnancy and the role of theory in promoting positive behavior change: a systematic review. *J Sport Health Sci.* Jun 2017;6(2):198-206. [doi: [10.1016/j.jshs.2015.08.001](https://doi.org/10.1016/j.jshs.2015.08.001)] [Medline: [30356571](https://pubmed.ncbi.nlm.nih.gov/30356571/)]
21. Harrison AL, Taylor NF, Shields N, Frawley HC. Attitudes, barriers and enablers to physical activity in pregnant women: a systematic review. *J Physiother.* Jan 2018;64(1):24-32. [doi: [10.1016/j.jphys.2017.11.012](https://doi.org/10.1016/j.jphys.2017.11.012)] [Medline: [29289592](https://pubmed.ncbi.nlm.nih.gov/29289592/)]
22. Morris T, Strömmer S, Vogel C, et al. Improving pregnant women's diet and physical activity behaviours: the emergent role of health identity. *BMC Pregnancy Childbirth.* Apr 25, 2020;20(1):244. [doi: [10.1186/s12884-020-02913-z](https://doi.org/10.1186/s12884-020-02913-z)] [Medline: [32334540](https://pubmed.ncbi.nlm.nih.gov/32334540/)]
23. Stotland NE, Gilbert P, Bogetz A, Harper CC, Abrams B, Gerbert B. Preventing excessive weight gain in pregnancy: how do prenatal care providers approach counseling? *J Womens Health (Larchmt).* Apr 2010;19(4):807-814. [doi: [10.1089/jwh.2009.1462](https://doi.org/10.1089/jwh.2009.1462)] [Medline: [20078239](https://pubmed.ncbi.nlm.nih.gov/20078239/)]
24. Heslehurst N, Newham J, Maniatopoulos G, Fleetwood C, Robalino S, Rankin J. Implementation of pregnancy weight management and obesity guidelines: a meta-synthesis of healthcare professionals' barriers and facilitators using the Theoretical Domains Framework. *Obes Rev.* Jun 2014;15(6):462-486. [doi: [10.1111/obr.12160](https://doi.org/10.1111/obr.12160)] [Medline: [24629076](https://pubmed.ncbi.nlm.nih.gov/24629076/)]
25. Dilworth S, Doherty E, Mallise C, et al. Barriers and enablers to addressing smoking, nutrition, alcohol consumption, physical activity and gestational weight gain (SNAP-W) as part of antenatal care: a mixed methods systematic review. *Implement Sci Commun.* Oct 9, 2024;5(1):112. [doi: [10.1186/s43058-024-00655-z](https://doi.org/10.1186/s43058-024-00655-z)] [Medline: [39385250](https://pubmed.ncbi.nlm.nih.gov/39385250/)]
26. Stengel MR, Kraschewski JL, Hwang SW, Kjerulff KH, Chuang CH. "What my doctor didn't tell me": examining health care provider advice to overweight and obese pregnant women on gestational weight gain and physical activity. *Womens Health Issues.* 2012;22(6):e535-40. [doi: [10.1016/j.whi.2012.09.004](https://doi.org/10.1016/j.whi.2012.09.004)] [Medline: [23122213](https://pubmed.ncbi.nlm.nih.gov/23122213/)]
27. Stoneburner A, Lucas R, Fontenot J, Brigance C, Jones E, DeMaria A. Nowhere to go: maternity care deserts across the US. (report no. 4). March of Dimes; URL: <https://www.marchofdimes.org/peristats/assets/s3/reports/2024-Maternity-Care-Report.pdf> [Accessed 2025-01-02]
28. McIntyre A, Ward T. Maternity deserts: an ethical crisis looming. *Clin Nurse Spec.* 2024;38(1):8-10. [doi: [10.1097/NUR.0000000000000790](https://doi.org/10.1097/NUR.0000000000000790)] [Medline: [38079138](https://pubmed.ncbi.nlm.nih.gov/38079138/)]
29. Koblinsky M, Moyer CA, Calvert C, et al. Quality maternity care for every woman, everywhere: a call to action. *The Lancet.* Nov 2016;388(10057):2307-2320. [doi: [10.1016/S0140-6736\(16\)31333-2](https://doi.org/10.1016/S0140-6736(16)31333-2)]
