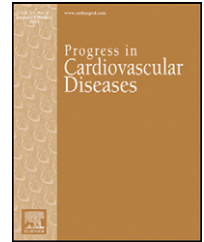


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# The Use of Behavior Change Techniques and Theory in Technologies for Cardiovascular Disease Prevention and Treatment in Adults: A Comprehensive Review

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## ARTICLE INFO

### Keywords:

Behavior change techniques  
Behavioral theory  
Cardiovascular disease prevention and treatment  
Health promotion technologies

## ABSTRACT

This review examined the use of health behavior change techniques and theory in technology-enabled interventions targeting risk factors and indicators for cardiovascular disease (CVD) prevention and treatment. Articles targeting physical activity, weight loss, smoking cessation and management of hypertension, lipids and blood glucose were sourced from PubMed (November 2010–2015) and coded for use of 1) technology, 2) health behavior change techniques (using the CALO-RE taxonomy), and 3) health behavior theories. Of the 984 articles reviewed, 304 were relevant (240 = intervention, 64 = review). Twenty-two different technologies were used ( $M = 1.45$ ,  $SD = +/-0.719$ ). The most frequently used behavior change techniques were self-monitoring and feedback on performance ( $M = 5.4$ ,  $SD = +/-2.9$ ). Half (52%) of the intervention studies named a theory/model - most frequently Social Cognitive Theory, the Trans-theoretical Model, and the Theory of Planned Behavior/Reasoned Action. To optimize technology-enabled interventions targeting CVD risk factors, integrated behavior change theories that incorporate a variety of evidence-based health behavior change techniques are needed.

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Modifiable health behaviors including tobacco use, physical inactivity, and poor diet contribute significantly to cardiovascular (CV) disease (CVD) morbidity and mortality.<sup>1</sup> Achieving population-wide, sustained improvements in these behaviors remains difficult. The use of health information technologies holds great promise for improving CV-related health

worldwide<sup>2</sup> as they are potentially cost-effective, broadly accessible, adaptive, and have the ability to operate in real-world and real-time circumstances. Examples of health information technologies include mobile phones, wearable sensors, telehealth devices and applications, interactive voice response (IVR) systems, gaming consoles, virtual reality, and

This work was supported in part by the Nutralite Health Institute Wellness Fund provided by Amway to the Stanford Prevention Research Center (Winter and King), US Public Health Service Grant 1U54EB020405 supporting The National Center for Mobility Data Integration and Insight (PI: S. Delp; partial support for King), and US Public Health Service grants 5R01HL11644803 (King, Sheats, and Winter) and 1R01DK102016 (King and Sheats) from the National Institutes of Health.

Statement of Conflict of Interest: see page 611.

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<http://dx.doi.org/10.1016/j.pcad.2016.02.005>

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### Abbreviations and Acronyms

AHA = American Heart Association

BP = Blood pressure

CV = Cardiovascular

CVD = Cardiovascular disease

IVR = Interactive voice response

PA = Physical activity

interactive Web 2.0 platforms. Recent findings from the Pew Research Center indicate that technology use among adults in the United States (US) is substantial<sup>3</sup> with high levels of cellphone (including smartphone) and computer ownership:

for example, 92% of US adults currently own a cellphone or smartphone. Notably, in the last four years the number of adults owning smartphones has nearly doubled – up from 35% in 2011 to 68% in 2015. In addition, three-quarters (73%) of US adults own a desktop or laptop computer. With numerous advances in technology occurring at a rapid rate, smartphones are being transformed into all-purpose devices that can perform functions of a computer and other devices such as e-readers, MP3 players, games, etc. Tablet computers, which are owned by almost half (45%) of US adults, have many functions in common with smartphones. While use is generally lower among older adults (78%), overall use is common among all major demographics in the US – including racial/ethnic minorities.<sup>3</sup>

Although the development of technologies for CVD prevention and treatment are increasing, there are recognized challenges that remain to be addressed. In the American Heart Association's (AHA) Scientific Statement "Current Science on Consumer Use of Mobile Health for Cardiovascular Disease Prevention",<sup>4</sup> one of the recommendations for future research highlighted the need for the development of technologies that are based on proven behavioral techniques and theories. The aim of this paper is to provide a comprehensive review of the current use of behavior change techniques and theories in technology-enabled approaches for CVD prevention and treatment.

## Methods

### Search terms

A search of the literature on technology-enabled approaches for CVD prevention and treatment was conducted using the

PubMed database in November 2015. The search began with a combination of terms in the following three categories: 1) health behaviors and indicators, 2) technologies, and 3) behavioral theories (Table 1). The health behaviors and relevant indicators were congruent with the key cardiovascular health metrics defined by the AHA in 2010<sup>5</sup> and included the following: physical activity (PA), weight management, tobacco use, blood glucose, blood pressure and lipids. To gain the broadest understanding of the current state of the science in this field, a comprehensive array of terms was included for technologies, including mobile, social media, wearables, and other Internet-based terms. Similarly, a comprehensive array of terms was used to search for behavior and behavior change theories. References from articles meeting the inclusion criteria for this review were subsequently reviewed to identify additional relevant articles meeting the search inclusion criteria (Table 1). Free English language full-text articles produced between November 2010 and November 2015 were included in this review.

### Inclusion criteria

The Article Review Diagram is displayed in Fig 1. Articles describing health behavior change interventions targeting CVD prevention and treatment among adults were included and, because of the substantial overlap of the risk factors for diabetes mellitus and CVD, articles describing diabetes prevention and treatment were also included. Exclusion criteria included articles that described observational, focus group, computer modeling, measurement validation or economic evaluation studies; expert opinion or conceptual articles; protocol papers that described study methodology for planned studies that did not include results; articles targeting other conditions, such as rheumatoid arthritis, macular degeneration or multiple sclerosis; and articles describing interventions targeting children or adolescents.

### Data extraction

The following data were extracted from each relevant article: year of publication, country of authorship, type of technology, health risk factor(s) and/or indicator(s) targeted, behavior change techniques utilized, and behavior change theory named. The behavior change techniques were categorized using the CALO-RE behavior change taxonomy created by Michie et al.<sup>6</sup>

**Table 1 – Search terms for comprehensive review of the use of behavior change theory in cardiovascular prevention and treatment.**

Health Behaviors and Indicators	Technologies	Behavioral Theories
<p><u>Physical Activity</u>: physical activity, exercise, physical inactivity, sedentary, sitting.</p> <p><u>Weight loss</u>: weight loss, weight reduction, obesity</p> <p><u>Tobacco use</u>: tobacco use, tobacco cessation, smoking, smokeless tobacco</p> <p><u>Health indicators</u>: blood pressure, hypertension, glucose, blood sugar, cholesterol, lipids</p>	<p>Social media, Twitter, Facebook, cell phone, smartphone, mobile phone, mobile applications, apps, text messaging, mobile health, technology, telemedicine, web-based, electronic mail, e-mail, Internet, wearable, monitoring sensors, GPS, interactive voice response, embodied conversational agent, virtual, electronic tablet, tablet-based, computers, handheld, digital health, eHealth, on-line systems, software, multimedia</p>	<p>Behavior, behavioral, behavior therapy, behavior change theory, health belief model, trans theoretical model, theory of planned behavior, precaution adoption process model, social cognitive theory, social influence theory, social ecological model, motivational frameworks, PRIME theory, self determination theory, operant conditioning, social support, theory of reasoned action, stages of change, social norms, social learning, diffusion of innovation, reasoned action approach, integrative model</p>

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