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School-Based Internet Obesity Prevention Programs for Adolescents: A Systematic Literature Review

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In response to the childhood obesity epidemic, numerous studies on school-based Internet obesity prevention interventions have been conducted. The purpose of this systematic review is to describe, synthesize, and evaluate the research on school-based Internet obesity prevention programs for adolescents. Medline, CINAHL, and PsycInfo were searched from January 1995 to August 2012 to locate relevant studies. Ninety-one reports were initially identified, with 12 meeting the inclusion criteria. Studies had variable control groups, program content, and sample characteristics. Though few authors reported on implementation processes or body mass index (BMI†) outcomes, the majority of studies were effective in improving health behaviors in the short term. Most studies were judged to have a high or unclear risk of bias in at least two domains, thus the quality of evidence for this body of literature is moderate. Further research is needed to examine programs of longer duration, optimal dose and timing of programs, cost-effectiveness, and mediators and moderators of intervention outcomes.

INTRODUCTION

The prevention of obesity in adolescents is a national priority. More than 16 percent of adolescents in the United States are obese, and more than 30 percent of adolescents are overweight or obese [1]. The prevalence of obesity is even higher in African American and Hispanic youth (24 percent and 21 percent respectively) compared to white youth (14 percent) [1]. There are numerous health risks associated with being overweight or obese in adolescence, including asthma, hyperlipidemia, hyper-

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†Abbreviations: BMI, body mass index; GRADE, Grading of Recommendations Assessment, Development and Evaluation; CONSORT, Consolidated Standards of Reporting Trials; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

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tension, and type 2 diabetes [2]. Compared to youth with type 1 diabetes, type 2 diabetes diagnosed in adolescence contributes to more significant and earlier complications of diabetes, such as nephropathy and cardiovascular disease [3]. Obesity in adolescents also has serious psychological consequences, including low self-esteem and depression [2].

Adolescence is a time of increased autonomy, which can negatively impact health behaviors. Health behaviors that can prevent obesity sharply decline in adolescence [4,5]. Approximately 60 percent of adolescents consume high fat diets, 79 percent do not eat the recommended amount of fruits and vegetables, and 40 percent drink soda at least once per day. In addition, 35 percent of adolescents report watching television for 3 or more hours on an average school day, and 65 percent do not meet recommended levels of moderate and vigorous exercise [6,7]. Minority youth have higher use of media per day compared to white youth, up to 8 hours per day [8].

Poor health behaviors and the development of overweight/obesity in adolescence are likely to persist into adulthood. Being overweight in adolescence has been identified as the single best predictor of adult obesity [9]. Adolescents, particularly minority youth, are an underserved population with respect to nutrition and health education [10]. Adolescents report a good understanding of the relationship between their behavior and their health, but a very limited understanding of how to eat healthily [11]. Thus, adolescence is a critical developmental phase for obesity prevention programs.

Prevention is advocated widely as an important strategy to address the rising prevalence of obesity in adolescents [10,12,13], as once youth become obese, treatment is difficult [14]. School-based Internet obesity prevention programs hold great promise in reaching adolescents at risk for obesity as well as engaging adolescents in learning strategies to improve health behaviors [15,16]. Adolescents spend 6 to 8 hours at school each day for the majority of the year and have one to two meals at school daily. Schools have an existing infrastructure to integrate obesity prevention education into the curriculum [17]. Thus, schools provide an attractive and natural setting to implement Internet-based obesity prevention programs. The Internet provides a highly interactive interface supportive of diverse media and allows for interaction with peers as well as health professionals. Other benefits to the use of the Internet for obesity prevention programs include the capability to standardize content, provide immediate and tailored feedback, and allow students to progress at their own pace [16]. Adolescents are very technologically savvy, with more than 93 percent actively using the Internet [18]. Thus, adolescence may represent a developmental stage in which individuals are particularly receptive to obesity prevention programs delivered on the Internet.