30. Antenatal care. UNICEF. 2024. URL: <https://data.unicef.org/topic/maternal-health/antenatal-care/> [Accessed 2025-01-02]
31. Redman LM, Gilmore LA, Breaux J, et al. Effectiveness of SmartMoms, a novel eHealth intervention for management of gestational weight gain: randomized controlled pilot trial. *JMIR Mhealth Uhealth.* Sep 13, 2017;5(9):e133. [doi: [10.2196/mhealth.8228](https://doi.org/10.2196/mhealth.8228)] [Medline: [28903892](https://pubmed.ncbi.nlm.nih.gov/28903892/)]
32. Feng Y, Shi C, Zhang C, Yin C, Zhou L. Effect of the smartphone application on caesarean section in women with overweight and obesity: a randomized controlled trial in China. *BMC Pregnancy Childbirth.* Oct 23, 2023;23(1):746. [doi: [10.1186/s12884-023-06004-7](https://doi.org/10.1186/s12884-023-06004-7)] [Medline: [37872503](https://pubmed.ncbi.nlm.nih.gov/37872503/)]
33. Koivuniemi E, Raats MM, Ollila H, Löyttyniemi E, Laitinen K. Characterising the use, users and effects of a health app supporting lifestyle changes in pregnant women. *Br J Nutr.* Aug 14, 2023;130(3):433-445. [doi: [10.1017/S0007114522003439](https://doi.org/10.1017/S0007114522003439)] [Medline: [36263460](https://pubmed.ncbi.nlm.nih.gov/36263460/)]
34. Olson CM, Groth SW, Graham ML, Reschke JE, Strawderman MS, Fernandez ID. The effectiveness of an online intervention in preventing excessive gestational weight gain: the e-Moms ROC randomized controlled trial. *BMC Pregnancy Childbirth.* May 9, 2018;18(1):148. [doi: [10.1186/s12884-018-1767-4](https://doi.org/10.1186/s12884-018-1767-4)] [Medline: [29743026](https://pubmed.ncbi.nlm.nih.gov/29743026/)]
35. Sandborg J, Söderström E, Henriksson P, et al. Effectiveness of a smartphone app to promote healthy weight gain, diet, and physical activity during pregnancy (HealthyMoms): randomized controlled trial. *JMIR Mhealth Uhealth.* Mar 11, 2021;9(3):e26091. [doi: [10.2196/26091](https://doi.org/10.2196/26091)] [Medline: [33704075](https://pubmed.ncbi.nlm.nih.gov/33704075/)]
36. Olson CM, Strawderman MS, Graham ML. Use of an online diet goal-setting tool: relationships with gestational weight gain. *J Nutr Educ Behav.* Apr 2019;51(4):391-399. [doi: [10.1016/j.jneb.2019.01.024](https://doi.org/10.1016/j.jneb.2019.01.024)] [Medline: [30975376](https://pubmed.ncbi.nlm.nih.gov/30975376/)]
37. Leonard KS, Evans MB, Oravec Z, Smyth JM, Symons Downs D. Effect of technology-supported interventions on prenatal gestational weight gain, physical activity, and healthy eating behaviors: a systematic review and meta-analysis. *J technol behav sci.* Mar 2021;6(1):25-41. [doi: [10.1007/s41347-020-00155-6](https://doi.org/10.1007/s41347-020-00155-6)]
38. Sherifali D, Nerenberg KA, Wilson S, et al. The effectiveness of eHealth technologies on weight management in pregnant and postpartum women: systematic review and meta-analysis. *J Med Internet Res.* Oct 13, 2017;19(10):e337. [doi: [10.2196/jmir.8006](https://doi.org/10.2196/jmir.8006)] [Medline: [29030327](https://pubmed.ncbi.nlm.nih.gov/29030327/)]
39. Global Strategy on Digital Health 2020-2025. World Health Organization; 2021. URL: <https://www.who.int/health-topics/digital-health/> [Accessed 2025-11-05] ISBN: 978-92-4-002092-1

