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Internet interventions to support lifestyle modification for diabetes management: A systematic review of the evidence☆,☆☆

Alexander P. Cotter [a], Nefertiti Durant [b], April A. Agne [c], Andrea L. Cherrington [c,*]

[a] School of Medicine, University of Alabama at Birmingham
[b] Department of Pediatrics, University of Alabama at Birmingham
[c] Division of Preventive Medicine, Department of Medicine, University of Alabama at Birmingham

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ABSTRACT

Background: The Internet presents a widely accessible, 24-h means to promote chronic disease management. The objective of this review is to identify studies that used Internet based interventions to promote lifestyle modification among adults with type 2 diabetes.
Methods: We searched PubMed using the terms: [internet, computer, phone, smartphone, mhealth, mobile health, web based, telehealth, social media, text messages] combined with [diabetes management and diabetes control] through January 2013. Studies were included if they described an Internet intervention, targeted adults with type 2 diabetes, focused on lifestyle modification, and included an evaluation component with behavioral outcomes.
Results: Of the 2803 papers identified, nine met inclusion criteria. Two studies demonstrated improvements in diet and/or physical activity and two studies demonstrated improvements in glycemic control comparing web-based intervention with control. Successful studies were theory-based, included interactive components with tracking and personalized feedback, and provided opportunities for peer support. Website utilization declined over time in all studies that reported on it. Few studies focused on high risk, underserved populations.
Conclusion: Web-based strategies provide a viable option for facilitating diabetes self-management. Future research is needed on the use of web-based interventions in underserved communities and studies examining website utilization patterns and engagement over time.

1. Introduction

Diabetes prevalence continues to grow in the United States, affecting an estimated 8.3% of the population (25.8 million people) (National Diabetes Fact Sheet, 2011). A future projection shows an estimated increase in the national prevalence of diabetes to roughly 26.5% of the population by the year 2050 (Boyle, Thompson, Gregg, Barker, & Williamson, 2010). Lifestyle modification and behavior changes are key components of diabetes management, especially type 2 diabetes (Norris, Lau, Smith, Schmid, & Engelgau, 2002). Numerous studies have documented the benefits lifestyle modification and disease management have on improving glycemic control and reduction of diabetes related complications (Norris et al., 2002). However translating evidence-based recommendations to practical strategies designed for real world settings has proven challenging and many individuals fail to achieve the glycemic control needed to avoid diabetes related complications (Centers for Disease Control and Prevention, 2011). Clearly practical strategies suitable for widespread dissemination are needed that can reach individuals where they live, work and play in order to address the diabetes epidemic in a meaningful way.

The Internet and related mobile technologies present a widely accessible, 24-h means to promote disease management and facilitate behavior modification (Kaufman, 2010). Implementation of web-based interventions to assist with diabetes management has exploded over the past decade (Chomutare, Fernandez-Luque, Arsand, & Hartvigsen, 2011; Osborn, Mayberry, Mulvaney, & Hess, 2010). To date, the majority has focused specifically on using web-based technology to facilitate the glucose monitoring process, allowing patients to upload monitoring data so their physician can adjust the dosage of insulin or medication (Chomutare et al., 2011; Harris, Hood, & Mulvaney, 2012; Yu et al., 2012). Generally these types of intervention have shown enhanced patient–provider communication,

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* Corresponding author. Division of Preventive Medicine, 624 Medical Towers, 1717 11th Avenue South, Birmingham, AL 35294-3407, USA.
E-mail address: cherrington@uab.edu (A.L. Cherrington).

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medication adherence and ultimately an improvement in glucose control. A review of Internet diabetes programs published in 2011 identified over 137 web-based mobile applications, with most focused on insulin titration and very few focused on lifestyle modification (Chomutare et al., 2011). When investigators reviewed the applications for content and strategies, inclusion of behavior theory and education with tailored feedback were notably lacking. These findings were surprising given that 95% of individuals with diabetes have type 2, where disease management is heavily focused on lifestyle modification and typically includes oral agents as first line therapy (Ramadas, Quek, Chan, & Oldenburg, 2011).

The primary objective of this review is to identify studies that used Internet based interventions to promote diabetes education and lifestyle modification among adults with type 2 diabetes. In light of existing diabetes related health disparities that exist along socioeconomic and racial/ethnic lines, an important secondary objective is to assess the extent to which these interventions have tailored their interventions for diverse and/or underserved communities.

2. Methods

2.1. Search strategy

We searched PubMed using the terms: [internet, computer, phone, smartphone, mhealth, mobile health, web based, telehealth, social media, OR text messages] combined with the terms [diabetes management and diabetes control] through January 2013. We supplemented this search by performing a backwards search of all of the references of articles that met inclusion criteria or were topically relevant. Only papers that measured patient outcomes and described the evaluation of the study were included.

