

Viewpoint

# The Emergence of Personalized Health Technology

Luke Nelson Allen<sup>1</sup>, BSc (Hon), MPH, MBChB, PGCE; Gillian Pepall Christie<sup>2</sup>, MA, MPhil

<sup>1</sup>Harvard T.H. Chan School of Public Health, Department of Global Health and Population, Boston, MA, United States

<sup>2</sup>Vitality Group, New York, NY, United States

**Corresponding Author:**

Luke Nelson Allen, BSc (Hon), MPH, MBChB, PGCE

Harvard T.H. Chan School of Public Health

Department of Global Health and Population

677 Huntington Av

Boston, MA, Ma 02115

United States

Phone: 1 1865289471

Fax: 1 1865289472

Email: [luke.allen@mail.harvard.edu](mailto:luke.allen@mail.harvard.edu)

## Abstract

Personalized health technology is a noisy new entrant to the health space, yet to make a significant impact on population health but seemingly teeming with potential. Devices including wearable fitness trackers and healthy-living apps are designed to help users quantify and improve their health behaviors. Although the ethical issues surrounding data privacy have received much attention, little is being said about the impact on socioeconomic health inequalities. Populations who stand to benefit the most from these technologies are unable to afford, access, or use them. This paper outlines the negative impact that these technologies will have on inequalities unless their user base can be radically extended to include vulnerable populations. Frugal innovation and public-private partnership are discussed as the major means for reaching this end.

(*J Med Internet Res* 2016;18(5):e99) doi: [10.2196/jmir.5357](https://doi.org/10.2196/jmir.5357)

**KEYWORDS**

personalized health technology; population health; frugal innovation; ethics; socioeconomic factors, inequalities; technology, health

## Introduction

Several larger technology giants and smaller upstarts are creating personalized health technologies. Sensors, smartwatches, and mobile health apps are strapped to wrists and placed in pockets to monitor and help to modify health behaviors [1]. High-profile devices include the Fitbit, Jawbone, Microsoft Band, and Apple smartwatch. While there is no widely agreed-upon definition, personalized health technology generally refers to wearable devices that monitor health-related activity and provide feedback at the individual level, usually through a corresponding app or minidisplays on the device. Current products track lifestyle information such as steps walked, hours slept, and calories consumed. Terabytes of data are analyzed to deliver instantaneous and predictive insights to users. These technologies contribute to the self-quantification movement and to the consumerization of health.

PHTs that empower consumers to quantify health behaviors could advance health for all populations. The modifiable risk

factors that are measured by these devices—including physical activity and diet—are major drivers of noncommunicable diseases. These conditions, including cardiovascular and lung diseases, type 2 diabetes, and various cancers, are the leading causes of death and disability worldwide [2]. They account for an estimated 60% of all deaths and will cost the global economy US \$30 trillion by 2025 [2,3].

Scientific evidence demonstrating the impact of personalized health technologies on health is still emerging. This is partly because rapid technological innovation is being driven by firms responding to a market for these products, leaving academics and clinicians to play catch-up with health impact evaluations. Early research suggests that the technologies can facilitate changes in behaviors and reductions in disease risks, and that the health impact is magnified when coupled with broader engagement strategies [4-6]. Although noncommunicable diseases disproportionately afflict disadvantaged groups [2,7,8], the uptake of personalized health technologies has been limited to the educated, healthy, and wealthy [9-11]. Devices remain largely unaffordable and inaccessible to lower-income

populations, and many lack the technological skills required to modify their health behaviors using information delivered by the technologies [12-14]. Until access is expanded to nontraditional users, personalized health technologies will continue to widen socioeconomic health inequities for vulnerable populations worldwide.

### ***The Problem: Exacerbating Inequity***

Inequities are often exacerbated in the shorter term when innovative technologies enter the marketplace. Companies place higher prices on new technologies to recover their original investment in research and development. Over time, the power of economies of scale and competitive forces push prices downward: technologies eventually become affordable to the masses. As relatively new products, personalized health technologies have served to widen inequities because only affluent early adopters can afford their higher prices, while marginalized populations remain excluded [10,15].