School-based Internet obesity prevention programs for youth have been developed and evaluated. Adolescents have demonstrated significant improvements in dietary behaviors [19-23], physical activity [19,21-23], and body mass index (BMI) [19] after participating in such programs, thus demonstrating the promise of this approach. However, programs have been heterogeneous with respect to type of media used, intervention components, quality, length of program, and outcomes. A synthesis of the evidence is needed to guide future school-based obesity prevention program development, dissemination, and research. Several reviews of Internet obesity prevention programs have been completed; however, these reviews included programs that were provided in different settings (e.g., school, camp, home) with both children and adolescents and evaluated obesity prevention and treatment [15,16]. There has not been any published synthesis of the evidence on school-based Internet obesity prevention programs for adolescents. The purpose of this systematic review is to describe, synthesize, and evaluate the research on school-based Internet obesity prevention programs for adolescents. This includes sample characteristics, geographical location, program framework and content, number of sessions,

attendance, attrition, BMI, and behavioral outcomes.

METHOD

We performed this systematic review on school-based obesity prevention Internet programs for adolescents in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement [24]. Relevant studies were located through a computer-assisted search using the keywords *adolescent, obesity/prevention, school/school-based, computer-based intervention*, and *Internet/technology/media* in the Medline, CINAHL, and PsycInfo databases. The search process was iterative; as studies met the inclusion criteria were located, additional searches were conducted using keywords of these articles, and related articles were reviewed. Reference lists of systematic reviews and reports were also reviewed for relevant studies. Due to a lack of translation resources, all searches were limited to English-language publications. The search was also limited to articles published between January 1995 and August 2012, as during the mid-1990s, the Internet gained widespread availability and accessibility. Articles were included if they reported an empirical study of a school-based obesity prevention program for adolescents, evaluated BMI, nutrition behavior, or physical activity behavior, and had a comparison group. Reports were excluded if they included samples of youth younger than middle school age and if they targeted obesity treatment.

The initial search yielded 91 reports. RW independently reviewed all titles/abstracts for eligibility. A total of 12 studies met the inclusion criteria and were included in this review. Reasons for elimination included that the study was not testing a school-based obesity prevention program, the age of sample was too young, the program focused on obesity treatment, or the report described program development but not evaluation.

Data were extracted from reports on the sample characteristics, geographical location, the program framework and content, the number of sessions, attendance, attrition, and outcomes on a form developed for this review. Data display matrices were created in order to compare and contrast results of reports [25]. The matrices and the original reports were iteratively reviewed to synthesize results.

Two authors (AC and RP) evaluated risk of bias for each study using the Cochrane Collaboration's Risk of Bias Tool [26]. Data were extracted from each study pertaining to the risk of bias domains of sequence generation; allocation concealment; blinding of participants, personnel, and outcome assessors; incomplete outcome data; selective outcome reporting; and other sources of bias. Following extraction of the quality data, the Cochrane guidelines were used to assign the domains within each study as high, low, or unclear. RW reviewed all results, and all disagreements were discussed until consensus was reached. Lastly, the authors evaluated the quality of the body of evidence using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach [27].

RESULTS

Of the 12 studies included in this review, five compared a school-based Internet obesity prevention program to a no-treatment control group, three studies compared an Internet program to traditional classroom education, two studies compared an Internet program to a print program, and two compared two different Internet programs (Table 1). Sample sizes in the studies ranged from 103 to 1,800 participants. Two programs targeted girls [23,28], while the rest included 46 percent to 62 percent female participants. The age range of participants was 12 to 18 years, with a mean age of 14.7 years, for studies that reported sample age. Race/ethnicity of participants was reported with a range of 28 percent to 87 percent of nonwhite participants.

Theory

All Internet programs were developed from a theoretical perspective, with six

Table 1. Description and outcomes of school-based Internet obesity prevention studies [19-23,28-35].