40. Walker R, Bennett C, Blumfield M, et al. Attenuating pregnancy weight gain-what works and why: a systematic review and meta-analysis. *Nutrients*. Jul 22, 2018;10(7):944. [doi: [10.3390/nu10070944](https://doi.org/10.3390/nu10070944)] [Medline: [30037126](https://pubmed.ncbi.nlm.nih.gov/30037126/)]
41. Barroso CS, Yockey A, Degon E, et al. Efficacious lifestyle interventions for appropriate gestational weight gain in women with overweight or obesity set in the health care system: a scoping review. *J Matern Fetal Neonatal Med*. Dec 12, 2022;35(25):6411-6424. [doi: [10.1080/14767058.2021.1914576](https://doi.org/10.1080/14767058.2021.1914576)]
42. Marques MM, Wright AJ, Corker E, et al. The behaviour change technique ontology: transforming the behaviour change technique taxonomy v1. *Wellcome Open Res*. 2023;8:308. [doi: [10.12688/wellcomeopenres.19363.2](https://doi.org/10.12688/wellcomeopenres.19363.2)] [Medline: [37593567](https://pubmed.ncbi.nlm.nih.gov/37593567/)]
43. Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Sci*. Dec 2011;6(1):42. [doi: [10.1186/1748-5908-6-42](https://doi.org/10.1186/1748-5908-6-42)]
44. Michie S, Richardson M, Johnston M, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Ann Behav Med*. Aug 2013;46(1):81-95. [doi: [10.1007/s12160-013-9486-6](https://doi.org/10.1007/s12160-013-9486-6)] [Medline: [23512568](https://pubmed.ncbi.nlm.nih.gov/23512568/)]
45. Michie S, Wood CE, Johnston M, Abraham C, Francis JJ, Hardeman W. Behaviour change techniques: the development and evaluation of a taxonomic method for reporting and describing behaviour change interventions (a suite of five studies involving consensus methods, randomised controlled trials and analysis of qualitative data). *Health Technol Assess*. Nov 2015;19(99):1-188. [doi: [10.3310/hta19990](https://doi.org/10.3310/hta19990)]
46. Michie S, Johnston M, Rothman AJ, et al. Developing an evidence-based online method of linking behaviour change techniques and theoretical mechanisms of action: a multiple methods study. *Health Serv Deliv Res*. Jan 2021;9(1):1-168. [doi: [10.3310/hsdr09010](https://doi.org/10.3310/hsdr09010)]
47. Black N, Johnston M, Michie S, et al. Behaviour change techniques associated with smoking cessation in intervention and comparator groups of randomized controlled trials: a systematic review and meta-regression. *Addiction*. Nov 2020;115(11):2008-2020. [doi: [10.1111/add.15056](https://doi.org/10.1111/add.15056)] [Medline: [32196796](https://pubmed.ncbi.nlm.nih.gov/32196796/)]
48. Whatnall MC, Sharkey T, Hutchesson MJ, et al. Effectiveness of interventions and behaviour change techniques for improving physical activity in young adults: a systematic review and meta-analysis. *J Sports Sci*. Aug 2021;39(15):1754-1771. [doi: [10.1080/02640414.2021.1898107](https://doi.org/10.1080/02640414.2021.1898107)] [Medline: [33685357](https://pubmed.ncbi.nlm.nih.gov/33685357/)]
49. Peters MD, Godfrey C, McInerney P, Munn Z, Tricco AC, Khalil H. Scoping reviews (2020). In: Aromataris E, Lockwood C, Porritt K, Pilla B, Jordan Z, editors. *JBIM Manual for Evidence Synthesis*. 2024. [doi: [10.46658/JBIMES-24-09](https://doi.org/10.46658/JBIMES-24-09)]
