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Review Article

Lifestyle interventions based on the diabetes prevention program delivered via eHealth: A systematic review and meta-analysis

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ABSTRACT

The objective was to describe Diabetes Prevention Program (DPP)-based lifestyle interventions delivered via electronic, mobile, and certain types of telehealth (eHealth) and estimate the magnitude of the effect on weight loss. A systematic review was conducted. PubMed and EMBASE were searched for studies published between January 2003 and February 2016 that met inclusion and exclusion criteria. An overall estimate of the effect on mean percentage weight loss across all the interventions was initially conducted. A stratified meta-analysis was also conducted to determine estimates of the effect across the interventions classified according to whether behavioral support by counselors post-baseline was not provided, provided remotely with communication technology, or face-to-face.

Twenty-two studies met the inclusion/exclusion criteria, in which 26 interventions were evaluated. Samples were primarily white and college educated. Interventions included Web-based applications, mobile phone applications, text messages, DVDs, interactive voice response telephone calls, telehealth video conferencing, and video on-demand programing. Nine interventions were stand-alone, delivered post-baseline exclusively via eHealth. Seventeen interventions included additional behavioral support provided by counselors post-baseline remotely with communication technology or face-to-face. The estimated overall effect on mean percentage weight loss from baseline to up to 15 months of follow-up across all the interventions was −3.98%. The subtotal estimate across the stand-alone eHealth interventions (−3.34%) was less than the estimate across interventions with behavioral support given by a counselor remotely (−4.31%), and the estimate across interventions with behavioral support given by a counselor in-person (−4.65%).

There is promising evidence of the efficacy of DPP-based eHealth interventions on weight loss. Further studies are needed particularly in racially and ethnically diverse populations with limited levels of educational attainment. Future research should also focus on ways to optimize behavioral support.

Contents

Abbreviations: DPP, The Diabetes Prevention Program; T2D, Type 2 diabetes.

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1. Introduction

Type 2 diabetes (T2D), accounting for 90 to 95% of all diabetes in the United States (US), has emerged as a dominant public health concern. Estimated to affect 9.3% of the US population, diabetes is a major risk factor for cardiovascular disease and stroke, and a primary cause of chronic kidney failure, non-traumatic lower-extremity amputations, and blindness (Centers for Disease Control and Prevention [CDC], 2014). The costs of diabetes care in the US are unsustainable; yearly diabetes medical expenditures alone have been estimated at $176 billion (CDC, 2014). If no action is taken, demographic and incidence trends suggest that by the year 2050, the proportion of the US adult population with diabetes may more than triple (CDC, 2015). T2D disproportionatly affects certain racial and ethnic minority subpopulations. While the rate of diabetes is 7.6% among non-Hispanic white adults, the rate is 9.0% among Asian American adults, 12.8% among Hispanic adults, and 13.2% among non-Hispanic black adults (CDC, 2014). T2D differentially impacts adults with lower educational attainment. Whereas, the rate of diabetes is 6.5% among adults with a bachelor's degree or higher, the rate is 9.6% among adults with some college, 10.5% among adults with a high school diploma or GED, and 15.1% among adults with less than a high school diploma (Schiller et al., 2012).

In some cases, T2D can be delayed or prevented, through modification of lifestyle, diet and physical activity, that reduces excess body weight. The Diabetes Prevention Program (DPP) lifestyle intervention demonstrated a 58% decrease in incidence of T2D among overweight adults of diverse race/ethnicity at high-risk of developing T2D. A reduction of body weight over a period of 6 months in the range of 5–7%, was achieved through the DPP lifestyle intervention (Knowler et al., 2002). T2D prevention benefits of the DPP lifestyle intervention have been shown to last up to 10 years (Knowler et al., 2009). Dissemination of DPP-based lifestyle interventions on a large scale in the US has not yet been achieved. One limiting factor to widespread dissemination is cost. The lifestyle intervention in the DPP, was estimated to cost $1399 per participant, over the first year (Hernan et al., 2003).