Personalized health technologies further exacerbate inequities in the shorter term because early adopters are motivated and health conscious [11]. Existing users tend to be highly educated and possess the necessary technological skills to operate the devices. They also have the linguistic and numeric capabilities to process information in order to change behaviors. While high-income earners possess these skills, vulnerable populations—older adults, racial and ethnic minorities, poorly educated individuals, and low-income earners—commonly lack them [16]. Without adequate technological or health literacy skills, marginalized populations cannot actively engage with personalized health technologies. These factors may widen socioeconomic health inequities further in the short term [15].

How can gaps in the affordability and accessibility of personalized health technologies be closed in the longer term? According to Tudor Hart's inverse care law, health products and services are always used most by those who need them least [17]. As devices become more efficacious, advancements in health will continue to disproportionately benefit the privileged. Personalized health technology will not realize its public health potential in reducing the global burden of noncommunicable diseases unless challenges associated with the affordability and accessibility of personalized health technologies are proactively mitigated.

### ***The Solution: Frugal Innovation***

Creative strategies are required to advance health for individuals occupying lower rungs of the socioeconomic ladder. Innovating for the bottom of the pyramid—the 3 billion people living on less than US \$2.50 a day—is not new [18]. In 2002, the renowned management professor CK Prahalad proposed the development of products and services for the bottom of the pyramid. Prahalad realized that fortunes were being left on the table as companies neglected to target the largest but poorest socioeconomic population [19]. Since Prahalad's writings, innovating with a frugal innovation mindset has emerged to target these previously marginalized consumers.

Frugal innovations are high-quality products created with limited resources [20]. Innovating with a frugal innovation mindset entails reducing the cost and complexity of products by removing nonessential features to create “good enough” products. Materials are repeatedly recycled to self-sustain the company and the environment, while diverse external partners such as universities and venture capitalists are often brought together to maximize efficiencies. The needs and requirements of end users in bottom-of-the-pyramid markets are central to the development process.

This relatively new model has received widespread support from socially oriented enterprises and influential corporate leaders alike. Unilever's Chief Executive Officer, Paul Polman, wrote in the foreword of Radjou and colleague's book *Frugal Innovation* that the “frugal ingenuity of developing nations with the advanced [research and development] capabilities of advanced economies [can enable] companies to create high-quality products and services that are affordable, sustainable, and benefit humanity as a whole” [20]. Indra Nooyi, Chairperson and Chief Executive Officer of PepsiCo, further contends that “frugal innovation is one of the most critical emerging models of value creation for both businesses and the customers they serve” [20].

Numerous companies have created products and services for health using this approach [21,22]. General Electric has developed an electrocardiograph machine that costs US \$800 as opposed to US \$2000 and has reduced the cost of an electrocardiographic test to US \$1 per person. Tata has established the Tata Swach to purify water without running water or electricity for US \$20. The innovative Jaipur foot is a prosthetic that costs less than US \$45 [23]. A majority of these innovations are widely used in developing as well as in developed countries. They also enable developing countries to leapfrog their developed country counterparts to provide cost-effective innovations at scale.

Despite the emergence of frugal innovations, challenges arise that could hinder their broader uptake and use. Predicting what consumers need and desire is relatively easier than actually engaging them, particularly when the target group is a marginalized population. In addition, balancing financial and social returns to sell at scale while continuing to generate profits is a ubiquitous issue for companies engaged in frugal innovation.

It is also important that emerging systems, tools, and personalized health technology devices be subject to rigorous technology assessments [24]. Established qualitative and quantitative tools [25] can be used to evaluate performance against a range of key performance indicators that extend beyond health metrics to include reliability, integration with other devices, cost, and data security [24].