50. Tricco AC, Lillie E, Zarin W, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. Oct 2, 2018;169(7):467-473. [doi: [10.7326/M18-0850](https://doi.org/10.7326/M18-0850)] [Medline: [30178033](https://pubmed.ncbi.nlm.nih.gov/30178033/)]
51. Pollak KI, Alexander SC, Bennett G, et al. Weight-related SMS texts promoting appropriate pregnancy weight gain: a pilot study. *Patient Educ Couns*. Nov 2014;97(2):256-260. [doi: [10.1016/j.pec.2014.07.030](https://doi.org/10.1016/j.pec.2014.07.030)] [Medline: [25153313](https://pubmed.ncbi.nlm.nih.gov/25153313/)]
52. Soltani H, Duxbury AMS, Arden MA, Dearden A, Furness PJ, Garland C. Maternal obesity management using mobile technology: a feasibility study to evaluate a text messaging based complex intervention during pregnancy. *J Obes*. 2015;2015:814830. [doi: [10.1155/2015/814830](https://doi.org/10.1155/2015/814830)] [Medline: [25960889](https://pubmed.ncbi.nlm.nih.gov/25960889/)]
53. Willcox JC, Wilkinson SA, Lappas M, et al. A mobile health intervention promoting healthy gestational weight gain for women entering pregnancy at a high body mass index: the txt4two pilot randomised controlled trial. *BJOG*. Oct 2017;124(11):1718-1728. [doi: [10.1111/1471-0528.14552](https://doi.org/10.1111/1471-0528.14552)] [Medline: [28220604](https://pubmed.ncbi.nlm.nih.gov/28220604/)]
54. Li LJ, Aris IM, Han WM, Tan KH. A promising food-coaching intervention program to achieve optimal gestational weight gain in overweight and obese pregnant women: pilot randomized controlled trial of a smartphone app. *JMIR Form Res*. Oct 24, 2019;3(4):e13013. [doi: [10.2196/13013](https://doi.org/10.2196/13013)] [Medline: [31651407](https://pubmed.ncbi.nlm.nih.gov/31651407/)]
55. Darvall JN, Wang A, Nazeem MN, et al. A pedometer-guided physical activity intervention for obese pregnant women (the Fit MUM study): randomized feasibility study. *JMIR Mhealth Uhealth*. May 26, 2020;8(5):e15112. [doi: [10.2196/15112](https://doi.org/10.2196/15112)] [Medline: [32348280](https://pubmed.ncbi.nlm.nih.gov/32348280/)]
56. Downs DS, Savage JS, Rivera DE, et al. Adaptive, behavioral intervention impact on weight gain, physical activity, energy intake, and motivational determinants: results of a feasibility trial in pregnant women with overweight/obesity. *J Behav Med*. Oct 2021;44(5):605-621. [doi: [10.1007/s10865-021-00227-9](https://doi.org/10.1007/s10865-021-00227-9)] [Medline: [33954853](https://pubmed.ncbi.nlm.nih.gov/33954853/)]
57. Thomas T, Xu F, Sridhar S, et al. A web-based mHealth intervention with telephone support to increase physical activity among pregnant patients with overweight or obesity: feasibility randomized controlled trial. *JMIR Form Res*. Jun 22, 2022;6(6):e33929. [doi: [10.2196/33929](https://doi.org/10.2196/33929)] [Medline: [35731565](https://pubmed.ncbi.nlm.nih.gov/35731565/)]
58. Waring ME, Simas TAM, Heersping GE, et al. Development and feasibility of a web-based gestational weight gain intervention for women with pre-pregnancy overweight or obesity. *Mhealth*. ;9:13-13. [doi: [10.21037/mhealth-22-49](https://doi.org/10.21037/mhealth-22-49)]
59. Mattson R, Barger MK. Feasibility of telehealth and innovative technologies to limit excessive gestational weight gain. *Nurs Womens Health*. Feb 2024;28(1):30-40. [doi: [10.1016/j.nwh.2023.08.002](https://doi.org/10.1016/j.nwh.2023.08.002)] [Medline: [37989496](https://pubmed.ncbi.nlm.nih.gov/37989496/)]