Modifications that are often proposed to decrease cost and increase scalability of DPP-based lifestyle interventions include delivery of interventions in churches (Boltri et al., 2008), workplaces (Aldana et al., 2006), and other community-based settings (e.g. YMCA) (Ackermann et al., 2008). Modification for delivery via different electronic health approaches (eHealth) is also advocated (Atienza and Patrick, 2011; Green et al., 2012; Ockene et al., 2011; Wolfenden et al., 2010). The efficacy of DPP-based lifestyle interventions modified to the local context or modified for delivery via eHealth has been evaluated in several systematic reviews with and without meta-analysis (Ali et al., 2012; Whittemore, 2011). While these reviews have included DPP-based eHealth interventions, conclusions about the efficacy on weight loss of DPP-based eHealth interventions were limited by the broad inclusion criteria of the reviews and the small number of eHealth interventions that were available at the time. A systematic review of 16 DPP-based interventions by Whittemore (2011) included only one eHealth intervention, and a systematic review and meta-analysis of 28 DPP-based interventions by Ali et al. (2012) included only four eHealth interventions. In the meta-analysis, a subtotal estimate across four eHealth interventions of the effect on mean percentage weight loss was 4.20% (Ali et al., 2012).

A factor that was not accounted for in the previous reviews is the provision of behavioral support in eHealth interventions by a counselor, either remotely with communication technology or through face-to-face encounters. Provision of behavioral support by a counselor in eHealth interventions is considered a factor to promote adherence (Ritterband et al., 2009), and a primary driver of cost (Tate et al., 2009). Given the implications of the scalability of DPP-based eHealth interventions, the rapid evolution of eHealth research, and the importance of systematically evaluating behavioral support provided in eHealth interventions, an updated review solely of DPP-based eHealth interventions in which provision of behavioral support is explored is warranted.

Therefore, the aims of this systematic review were to: 1) describe DPP-based eHealth interventions, 2) describe the characteristics of the DPP-based eHealth intervention samples, 3) estimate the overall effect across all the DPP-based eHealth interventions on weight loss, 4) estimate subtotal effects across the DPP-based eHealth interventions stratified by behavioral support on weight loss.

2. Methods

This systematic review and meta-analysis was conducted following the PRISMA guidelines (Moher et al., 2010). Inclusion criteria were: 1) randomized controlled trials or cohort studies with or without a control group that evaluated the effect of an intervention on weight loss; 2) intervention based on the DPP lifestyle intervention curriculum delivered via eHealth approaches [web-based/Internet-based applications, social media, serious games, DVDs, mobile applications, and certain computer-based telehealth applications (e.g. interactive voice response, videoconferencing) as defined by Eysenbach and the CONSORT-EHEALTH Group (2011)]; 3) participants ≥18 years of age residing in the US; and 4) study results published in English in a peer-reviewed article.

2.1. Search, study selection, and data collection processes

The online databases Medline and EMBASE were searched to identify records published from January 1, 2003 to February 29, 2016 that met the inclusion criteria. This start date of the search was selected to include translations of the DPP lifestyle intervention, the results of which were published in February 2002 (Knowler et al., 2002). The search strategy was developed with the collaboration of a professional librarian (GW). A full description of the electronic search strategy for Medline, from which the search of the EMBASE database was modeled, is available in the appendices (Appendix 1). After duplicates were removed, one reviewer (KJ) screened the record titles and abstracts to identify records that met the search criteria. Reference lists and review articles were checked for relevant articles. Full-text articles were retrieved and assessed by one reviewer (KJ). Questions about whether an article should be included were resolved through discussion with a second reviewer (RW) and decisions were made by consensus.

Data extracted from the articles, included sample characteristics, intervention characteristics, and weight loss outcomes. Only data provided numerically in the articles and/or supplementary materials was extracted; data was not read off graphs. When studies did not report mean percentage weight loss, calculations were carried out using the data available. We attempted to contact authors by email if insufficient data was reported in the article to estimate size of the effect of the intervention on weight loss. One reviewer (KJ) extracted and coded data from all of the studies that met the inclusion criteria. To check for errors in