### ***Frugal Innovation and Personalized Health Technology***

A frugal innovation mindset can be applied to personalized health technologies to minimize socioeconomic health inequities. Companies can engage end users in bottom-of-the-pyramid markets to design, develop, and test the effectiveness of

personalized health technologies. There are several ongoing pilot projects that use personalized health technologies to improve health outcomes in low-income populations [26-28]. Unfortunately, the majority of early personalized health technology initiatives in low- and middle-income countries tended to lack careful targeting, sustainable funding, robust evaluation, and the ability to work at scale [29-31]. In addition to these projects, more affordable personalized health technologies and programs are emerging to benefit bottom-of-the-pyramid markets, including the Xiaomi Mi Band and United Nations Children's Fund (UNICEF) Kid Power Bands. In a recent study, the Mi Band—sold in Asia and priced at less than US \$20—outperformed more expensive competitors in accurately monitoring vital signs and steps walked [32]. Another innovative example of frugal personalized health technology that benefits low-income groups in both high- and low-income countries is the UNICEF Kid Power Program. UNICEF and the US retailer Target market the discounted Kid Power Band (a wrist-worn activity-monitoring device) at children in high-income countries with obesity problems. By meeting physical activity goals, wearers earn points, recorded on a parallel mobile app. Corporate sponsors translate these points into funding for childhood nutrition programs in developing countries. To date, over 50,000 children have engaged with the initiative, raising enough money to provide

over a quarter of a million UNICEF therapeutic food packets for malnourished children [33].

As evidence for the effectiveness of these technologies mounts, governments with legal and constitutional obligations to promote the health of their citizens can subsidize the creation of personalized health technologies and provide them through state-funded programs. These measures will help to mitigate the inequities that this disruptive technology is exacerbating.

### *Conclusion: A Call for Collective Action*

Technologies are tools—they are designed by people and for people. While personalized health technologies are pregnant with potential, the extent to which they affect the health of all populations remains limited. With the current user base, any health benefits derived from using personalized health technologies or future iterations will disproportionately accrue to the affluent unless strategies are adopted to widen access among disadvantaged groups. In time, new business models are likely to emerge that reduce costs, increase affordability, and expand access. Until then, the combination of frugal innovation with public and private sector action can leverage personalized health technologies to advance global health responsibly, sustainably, and equitably.

### **Acknowledgments**

We are grateful to Dr Derek Yach, Chief Health Officer at the Vitality Group, for his insightful guidance and comments on earlier versions of this manuscript. We thank Sarah Kunkle for her support in the preparation of this paper.

This paper received no specific funding.

### **Conflicts of Interest**

None declared.

### **References**

1. Lyons EJ, Lewis ZH, Mayrsohn BG, Rowland JL. Behavior change techniques implemented in electronic lifestyle activity monitors: a systematic content analysis. *J Med Internet Res* 2014 Aug;16(8):e192 [FREE Full text] [doi: [10.2196/jmir.3469](https://doi.org/10.2196/jmir.3469)] [Medline: [25131661](https://pubmed.ncbi.nlm.nih.gov/25131661/)]
2. World Health Organization. Noncommunicable diseases. Geneva, Switzerland: World Health Organization; 2015 Jan. URL:<http://www.who.int/mediacentre/factsheets/fs355/en/> [accessed 2015-05-03] [WebCite Cache ID 6d8UOOTir]
3. Bloom DE, Cafiero ET, Jané-Llopis E, Abrahams-Gessel S, Bloom LR, Fathima S, Feigl AB, Gaziano T, Mowafi M, Pandya A, Prettner K, Rosenberg L, Seligman B, Stein AZ, Weinstein C. The Global Economic Burden of Non-communicable Diseases. Geneva: World Economic Forum; 2011 Sep. URL:[http://www3.weforum.org/docs/WEF\\_Harvard\\_HE\\_GlobalEconomicBurdenNonCommunicableDiseases\\_2011.pdf](http://www3.weforum.org/docs/WEF_Harvard_HE_GlobalEconomicBurdenNonCommunicableDiseases_2011.pdf) [accessed 2016-04-22] [WebCite Cache ID 6gxcETMst]
4. Hsu WC, Lau KH, Huang R, Ghiloni S, Le H, Gilroy S, et al. Utilization of a cloud-based diabetes management program for insulin initiation and titration enables collaborative decision making between healthcare providers and patients. *Diabetes Technol Ther* 2016 Feb;18(2):59-67 [FREE Full text] [doi: [10.1089/dia.2015.0160](https://doi.org/10.1089/dia.2015.0160)] [Medline: [26645932](https://pubmed.ncbi.nlm.nih.gov/26645932/)]
5. Rabbi M, Pfammatter A, Zhang M, Spring B, Choudhury T. Automated personalized feedback for physical activity and dietary behavior change with mobile phones: a randomized controlled trial on adults. *JMIR Mhealth Uhealth* 2015 May;3(2):e42 [FREE Full text] [doi: [10.2196/mhealth.4160](https://doi.org/10.2196/mhealth.4160)] [Medline: [25977197](https://pubmed.ncbi.nlm.nih.gov/25977197/)]
6. Bravata DM, Smith-Spangler C, Sundaram V, Gienger AL, Lin N, Lewis R, et al. Using pedometers to increase physical activity and improve health: a systematic review. *JAMA* 2007 Nov 21;298(19):2296-2304. [doi: [10.1001/jama.298.19.2296](https://doi.org/10.1001/jama.298.19.2296)] [Medline: [18029834](https://pubmed.ncbi.nlm.nih.gov/18029834/)]
7. World Health Organization. Global Status Report on Alcohol and Health 2014. Geneva, Switzerland: WHO; May 12, 2014:1-392.