60. Herring SJ, Cruice JF, Bennett GG, Rose MZ, Davey A, Foster GD. Preventing excessive gestational weight gain among African American women: a randomized clinical trial. *Obesity (Silver Spring)*. Jan 2016;24(1):30-36. [doi: [10.1002/oby.21240](https://doi.org/10.1002/oby.21240)] [Medline: [26592857](https://pubmed.ncbi.nlm.nih.gov/26592857/)]
61. Smith K, Lanningham-Foster L, Welch A, Campbell C. Web-based behavioral intervention increases maternal exercise but does not prevent excessive gestational weight gain in previously sedentary women. *J Phys Act Health*. Jun 2016;13(6):587-593. [doi: [10.1123/jpah.2015-0219](https://doi.org/10.1123/jpah.2015-0219)] [Medline: [26594820](https://pubmed.ncbi.nlm.nih.gov/26594820/)]
62. Van Horn L, Peaceman A, Kwasny M, et al. Dietary approaches to stop hypertension diet and activity to limit gestational weight: maternal offspring metabolics family intervention trial, a technology enhanced randomized trial. *Am J Prev Med*. Nov 2018;55(5):603-614. [doi: [10.1016/j.amepre.2018.06.015](https://doi.org/10.1016/j.amepre.2018.06.015)] [Medline: [30262148](https://pubmed.ncbi.nlm.nih.gov/30262148/)]
63. Altazan AD, Redman LM, Burton JH, et al. Mood and quality of life changes in pregnancy and postpartum and the effect of a behavioral intervention targeting excess gestational weight gain in women with overweight and obesity: a parallel-arm randomized controlled pilot trial. *BMC Pregnancy Childbirth*. Jan 29, 2019;19(1):50. [doi: [10.1186/s12884-019-2196-8](https://doi.org/10.1186/s12884-019-2196-8)] [Medline: [30696408](https://pubmed.ncbi.nlm.nih.gov/30696408/)]
64. Gonzalez-Plaza E, Bellart J, Arranz Á, Luján-Barroso L, Crespo Mirasol E, Seguranyes G. Effectiveness of a step counter smartband and midwife counseling Intervention on gestational weight gain and physical activity in pregnant women with obesity (Pas and Pes study): randomized controlled trial. *JMIR Mhealth Uhealth*. Feb 15, 2022;10(2):e28886. [doi: [10.2196/28886](https://doi.org/10.2196/28886)] [Medline: [35166684](https://pubmed.ncbi.nlm.nih.gov/35166684/)]
65. Chen HH, Lee CF, Huang JP, Hsiung Y, Chi LK. Effectiveness of a nurse-led mHealth app to prevent excessive gestational weight gain among overweight and obese women: a randomized controlled trial. *J Nurs Scholarsh*. Jan 2023;55(1):304-318. [doi: [10.1111/jnu.12813](https://doi.org/10.1111/jnu.12813)] [Medline: [36121127](https://pubmed.ncbi.nlm.nih.gov/36121127/)]
66. Litman EA, Kavathekar T, Amdur R, Sebastian A, Marko K. Remote gestational weight gain monitoring in a large low-risk US population. *Obes Sci Pract*. Sep 1, 2021;8(2):147-152. [doi: [10.1002/osp4.554](https://doi.org/10.1002/osp4.554)] [Medline: [35388344](https://pubmed.ncbi.nlm.nih.gov/35388344/)]
67. Souza SCS, da Silva DF, Nagpal TS, et al. The short-term effect of a mHealth intervention on gestational weight gain and health behaviors: the SmartMoms Canada pilot study. *Physiol Behav*. Dec 1, 2022;257:113977. [doi: [10.1016/j.physbeh.2022.113977](https://doi.org/10.1016/j.physbeh.2022.113977)] [Medline: [36181787](https://pubmed.ncbi.nlm.nih.gov/36181787/)]
