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Review article

A Systematic Review of Digital Interventions for Improving the Diet and Physical Activity Behaviors of Adolescents

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ABSTRACT

Many adolescents have poor diet and physical activity behaviors, which can lead to the development of noncommunicable diseases in later life. Digital platforms offer inexpensive means of delivering health interventions, but little is known about their effectiveness. This systematic review was conducted to synthesize evidence on the effectiveness of digital interventions to improve diet quality and increase physical activity in adolescents, to effective intervention components and to assess the cost-effectiveness of these interventions. Following a systematic search, abstracts were assessed against inclusion criteria, and data extraction and quality assessment were performed for included studies. Data were analyzed to identify key features that are associated with significant improvement in behavior.

A total of 27 studies met inclusion criteria. Most ($n = 15$) were Web site interventions. Other delivery methods were text messages, games, multicomponent interventions, emails, and social media. Significant behavior change was often seen when interventions included education, goal setting, self-monitoring, and parental involvement. None of the publications reported cost-effectiveness. Due to heterogeneity of studies, meta-analysis was not feasible. It is possible to effect significant health behavior change in adolescents through digital interventions that incorporate education, goal setting, self-monitoring, and parental involvement. Most of the evidence relates to Web sites and further research into alternate media is needed, and longer term outcomes should be evaluated. There is a paucity of data on the cost-effectiveness of digital health interventions, and future trials should report these data.

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IMPLICATIONS AND CONTRIBUTION

It is possible to effect significant health behavior change in adolescents through digital interventions that incorporate education, goal setting, self-monitoring, and parental involvement, though there is a paucity of data on the cost-effectiveness of these interventions.

Conflicts of Interest: The authors have no conflict of interest to disclose.

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Adolescents have the unhealthiest diets of all age groups [1–4], and most adolescents do not meet national guidelines for physical activity (PA), spending too much time being sedentary [4]. These behaviors can lead to obesity and increase the risk of

noncommunicable diseases such as diabetes, cancer, and heart disease in adulthood [5–7]. An additional challenge with adolescents is that they are in a developmental stage where a sense of autonomy develops, and many adolescents are resistant to interventions they feel impede their independence [8]. In response to the poor health behaviors of adolescents, plus the challenges associated with changing the behaviors of this group, a range of interventions have been developed and tested. Many of these focused on giving diet or PA education and are often school based [9–13]. In the context of the studies included in this review, education components include classroom-based lectures, face-to-face provision of information, or teaching through printed materials or digital media. Other interventions for improving adolescents' health behaviors are community based [14–16] and may include parental or family involvement [17,18]. Recently, however, there has been an explosion in the use of digital interventions to improve health behaviors.

Over recent years, Internet usage and smartphone ownership have seen a worldwide increase; approximately, 90% of adults in the United States and United Kingdom use the Internet and 91% of millennials in these countries own smartphones [19]. U.S. data from 2015 suggested that 92% of adolescents accessed the Internet daily, with 24% saying that they were online almost constantly [20]. In addition, the advent of fitness trackers like Fitbit has introduced a new platform for motivating people to be physically active, although evidence for their effectiveness is limited [21]. Digital means of communication are considered to be acceptable to adolescents, and a review of text messaging interventions for preventing obesity in adolescents confirmed this [22]. Given the nearly universal accessibility of digital media in high-income countries, as well as the affordability and scalability of interventions using these platforms, it is unsurprising that there is now considerable interest in developing digital interventions for behavior change.

To develop interventions that result in sustained change to adolescent health behavior, it is necessary to understand which elements of such interventions are effective. A 2011 systematic review of digital interventions for increasing PA in adolescents found that such interventions could produce small but significant increases in PA and that they were most effective when combined with face-to-face contact [23]. Since then, there has been a rapid change in the way adolescents use digital media, coinciding with an increase in the number of digital interventions developed. For example, social media platforms such as Snapchat [24] and Instagram [25] have been launched since 2010, with widespread usage among young people. In addition, the running app "Zombies, Run!" was launched in 2012 and gained record-breaking popularity [26]. The dynamic nature of the digital world and the ways in which it is used by adolescents mean that up-to-date reviews of evidence are required to understand the factors that influence the effectiveness of digital interventions for improving the diet and PA behaviors of adolescents.

Recently, Lappan et al. [27] reviewed randomized controlled trials (RCTs) of interventions that included text messages, Web sites, or smartphone apps that aimed to improve diet, PA, or body mass index in children or adolescents. They found that digital platforms often supported improvements in diet and PA and sometimes in body weight or body mass index. The authors concluded that it was important to use a behavior change theory to design digital interventions for improving health behaviors. In our review, we contributed to the growing body of knowledge on digital interventions for improving the health behaviors of adolescents. Our

search was not limited to RCTs or to any specific form of digital intervention. We aimed to identify specific intervention components that characterize the more successful interventions.

As well as assessing the effectiveness of digital interventions with regard to improving diet and PA, it is important to understand the cost-effectiveness of each approach [28]. Evaluation of cost-effectiveness assesses whether an intervention is a good use of resources and, in health care, can be calculated as cost per quality-adjusted life year. We aimed to take a broad definition and, where they available, would include any data about the cost of a given intervention. Digital platforms are often regarded as representing a cost-effective resource for intervention [29,30]. Health care interventions delivered digitally have been found to be cost-effective [31,32], but data for cost-effectiveness of behavior change interventions are lacking [32]. Therefore, this review aimed to collate cost-effectiveness data presented in included publications.

Aims

The aim of this review was to synthesize evidence on the effectiveness of digital interventions to improve diet quality and increase PA in adolescents, to identify the most effective intervention components, and to assess the cost-effectiveness of these interventions.

The following questions were addressed:

- 1) How can digital interventions be used to improve quality of diet and increase PA in adolescents, and which intervention features characterize successful interventions?
- 2) How cost-effective are such interventions?

Methods

Study selection

The methods for this systematic review followed the best practice guidelines for the conduct of systematic reviews, developed by the Centre for Reviews and Dissemination [33]. First, a search was carried out in November 2015 by an information specialist using electronic databases MEDLINE, PsycINFO, CINAHL, PubMed Central, Embase, ERIC, the NHS EED, and CENTRAL with no restrictions on the date of publication (from the earliest available through November 2015). A combination of medical subject headings and free-text terms were selected to find publications pertaining to adolescent health behaviors, nutrition, PA, and intervention studies that aimed to improve them. The complete search strategy is in [Appendix A](#).

After removing duplicates, this search identified 6,791 publications, which were independently screened by two researchers (T.R. and C.J.) who compared the titles and abstracts against the inclusion criteria listed in [Table 1](#). A total of 31 publications reporting on 26 studies met inclusion criteria ([Figure 1](#)). Reference lists of included studies were screened for additional publications that might address review questions. In addition, experts in the field were consulted to identify further relevant publications, which resulted in one additional publication so the review included a total of 32 publications reporting on 26 studies.

Studies were selected if they met inclusion criteria based on study design, target population, intervention type, and study outcomes. Included studies described an intervention study

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