	Sample Characteristics	Program Description	Implementation	Outcome: BMI	Outcome: Self-efficacy	Outcome: Dietary Behavior	Outcome: Physical Activity (PA)
School-based Internet program compared to standard care (no treatment control group)							
Ezendam et al., 2007, 2012	n=883 (Netherlands); Age: 12-13 years; Non-western: 28%; Female: 46%	Framework: Theory of Planned Behavior; Principles: Education, tailored feedback, goal setting, action plan; Content: PA (PA and sedentary behavior) and Nutrition (sugar, snacking, fruits and vegetables); Dose: 8 modules over 10 weeks	Follow-up: 4 months & 2 years; Attrition: 13.5% -	No effect		Decrease in sugar beverage, snacking Increase in vegetable intake; High risk students increase in fruit intake	Decrease in PA at 4 months; High risk students increase in PA at 2 years
Frenn et al., 2005	n=103 (US, Midwest); Age: 12-14 years; Non-white: 87%; Female: 70%	Framework: Health promotion and Transtheoretical Model; Principles: Education and content based on stage of change; Content: PA (PA and sedentary behavior) and Nutrition (decrease fat, increase healthy snacking, eat food during day); Dose: 8 modules				Decrease in fat intake for students who completed more than 50% modules	Increase in PA for students who completed more than 50% modules
Haerens, De Bourdeaudhuij et al., 2007	n=281 (Belgium); Age: 11-15 years; Female: 52%	Framework: Transtheoretical Model; Principles: Assessment and tailored advice; Content: PA; Dose: 1 module (50 minutes)	Follow-up: 3 months				No effect on PA or leisure time sports; Increase in school PA
Haerens, Deforche et al., 2007	n=304 (Belgium); Age (mean): 13.2 years	Framework: Transtheoretical Model; Principles: Assessment and tailored advice; Content: Nutrition (fat intake); Dose: 1 module (50 minutes)	Follow-up: 3 months			No effect on fat intake of total sample; Decrease in fat intake girls at technical school and boys and girls of general education	
Mauriello et al., 2010	n=1800 (US, New England, Tennessee); Age: 9th – 11th grade; Female: 51%	Framework: Transtheoretical Model; Principles: Assessment and tailored feedback; Content: PA (PA and sedentary behavior) and Nutrition (fruits and vegetables); Dose: 1 module	Follow-up: 12 months			Increase in fruit and vegetable intake at 2, 6, 12 months	Increase in PA at 2 month; No effect on sedentary behavior (TV)

Table 1. Description and outcomes of school-based Internet obesity prevention studies [19-23,28-35] cont.

	Sample Characteristics	Program Description	Implementation	Outcome: BMI	Outcome: Self-efficacy	Outcome: Dietary Behavior	Outcome: Physical Activity (PA)
School-based Internet program compared to print program							
Marks et al., 2006	n=359 (US, North Carolina); Age: 12.2 years; Non-white: 62%	Framework: Social Cognitive Theory and Theory of Reasoned Action; Principles: Not specified; Content: PA; Dose: 1 module, reviewed 4 times over 2 weeks	Follow-up: 2 weeks; Attrition: 11%; Web usage was 89 minutes (SD 65); Print usage was 95 minutes (SD 66)		Increase in self efficacy in both groups		Increase in PA in both groups, greater in print program compared to Internet
Robbins et al., 2006	n= 77 (US Midwest); Age: 11-14 years; Non-white: 67%; Female: 100%	Framework: Health Promotion and Transtheoretical Model; Principles: Tailored feedback reinforced with brief counseling by nurse practitioner; Content: PA; Dose: Not specified	Follow-up: 3 months; Attrition: 0%				Increase in PA in both groups
School-based Internet program compared to traditional classroom education							
Casazza et al., 2007	n= 311; Age: 13-18 years; Non-white: 85%; Female: 51%	Framework: Cognitive, affective and behavioral approach; Principles: Education, goal setting, skill building, incentives; Content: Nutrition and PA; Dose: Not specified	Follow-up: 3 months; Attrition: 12%	Decrease in BMI in Internet program	Increase in CDI in Internet program	Decrease in meals skipped in Internet program; Decrease in calories in both programs	Increase in PA in Internet program
Long & Stevens, 2004	n= 121; Age: 12-16 years; Non-white: 54%; Female: 52%	Framework: Social Cognitive Theory; Principles: Not specified; Content: Nutrition ; Dose: 3 modules (5 hours)	Follow-up: 1 month	Increase in BMI both programs	Increase in self efficacy for fat and usual choices in Internet program	Increase in fruit and vegetable intake, decrease in fat intake both programs	