68. Rhodes A, Smith AD, Chadwick P, Croker H, Llewellyn CH. Exclusively digital health interventions targeting diet, physical activity, and weight gain in pregnant women: systematic review and meta-analysis. *JMIR Mhealth Uhealth*. Jul 10, 2020;8(7):e18255. [doi: [10.2196/18255](https://doi.org/10.2196/18255)] [Medline: [32673251](https://pubmed.ncbi.nlm.nih.gov/32673251/)]
69. Lau Y, Klainin-Yobas P, Htun TP, et al. Electronic-based lifestyle interventions in overweight or obese perinatal women: a systematic review and meta-analysis. *Obes Rev*. Sep 2017;18(9):1071-1087. [doi: [10.1111/obr.12557](https://doi.org/10.1111/obr.12557)] [Medline: [28544551](https://pubmed.ncbi.nlm.nih.gov/28544551/)]
70. Wu S, Jin J, Hu KL, Wu Y, Zhang D. Prevention of gestational diabetes mellitus and gestational weight gain restriction in overweight/obese pregnant women: a systematic review and network meta-analysis. *Nutrients*. Jun 9, 2022;14(12):2383. [doi: [10.3390/nu14122383](https://doi.org/10.3390/nu14122383)] [Medline: [35745114](https://pubmed.ncbi.nlm.nih.gov/35745114/)]
71. Vincze L, Rollo M, Hutchesson M, et al. Interventions including a nutrition component aimed at managing gestational weight gain or postpartum weight retention: a systematic review and meta-analysis. *JBI Database System Rev Implement Rep*. 2019;17(3):297-364. [doi: [10.11124/JBISRIR-2017-003593](https://doi.org/10.11124/JBISRIR-2017-003593)]
72. The International Weight Management in Pregnancy (i-WIP) Collaborative Group. Effect of diet and physical activity based interventions in pregnancy on gestational weight gain and pregnancy outcomes: meta-analysis of individual participant data from randomised trials. *BMJ*. Jul 19, 2017;358:j3119. [doi: [10.1136/bmj.j3119](https://doi.org/10.1136/bmj.j3119)]
73. Chan KL, Chen M. Effects of social media and mobile health apps on pregnancy care: meta-analysis. *JMIR Mhealth Uhealth*. Jan 30, 2019;7(1):e11836. [doi: [10.2196/11836](https://doi.org/10.2196/11836)] [Medline: [30698533](https://pubmed.ncbi.nlm.nih.gov/30698533/)]
74. O'Brien OA, McCarthy M, Gibney ER, McAuliffe FM. Technology-supported dietary and lifestyle interventions in healthy pregnant women: a systematic review. *Eur J Clin Nutr*. Jul 2014;68(7):760-766. [doi: [10.1038/ejcn.2014.59](https://doi.org/10.1038/ejcn.2014.59)] [Medline: [24781682](https://pubmed.ncbi.nlm.nih.gov/24781682/)]
75. Iyawa GE, Dansharif AR, Khan A. Mobile apps for self-management in pregnancy: a systematic review. *Health Technol*. Mar 2021;11(2):283-294. [doi: [10.1007/s12553-021-00523-z](https://doi.org/10.1007/s12553-021-00523-z)]
76. Overdijkink SB, Velu AV, Rosman AN, van Beukering MD, Kok M, Steegers-Theunissen RP. The usability and effectiveness of mobile health technology-based lifestyle and medical intervention apps supporting health care during pregnancy: systematic review. *JMIR Mhealth Uhealth*. Apr 24, 2018;6(4):e109. [doi: [10.2196/mhealth.8834](https://doi.org/10.2196/mhealth.8834)] [Medline: [29691216](https://pubmed.ncbi.nlm.nih.gov/29691216/)]
77. Mertens L, Braeken M, Bogaerts A. Effect of lifestyle coaching including telemonitoring and telecoaching on gestational weight gain and postnatal weight loss: a systematic review. *Telemed J E Health*. Oct 2019;25(10):889-901. [doi: [10.1089/tmj.2018.0139](https://doi.org/10.1089/tmj.2018.0139)] [Medline: [30523742](https://pubmed.ncbi.nlm.nih.gov/30523742/)]