8. Mackenbach JP, Stirbu I, Roskam AR, Schaap MM, Menvielle G, Leinsalu M, European Union Working Group on Socioeconomic Inequalities in Health. Socioeconomic inequalities in health in 22 European countries. *N Engl J Med* 2008 Jun 5;358(23):2468-2481. [doi: [10.1056/NEJMs0707519](https://doi.org/10.1056/NEJMs0707519)] [Medline: [18525043](https://pubmed.ncbi.nlm.nih.gov/18525043/)]
9. Patel MS, Asch DA, Volpp KG. Wearable devices as facilitators, not drivers, of health behavior change. *JAMA* 2015 Feb 3;313(5):459-460. [doi: [10.1001/jama.2014.14781](https://doi.org/10.1001/jama.2014.14781)] [Medline: [25569175](https://pubmed.ncbi.nlm.nih.gov/25569175/)]
10. Fox S, Duggan M. Tracking for health. Washington, DC: Pew Internet & American Life Project; 2013 Jan 28. URL:[http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP\\_TrackingforHealth%20with%20appendix.pdf](http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_TrackingforHealth%20with%20appendix.pdf) [accessed 2016-02-11] [WebCite Cache ID [6fDMpBEIs](https://www.webcitation.org/6fDMpBEIs)]
11. Epps SR, Doty CA, Knott J, Vokshi A. Fitness Wearables — Many Products, Few Customers. Cambridge, MA: Forrester Reserach Inc; 2013 Jan 28. URL:<https://www.forrester.com/Fitness+Wearables+Many+Products+Few+Customers/fulltext/-E-res89941> [accessed 2016-02-05] [WebCite Cache ID [6f4KBG0xx](https://www.webcitation.org/6f4KBG0xx)]
12. Ericsson Mobility Report: On the Pulse of the Networked Society. Stockholm, Sweden: Ericsson; 2014 Jun. URL:<http://www.ericsson.com/res/docs/2014/ericsson-mobility-report-june-2014.pdf> [accessed 2016-02-11] [WebCite Cache ID [6fDN3vJEn](https://www.webcitation.org/6fDN3vJEn)]
13. Rhodes H. Accessing and using data from wearable fitness devices. *J AHIMA* 2014 Sep;85(9):48-50. [Medline: [25286622](https://pubmed.ncbi.nlm.nih.gov/25286622/)]
14. Nelson LA, Mulvaney SA, Gebretsadik T, Ho Y, Johnson KB, Osborn CY. Disparities in the use of a mHealth medication adherence promotion intervention for low-income adults with type 2 diabetes. *J Am Med Inform Assoc* 2016 Jan;23(1):12-18. [doi: [10.1093/jamia/ocv082](https://doi.org/10.1093/jamia/ocv082)] [Medline: [26186935](https://pubmed.ncbi.nlm.nih.gov/26186935/)]
15. McAuley A. Digital health interventions: widening access or widening inequalities? *Public Health* 2014 Dec;128(12):1118-1120. [doi: [10.1016/j.puhe.2014.10.008](https://doi.org/10.1016/j.puhe.2014.10.008)] [Medline: [25458115](https://pubmed.ncbi.nlm.nih.gov/25458115/)]
16. Quick Guide to Health Literacy. Washington, DC: U.S. Department of Health and Human Services URL:<http://health.gov/communication/literacy/quickguide/factsbasic.htm> [accessed 2015-05-03] [WebCite Cache ID [6d8TodiGh](https://www.webcitation.org/6d8TodiGh)]
17. Hart JT. The inverse care law. *The Lancet* 1971 Feb;297(7696):405-412. [doi: [10.1016/S0140-6736\(71\)92410-X](https://doi.org/10.1016/S0140-6736(71)92410-X)]
18. Shah A. Global Issues: Poverty Facts and Stats.: Anup Shah; 2013 Jan 07. URL:<http://www.globalissues.org/article/26/poverty-facts-and-stats> [accessed 2015-11-18] [WebCite Cache ID [6d8TXVik9](https://www.webcitation.org/6d8TXVik9)]
19. Prahalad CK, Hart SL. The fortune at the bottom of the pyramid. *Strategy+Business* 2002 Jan 10;First Quarter(26):1-26 [FREE Full text]
20. Radjou N, Prabhu J. Frugal Innovation: How to do More With Less. New York, NY: Public Affairs; 2015.
21. O'Hara NN. Is safe surgery possible when resources are scarce? *BMJ Qual Saf* 2015 Jul;24(7):432-434. [doi: [10.1136/bmjqs-2015-004377](https://doi.org/10.1136/bmjqs-2015-004377)] [Medline: [25998062](https://pubmed.ncbi.nlm.nih.gov/25998062/)]