Table 1. Description and outcomes of school-based Internet obesity prevention studies [19-23,28-35] cont.

	Sample Characteristics	Program Description	Implementation	Outcome: BMI	Outcome: Self-efficacy	Outcome: Dietary Behavior	Outcome: Physical Activity (PA)
School-based Internet program compared to print program							
Winett et al., 1999	n= 180; Age: 9th - 10th grade; Female: 100%	Framework: Social Cognitive Theory; Principles: Assessments, prescriptive strategies, personalized goals and feedback; Content: PA and Nutrition (regular meals, increase fruits, vegetables, and fiber, decrease sugar and soda); Dose: 5 modules	Follow-up: after completion of modules			Decrease in fast food in Internet program; Increase in regular meals, fruits, vegetables, and fiber and decrease in soda both programs	Increase in PA in Internet program
Two different school-based Internet programs							
Haerens et al., 2009	n= 1171 (Belgium); Age:14.6 years	Framework: Transtheoretical Model; Principles: Interactive assessment and tailored advice; Content: PA; Dose: 1 module (50 minutes); Control Group: Internet non-tailored advice	Follow-up: 3 month				No difference between programs
Whitttemore et al., (In press)	n=384 (US, Northeast); Age: 14-17 years; Non-white: 65%; Female: 62%	Framework: Social Cognitive Theory; Principles: Interactive education, behavioral support (e.g., goal setting), coping skills training; Content: PA (PA and sedentary behavior) and Nutrition (Sugar beverages, fruits and vegetables, breakfast, fast food); Dose: 12 modules; Control group: Interactive education and behavioral support	Follow-up: 6 months; Attrition: 3%	No effect	No difference between programs; Increase in self efficacy both programs	No difference between programs; Increase in fruit and vegetable intake, healthy eating and decrease in sugar beverages and junk food both programs	Increase in PA both programs; No difference between programs; Increase in PA and decrease in sedentary behavior both programs

based on the Transtheoretical Model [21,22,28-31], four based on Social Cognitive Theory [23,32-34], two with a Health Promotion Model [21,28], two based on Models of Behavior Change [19,34], and one based on the Theory of Planned Behavior [20,35]. The major premise underlying the Transtheoretical Model of behavioral change is that an individual progresses through six stages of change when establishing healthy behaviors: precontemplation, contemplation, preparation, action, maintenance, and termination [36]. The Social Cognitive Theory posits that individuals learn by observing others in the context of behavioral, personal, and environmental determinants [37]. The Health Promotion Model classifies health behavior determinants into individual characteristics and experiences (i.e., prior related behaviors and personal factors) and behavior-specific cognitions and effect (i.e., perceived benefits and barriers, interpersonal influences, and situational influences) [38]. Models of Behavior Change identify the cognitive (i.e., education), affective, (i.e., attitudes), and behavioral (i.e., goal setting, self-monitoring) strategies needed to promote dietary and physical activity change [39,40]. The Theory of Planned Behavior is based on the assumption that intentions motivate behavior. Intentions are influenced by attitudes toward behaviors, subjective norms, and perceived behavioral control [41]. Variation in content and implementation as well as lack of details on how the theory informed the program content precludes the ability to compare programs of differing theoretical perspectives.