78. Hussain T, Smith P, Yee LM. Mobile phone-based behavioral interventions in pregnancy to promote maternal and fetal health in high-income countries: systematic review. *JMIR Mhealth Uhealth*. May 28, 2020;8(5):e15111. [doi: [10.2196/15111](https://doi.org/10.2196/15111)] [Medline: [32463373](https://pubmed.ncbi.nlm.nih.gov/32463373/)]
79. Raab R, Geyer K, Zagar S, Hauner H. App-supported lifestyle interventions in pregnancy to manage gestational weight gain and prevent gestational diabetes: scoping review. *J Med Internet Res*. Nov 10, 2023;25(1):e48853. [doi: [10.2196/48853](https://doi.org/10.2196/48853)] [Medline: [37948111](https://pubmed.ncbi.nlm.nih.gov/37948111/)]
80. Hutchesson MJ, de Jonge Mulock Houwer M, Brown HM, et al. Supporting women of childbearing age in the prevention and treatment of overweight and obesity: a scoping review of randomized control trials of behavioral interventions. *BMC Womens Health*. Jan 23, 2020;20(1):14. [doi: [10.1186/s12905-020-0882-3](https://doi.org/10.1186/s12905-020-0882-3)] [Medline: [31973716](https://pubmed.ncbi.nlm.nih.gov/31973716/)]
81. Graham ML, Strawderman MS, Demment M, Olson CM. Does usage of an eHealth intervention reduce the risk of excessive gestational weight gain? Secondary analysis from a randomized controlled trial. *J Med Internet Res*. Jan 9, 2017;19(1):e6. [doi: [10.2196/jmir.6644](https://doi.org/10.2196/jmir.6644)] [Medline: [28069560](https://pubmed.ncbi.nlm.nih.gov/28069560/)]
82. Olson CM, Strawderman MS, Graham ML. Association between consistent weight gain tracking and gestational weight gain: secondary analysis of a randomized trial. *Obesity (Silver Spring)*. Jul 2017;25(7):1217-1227. [doi: [10.1002/oby.21873](https://doi.org/10.1002/oby.21873)] [Medline: [28573669](https://pubmed.ncbi.nlm.nih.gov/28573669/)]
83. Henriksson P, Migueles JH, Söderström E, Sandborg J, Maddison R, Löf M. User engagement in relation to effectiveness of a digital lifestyle intervention (the HealthyMoms app) in pregnancy. *Sci Rep*. Aug 13, 2022;12(1):13793. [doi: [10.1038/s41598-022-17554-9](https://doi.org/10.1038/s41598-022-17554-9)] [Medline: [35963935](https://pubmed.ncbi.nlm.nih.gov/35963935/)]
84. Davis R, Campbell R, Hildon Z, Hobbs L, Michie S. Theories of behaviour and behaviour change across the social and behavioural sciences: a scoping review. *Health Psychol Rev*. 2015;9(3):323-344. [doi: [10.1080/17437199.2014.941722](https://doi.org/10.1080/17437199.2014.941722)] [Medline: [25104107](https://pubmed.ncbi.nlm.nih.gov/25104107/)]
85. Willmott T, Rundle-Thiele S. Are we speaking the same language? Call for action to improve theory application and reporting in behaviour change research. *BMC Public Health*. Mar 10, 2021;21(1):479. [doi: [10.1186/s12889-021-10541-1](https://doi.org/10.1186/s12889-021-10541-1)] [Medline: [33691658](https://pubmed.ncbi.nlm.nih.gov/33691658/)]
86. Weight gain pregnancy. National Health Service. 2023. URL: <https://www.nhs.uk/pregnancy/related-conditions/common-symptoms/weight-gain/> [Accessed 2025-01-10]
87. 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*. Feb 17, 2010;12(1):e4. [doi: [10.2196/jmir.1376](https://doi.org/10.2196/jmir.1376)] [Medline: [20164043](https://pubmed.ncbi.nlm.nih.gov/20164043/)]
88. Carver CS, Scheier MF. Control theory: a useful conceptual framework for personality-social, clinical, and health psychology. *Psychol Bull*. Jul 1982;92(1):111-135. [doi: [10.1037/0033-2909.92.1.111](https://doi.org/10.1037/0033-2909.92.1.111)] [Medline: [7134324](https://pubmed.ncbi.nlm.nih.gov/7134324/)]
89. Michie S, Abraham C, Whittington C, McAteer J, Gupta S. Effective techniques in healthy eating and physical activity interventions: a meta-regression. *Health Psychol*. Nov 2009;28(6):690-701. [doi: [10.1037/a0016136](https://doi.org/10.1037/a0016136)] [Medline: [19916637](https://pubmed.ncbi.nlm.nih.gov/19916637/)]
90. Michie S, Yardley L, West R, Patrick K, Greaves F. Developing and evaluating digital interventions to promote behavior change in health and health care: recommendations resulting from an international workshop. *J Med Internet Res*. Jun 29, 2017;19(6):e232. [doi: [10.2196/jmir.7126](https://doi.org/10.2196/jmir.7126)] [Medline: [28663162](https://pubmed.ncbi.nlm.nih.gov/28663162/)]
91. Dodd JM, Deussen AR, Poprzeczny AJ, Slade LJ, Mitchell M, Louise J. Investigating discrepancies in findings between rigorous randomized trials and meta-analyses evaluating pregnancy interventions to limit gestational weight gain. *Obes Rev*. Dec 2024;25(12):e13826. [doi: [10.1111/obr.13826](https://doi.org/10.1111/obr.13826)] [Medline: [39363588](https://pubmed.ncbi.nlm.nih.gov/39363588/)]
92. Lean ME, Leslie WS, Barnes AC, et al. Primary care-led weight management for remission of type 2 diabetes (DiRECT): an open-label, cluster-randomised trial. *The Lancet*. Feb 2018;391(10120):541-551. [doi: [10.1016/S0140-6736\(17\)33102-1](https://doi.org/10.1016/S0140-6736(17)33102-1)]
93. McCombie L, Leslie W, Taylor R, Kennon B, Sattar N, Lean MEJ. Beating type 2 diabetes into remission. *BMJ*. Sep 13, 2017;j4030. [doi: [10.1136/bmj.j4030](https://doi.org/10.1136/bmj.j4030)]
94. Malloy S. Impact of digital health interventions on birth equity: a review. *Semin Reprod Med*. Jun 2024;42(2):140-150. [doi: [10.1055/s-0044-1791206](https://doi.org/10.1055/s-0044-1791206)] [Medline: [39348847](https://pubmed.ncbi.nlm.nih.gov/39348847/)]
95. Olawade DB, Aderinto N, Clement David-Olawade A, et al. Integrating AI-driven wearable devices and biometric data into stroke risk assessment: a review of opportunities and challenges. *Clin Neurol Neurosurg*. Feb 2025;249:108689. [doi: [10.1016/j.clineuro.2024.108689](https://doi.org/10.1016/j.clineuro.2024.108689)] [Medline: [39675149](https://pubmed.ncbi.nlm.nih.gov/39675149/)]
96. Nahavandi D, Alizadehsani R, Khosravi A, Acharya UR. Application of artificial intelligence in wearable devices: opportunities and challenges. *Comput Methods Programs Biomed*. Jan 2022;213:106541. [doi: [10.1016/j.cmpb.2021.106541](https://doi.org/10.1016/j.cmpb.2021.106541)] [Medline: [34837860](https://pubmed.ncbi.nlm.nih.gov/34837860/)]
97. Berdichevsky D, Neuenschwander E. Toward an ethics of persuasive technology. *Commun ACM*. May 1999;42(5):51-58. [doi: [10.1145/301353.301410](https://doi.org/10.1145/301353.301410)]