22. Tiwari R, Herstatt C. Assessing India's lead market potential for cost-effective innovations. *J Indian Bus Res* 2012 Jun;4(2):97-115. [doi: [10.1108/17554191211228029](https://doi.org/10.1108/17554191211228029)]
23. Bound K, Thornton I. Our Frugal Future: Lessons from India's Innovation System. London, UK: Nesta; 2012 Jul. URL:[http://www.nesta.org.uk/sites/default/files/our\\_frugal\\_future.pdf](http://www.nesta.org.uk/sites/default/files/our_frugal_future.pdf) [accessed 2016-04-22] [WebCite Cache ID [6gxeRlclY](https://www.webcitation.org/6gxeRlclY)]
24. Martinez-Millana A, Fico G, Fernández-Llatas C, Traver V. Performance assessment of a closed-loop system for diabetes management. *Med Biol Eng Comput* 2015 Dec;53(12):1295-1303. [doi: [10.1007/s11517-015-1245-3](https://doi.org/10.1007/s11517-015-1245-3)] [Medline: [25667016](https://pubmed.ncbi.nlm.nih.gov/25667016/)]
25. van der Weegen S, Verwey R, Spreeuwenberg M, Tange H, van der Weijden T, de Witte L. The development of a mobile monitoring and feedback tool to stimulate physical activity of people with a chronic disease in primary care: a user-centered design. *JMIR Mhealth Uhealth* 2013 Jul;1(2):e8 [FREE Full text] [doi: [10.2196/mhealth.2526](https://doi.org/10.2196/mhealth.2526)] [Medline: [25099556](https://pubmed.ncbi.nlm.nih.gov/25099556/)]
26. Baum S. MedCity News: Omada Health Raises \$48M With Plans to Extend Program to Medicaid Patients. New York, NY: Breaking Media Inc; 2015 Sep 16. URL:<http://medcitynews.com/2015/09/omada-health-raises-48m-with-plans-to-provide-program-for-medicaid-patients/> [accessed 2016-02-11] [WebCite Cache ID [6fDO544X8](https://www.webcitation.org/6fDO544X8)]
27. LaMantia J. Crain's New York Business: Verizon Teams Up With Digital Health Company to Give Broadband to Low-Income Patients. New York, NY: Crain Communications Inc; 2015 Jul 23. URL:<http://www.craainsnewyork.com/article/20150723/TECHNOLOGY/150729918/verizon-teams-up-with-digital-health-company-to-give-broadband-to-low-income-patients> [accessed 2016-01-28] [WebCite Cache ID [6espUr6Np](https://www.webcitation.org/6espUr6Np)]
28. Winners of the Super-Utilizer Health Innovation Challenge: AdhereTech, A-CHESS, and Wellth. Hamilton, NJ: Center for Health Care Strategies, Inc; 2015 Aug. URL:<http://www.chcs.org/highlight/winners-super-utilizer-health-innovation-challenge-adheretech-chess-wellth/> [accessed 2016-01-28] [WebCite Cache ID [6espXMidu](https://www.webcitation.org/6espXMidu)]
29. Lemaire J. Scaling Up Mobile Health: Elements Necessary for the Successful Scale Up of mHealth in Developing Countries. Geneva: Advanced Development for Africa; 2011 Dec. URL:[https://www.k4health.org/sites/default/files/ADA\\_mHealth%20White%20Paper.pdf](https://www.k4health.org/sites/default/files/ADA_mHealth%20White%20Paper.pdf) [accessed 2016-04-22] [WebCite Cache ID [6gxdzHmkN](https://www.webcitation.org/6gxdzHmkN)]
30. Blaya JA, Fraser HS, Holt B. E-health technologies show promise in developing countries. *Health Aff (Millwood)* 2010 Feb;29(2):244-251 [FREE Full text] [doi: [10.1377/hlthaff.2009.0894](https://doi.org/10.1377/hlthaff.2009.0894)] [Medline: [20348068](https://pubmed.ncbi.nlm.nih.gov/20348068/)]
31. Lewis T, Synowiec C, Lagomarsino G, Schweitzer J. E-health in low- and middle-income countries: findings from the Center for Health Market Innovations. *Bull World Health Organ* 2012 May 1;90(5):332-340 [FREE Full text] [doi: [10.2471/BLT.11.099820](https://doi.org/10.2471/BLT.11.099820)] [Medline: [22589566](https://pubmed.ncbi.nlm.nih.gov/22589566/)]