Content

Content on both nutrition and physical activity was included in six programs [19,21-23,34,35]; content on physical activity was included in only four programs [28-30,33]; and content on nutrition was included in only two [31,32]. In one study, an Internet program was supplemented with brief counseling by a nurse practitioner [28]. The content on physical activity in programs included the promotion of exercise and/or physical activity (n = 6) and decreasing sedentary behavior (n= 4). With respect to nutrition content, the behaviors targeted included decreasing sugar-sweetened beverages (n = 2), sugar (n = 2), fat (n = 3), and fast-food intake (n = 1) and increasing fruit, vegetables, and fiber (n = 4). A few reports also mentioned targeting eating breakfast or eating regularly throughout the day (n = 3). In general, details on program content were lacking in all study reports.

Implementation Process

Little information on the implementation process was provided. Nine reports included data on the number of modules in the Internet program, which ranged from 1 to 12 modules. Five programs had one module [22,29-31,33], one program had five modules [23], two had eight modules [21,35], and one had 8 to 12 modules [34]. The amount of time students spent on the modules was rarely provided (n = 4), nor were data on how many modules students completed or the time frame for their completion (i.e., once per week over 8 weeks). There was one study that demonstrated significant improvements in fat intake and physical activity behavior for students who completed more than 50 percent of the eight modules [21]. Attrition across studies was low, ranging from 0 percent to 14 percent; however, these data were not provided in most of the reports (n = 7). Lastly, follow-up for program efficacy was short, with the majority of studies (n = 8) at 3 months or less.

Efficacy of Programs

Outcomes

Overall, school-based Internet obesity prevention programs were effective in improving health behaviors of adolescents in the short term (< 3-6 months). Across all studies, researchers used self-report measures to assess health behaviors. Improvement in dietary behavior and/or physical activity, regardless of theoretical perspective, content, or number of modules was reported for the majority of programs (n = 10). Improvements in adolescents' self-efficacy for healthy eating or being physically active were reported in programs that targeted self-

efficacy (n = 3). There were four studies in which the program's effect on BMI was evaluated. In only one study, based on Models of Behavior Change, there was a significant decrease in BMI over time [19]. One program resulted in an increase in BMI over time [32], and in the other two programs that evaluated BMI, no effect on BMI was found [20,34].

Comparison to standard care

Comparison groups in these studies included standard care, traditional classroom education, print materials, and an alternate Internet program (Table 1). In five studies, an Internet obesity prevention program was compared to standard care; however, standard care condition was not described in any report (Table 1). Of these five studies, three demonstrated a positive effect of the Internet program on healthy eating behaviors, improving fruit intake [20], vegetable intake [20,22], decreasing sugar intake [20], and decreasing fat intake [21] compared to the standard care group. Two programs resulted in a significant increase in physical activity in the short-term compared to the standard care group [21,22]; however, one program resulted in a decrease in physical activity [20]. No significant improvement was shown in health behaviors in two studies that compared the Internet program with a control group [29,31]. Both of these programs were developed in Belgium by the same research team based on the Transtheoretical Model, with one program targeting nutrition and the other targeting physical activity. Both of these programs consisted of only one module.

Comparison to traditional education

An Internet obesity prevention program was compared to traditional classroom education in three studies (Table 1). The outcomes of these studies demonstrated that Internet and traditional classroom education on obesity prevention improve health behaviors in the short term. In two of the three studies, the Internet obesity prevention program had a greater effect on select health behaviors compared to traditional education, including an increase in physical activity [19,23] and a decrease in BMI compared to traditional education [19]. Outcomes of one study indicated that students who participated in the Internet program preferred Internet education over traditional classroom education [19].

Comparison to print

An Internet obesity prevention program targeting physical activity was compared to a similar print obesity prevention program in two studies (Table 1). In both studies, students improved physical activity behavior regardless of program; however, in one study, students of the print program demonstrated greater improvements in physical activity compared to the Internet program [33].