2.2. Eligibility/exclusion criteria

To be eligible, studies had to describe an internet intervention that targeted adults with type 2 diabetes, focused on behavior change and/or lifestyle, and included an evaluation component (Fig. 1). Studies that focused exclusively on glucose monitoring or electronic health records/web portals for uploading data were not included. Studies that included glucose monitoring or electronic health records as part of a larger intervention focused on lifestyle modification and patient education were eligible. Two authors independently reviewed each abstract of identified articles. Studies were excluded at this stage if both reviewers agreed that the eligibility criteria were clearly not met. If either reviewer could not exclude the study based on the abstract, the full article was reviewed independently by two authors.

2.3. Data abstraction

One author abstracted the data from the articles using predetermined tables. A second confirmed the accuracy of the data abstracted into evidence tables. Since selected outcomes differed markedly between studies, data were not extracted for meta-analysis. Abstraction forms included sample size, study duration, target population, behavior theory, targeted behaviors, measured outcomes, as well as intervention strategies, including peer support and/or interactive components. Interactive components were defined as features that allowed users to comment, chat, edit, or interact with the information, other users, or members of the healthcare team. Target behaviors as described from the American Association of Diabetes Educators 7 were also summarized for each study (AADE7, 2013). These behaviors included, healthy eating, being active, monitoring, taking medication, healthy coping, reducing risks, and problem solving.

3. Results

The search identified 2803 papers; nine studies (13 papers) met inclusion criteria (Carter, Nunlee-Bland, & Callender, 2011; Feil, Glasgow, Boles, & McKay, 2000; Glasgow, Boles, McKay, Feil, & Barrera, 2003; Glasgow, Christiansen, Kurz, et al., 2011; Glasgow, Kurz, King, et al., 2010; Glasgow, Strycker, Kurz, et al., 2010; Kim & Kang, 2006; Liebreich, Plotnikoff, Courneya, & Boule, 2009; Lorig, Ritter, Laurent, et al., 2010; McIlhenny, Riba, Barbanoj, Strassman, & Barker, 2012; McKay, King, Eakin, Seeley, & Glasgow, 2001; Noh, Cho, Nam, et al., 2010; Richardson, Mehari, McIntyre, et al., 2007) (Fig. 1). Eight of the studies reviewed were randomized controlled trials with patients with type 2 diabetes (5 small trials <100 participants; 3 larger trials >300 participants) and one was quasi-experimental with a control group ($n = 98$) (McIlhenny et al., 2012).

Each study created a web-based intervention designed to promote diabetes education and some health behavior change; a brief description of the web-based program is provided in Table 1. The most commonly targeted behaviors included being active (8/9), healthy eating (6/9), and glucose monitoring (5/9). Just under half of programs (4/9) included a specific focus on coping skills and support; similarly 4 of 9 programs included a specific focus on medication adherence. One third of programs included a focus on problem solving (3/8) and reducing risks (3/8) such as smoking. In general, applications provided a variety of mechanisms to promote behavior modification ranging from static education to structured goal setting and progress tracking tools to platforms for social support. For example, in the Glasgow 2010 study, participants were asked to set dietary and exercise goals and track their progress using the tracking section of the website (Glasgow, Kurz, King, et al., 2010). In the Carter study, participants used a social networking module to discuss issues with other participants and provide support for one another (Carter et al., 2011). Six of nine programs specifically included some form of peer support or online community to engage users. These online communities could take the shape of live chats, allowing users to talk to one another instantly, as in the Glasgow 2003 study, or message boards, allowing users to post topics for everyone to discuss, as in the Liebreich study (Glasgow et al., 2003; Liebreich et al., 2009). Over half of the programs (6/9) reported using specific theory/conceptual framework to design their intervention. These included Self-efficacy/Social Cognitive Theory (Glasgow et al., 2003; Liebreich et al., 2009; Lorig et al., 2010), Social Support Theory, (Glasgow et al., 2003) Social–Ecological Framework, (Glasgow, Kurz, King, et al., 2010) Health Belief Model (Richardson et al., 2007) and Transtheoretical Model (Kim & Kang, 2006).

3.1. Behavioral outcomes

Nearly all of the studies measured change in physical activity (8/9) (Table 2). Of those, only one study reported statistically significant differences in activity levels for participants enrolled in a web-based program vs participants in the non-web-based control group (Glasgow, Kurz, King, et al., 2010). In intent to treat analyses, Glasgow et al. ($n = 463$) reported an increase in physical activity as measured by self-report using the Community Health Activities Model Program Questionnaire ($p = 0.04$). Comparing a web-based program with email counseling to a control condition that provided links to publicly available web-sites, Liebreich et al. ($n = 49$) reported an increase in total vigorous and moderate minutes of physical activity (measured by) but did not report comparison between groups (Liebreich et al., 2009). Kim et al. found that the study's internet intervention and print based intervention were both effective at increasing physical activity when compared to no intervention at all but did not find a significant difference between the two interventions (Kim & Kang, 2006). Richardson et al. compared two different styles of goal setting for physical activity, encouraging a focus on total number of steps