32. El-Amrawy F, Nounou M. Are currently available wearable devices for activity tracking and heart rate monitoring accurate, precise, and medically beneficial? *Healthc Inform Res* 2015 Oct 20;21(4):315-320 [[FREE Full text](#)]
33. UNICEF Kid Power: Get Active. Save Lives. New York, NY: U.S. Fund for UNICEF; 2015. URL:<http://unicefkidpower.org/> [accessed 2016-02-05] [[WebCite Cache ID 6f4FrFxML](#)]

---

## Abbreviations

**UNICEF:** United Nations Children's Fund

---

*Edited by G Eysenbach; submitted 19.11.15; peer-reviewed by J Williams, A Ottaway, A Martinez-Millana; comments to author 24.12.15; revised version received 10.02.16; accepted 10.02.16; published 10.05.16*

*Please cite as:*

*Allen LN, Christie GP*

*The Emergence of Personalized Health Technology*

*J Med Internet Res* 2016;18(5):e99

URL: <http://www.jmir.org/2016/5/e99/>

doi: [10.2196/jmir.5357](https://doi.org/10.2196/jmir.5357)

PMID: [27165944](https://pubmed.ncbi.nlm.nih.gov/27165944/)

©Luke Nelson Allen, Gillian Pepall Christie. Originally published in the Journal of Medical Internet Research (<http://www.jmir.org>), 10.05.2016. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/2.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research, is properly cited. The complete bibliographic information, a link to the original publication on <http://www.jmir.org/>, as well as this copyright and license information must be included.