Comparison to alternate Internet programs

There were two studies that compared two different Internet obesity prevention programs (Table 1). An interactive Internet program with tailored advice was compared to a similar interactive Internet program without tailored advice in one study, with no difference demonstrated between programs [30]. In the other study, an Internet program with interactive education and behavioral support was compared to an Internet program with interactive education, behavioral support, and the addition of coping skills training. In this study, students of both programs improved health behaviors; however, there was no difference between programs on any of the outcome measures [34].

Risk of Bias

According to the Cochrane methodology, we assessed studies for risk of bias and the overall body of literature to generate a quality GRADE (Table 2). Of the 12 studies included, only four authors reported using adequate random sequence generation and only one author reported using adequate allocation concealment. Due to the design of Internet-based behavioral interventions, there was a high risk of performance bias due to inadequate blinding. All studies had a low risk for detection bias. Three studies had a low risk of attrition bias, while six studies had a high risk of bias. Study protocols were

Table 2. Risk of bias assessment.

	Selection						
	Random sequence generation	Allocation concealment	Performance	Detection	Attrition	Reporting	Other
Casazza et al., 2007	?	?	--	+	+	+	--
Ezendam et al., 2007, 2012	+	?	--	+	--	+	+
Frenn et al., 2005	?	?	--	+	--	+	--
Haerens, De Bourdeaudhuij et al., 2007	?	?	--	+	--	+	--
Haerens et al., 2009	?	?	--	+	--	+	--
Haerens, Deforche, et al., 2007	?	?	--	+	--	+	+
Long & Stevens, 2004	--	?	--	+	?	+	+
Marks et al., 2006	+	?	--	+	--	+	+
Mauriello et al., 2010	--	?	--	+	?	+	--
Robbins et al., 2006	+	+	--	+	+	+	+
Whittemore et al., (In press)	+	?	--	+	+	+	+
Winett et al., 1999	--	?	--	+	?	+	--

+ = low risk of bias; -- = high risk of bias; ? = unclear risk of bias

not obtained for review, but it appears that all studies reported expected outcomes. Most studies received a high or unclear risk of bias in at least two domains. As a result, the body of evidence in this review was assigned a GRADE of moderate.

DISCUSSION

This review suggests that school-based Internet obesity prevention programs are effective in improving health behaviors in the short term. Overall, 10 of the 12 programs resulted in positive obesity-related outcomes in the Internet group over time; however, only seven of the 12 programs demonstrated positive outcomes in the Internet group compared to the control group. Studies that did not result in a differential effect compared the Internet program to standard care (n = 2), to a print program (n = 1), or to an alternate Internet program (n = 2). Three of the studies that did not demonstrate a positive effect of the Internet program compared

to a control or comparison group consisted of only one module; thus, it appears that very brief Internet programs are not effective in changing health behaviors in adolescents.

The school-based Internet obesity prevention programs reached diverse adolescents at risk for overweight and obesity. Seven of the 12 reports provided data on race/ethnicity, with an overall average of 64 percent non-white participants. This is important as youth of diverse race/ethnicity have an increased risk for overweight and obesity [42,43]. The use of a high school setting allowed for the programs to reach a relatively large number of adolescents. Attrition data were provided in only five reports, but in those studies, attrition was low (7.9 percent). This provides further evidence that schools represent an excellent setting to provide an obesity prevention program for adolescents at risk for being overweight or obesity. Nonetheless, it is important to consider whether the nature of the school setting actually encourages full participation leading to behavioral change or rote learning.

School-based Internet obesity prevention programs appeared to be superior to standard care and traditional classroom education. However, the efficacy of school-based Internet obesity prevention programs compared to print-based programs has not been established. Further research is needed to compare Internet and print programs that include more modules and are of longer duration. With respect to the comparison of different Internet obesity prevention programs, a tailored Internet program was not more effective than a non-tailored Internet program. This program consisted of only one module and thus may need further research to determine the effect of tailoring advice with a program that includes more modules. Lastly, an Internet education, behavioral, and coping skills training program was not more effective than an Internet education and behavioral program. While this program was of longer duration and included 12 modules, it may be that the 6-month length of follow-up was insufficient to evaluate the effect of coping skills, which take time for adolescents to develop.