98. Davis J. Design methods for ethical persuasive computing. Presented at: Persuasive '09: Proceedings of the 4th International Conference on Persuasive Technology; Apr 26-29, 2009:1-8; Claremont California USA. [doi: [10.1145/1541948.1541957](https://doi.org/10.1145/1541948.1541957)]
99. Spahn A. And lead us (not) into persuasion...? Persuasive technology and the ethics of communication. *Sci Eng Ethics*. Dec 2012;18(4):633-650. [doi: [10.1007/s11948-011-9278-y](https://doi.org/10.1007/s11948-011-9278-y)] [Medline: [21544700](https://pubmed.ncbi.nlm.nih.gov/21544700/)]
100. Nickel P, Spahn A. Trust, discourse ethics, and persuasive technology. Presented at: International Conference on Persuasive Technology (Persuasive Technology 2012; Jun 6-8, 2012; Linköping, Sweden.
101. Weitz K, Schiller D, Schlagowski R, Huber T, André E. Do you trust me?": increasing user-trust by integrating virtual agents in explainable AI interaction design. Presented at: IVA '19: Proceedings of the 19th ACM International Conference on Intelligent Virtual Agents; Jul 2-5, 2019:7-9; Paris France. [doi: [10.1145/3308532.3329441](https://doi.org/10.1145/3308532.3329441)]
102. Carrandi A, Hu Y, Karger S, et al. Systematic review on the cost and cost-effectiveness of mHealth interventions supporting women during pregnancy. *Women Birth*. Feb 2023;36(1):3-10. [doi: [10.1016/j.wombi.2022.03.007](https://doi.org/10.1016/j.wombi.2022.03.007)] [Medline: [35339412](https://pubmed.ncbi.nlm.nih.gov/35339412/)]
103. Gentili A, Failla G, Melnyk A, et al. The cost-effectiveness of digital health interventions: a systematic review of the literature. *Front Public Health*. 2022;10:787135. [doi: [10.3389/fpubh.2022.787135](https://doi.org/10.3389/fpubh.2022.787135)] [Medline: [36033812](https://pubmed.ncbi.nlm.nih.gov/36033812/)]

## Abbreviations

**BCT:** behavior change technique

**GWG:** gestational weight gain

**IOM:** Institute of Medicine

**mHealth:** mobile health

**PA:** physical activity

**PRISMA-ScR:** Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews

**RCT:** randomized controlled trial

*Edited by Naomi Cahill; peer-reviewed by Danielle Downs, Wendy Bennett; submitted 30.Jan.2025; final revised version received 27.Jun.2025; accepted 30.Jul.2025; published 14.Nov.2025*

### *Please cite as:*

Otte RA, Duracher L, Demir O, Spelt HAA

*Digital Lifestyle Interventions to Support Healthy Gestational Weight Gain: Scoping Review*

*J Med Internet Res*2025;27:e71548

URL: <https://www.jmir.org/2025/1/e71548>

doi: [10.2196/71548](https://doi.org/10.2196/71548)

© Renée A Otte, Lucie Duracher, Ozge Demir, Hanne A A Spelt. Originally published in the Journal of Medical Internet Research (<https://www.jmir.org>), 14.Nov.2025. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research (ISSN 1438-8871), is properly cited. The complete bibliographic information, a link to the original publication on <https://www.jmir.org/>, as well as this copyright and license information must be included.