Studies included in this review had an unclear or high risk of bias, and the quality of the body of evidence is moderate. Though studies had a low risk of detection and reporting bias, study outcomes may have been influenced by performance and attrition bias. Very few reports included sufficient detail about random sequence generation, allocation concealment, and the content and components of programs. Clear information about random sequence generation, allocation concealment, blinding of participants, personnel and outcomes, pre-specified outcomes, and attrition is necessary in future research in order to accurately evaluate risk of bias and quality of evidence [26,27]. Recently, a CONSORT e-Health checklist has been published that identifies important data to report in e-Health clinical trials [44].

Poorly described interventions contribute to challenges in the interpretation of results and hinder further research and dissemination [45]. The way in which the theoretical framework was operationalized in the program was included in only two reports [34,46]. Thus, more consistent reporting of the content and components of Internet programs is needed to advance the field. Elements of an intervention that should also be described in a research report include theory, intervention recipient, interventionist, intervention content, and intervention delivery (including quantity, frequency, and duration) [47].

Description of the interactivity capability of the Internet incorporated in the program was provided in only a few reports. Only one report included information on the interactivity in the program [34]. It appears that the majority of programs provided tailored responses or advice based on a self-assessment of the student. In one study, only 50 percent of students reported that they read the tailored advice to promote physical activity, stating that the advice was too long [29]. This comment implies that the information was not presented in an engaging and interactive format. The Internet allows for a highly interactive interface, allowing

content to be brief and highly tailored to the user response. It also allows users to record behaviors over time and visualize patterns (self-monitoring), set goals and follow progress toward goal completion, and communicate with other users as well as a health coach. Further research on programs that include such interactivity and the use of innovative technologies (e.g., social networking, smartphones) are needed.

There was also insufficient information on the process of implementation in the reports. While the use of the Internet allows for standardization of the content, schools represent a complex environment with many factors affecting program implementation [48,49]. Classroom technology, firewalls, and access to computers may affect implementation. Teachers' perceptions about the program, involvement with the program, and ability to provide student support may also influence implementation. At a minimum, student completion of modules or other key theoretical components of the program need to be evaluated and reported. Health-related Internet interventions for youth have been shown to have decreasing participation over time as well as a correlation between participation and outcomes [50]. In one study in this review, a positive effect was shown on outcomes in students who completed more than 50 percent of the program (four of eight modules) [21]. A taxonomy for delivery characteristics of interventions has been developed that identifies the need to specify the mode, materials, location, schedule, scripting, tailoring, and adaptability of interventions [51]. Systematic evaluation of program implementation is critical in future research on school-based Internet programs to determine optimal composition and implementation.

The majority of school-based obesity prevention programs for adolescents that have been developed and evaluated have been brief. Nine of the reports included information on the number of modules or sessions, but five of them included only one module. Thus, it is not surprising that the effect on behavior change was modest at best. The literature on behavior change and weight loss has suggested that programs have content and behavioral support provided over approximately 4 months, supplemented with a maintenance component for approximately 1 year [52,53]. Future research is needed to evaluate programs of longer duration, optimal dose and timing of programs, long-term follow-up, and cost-effectiveness. While potential cost-effectiveness has been cited as an advantage to Internet interventions [15], Internet programs are costly to develop, and there has not been any research on the cost effectiveness of health-related Internet interventions for children or adolescents to date.

Lastly, the effect of programs on weight status and BMI was not reported in many studies. In studies where researchers did report BMI (n = 4), only one demonstrated a significant decrease in BMI [19], and one demonstrated a significant increase in BMI [32]. This result may be partially explained by the challenges of evaluating BMI in programs of short duration, which may not allow for consideration of normal growth and development in youth, particularly if the sample was predominately of normal weight at baseline. More intensive or multi-level programs may also be needed to have an effect on adolescent weight and BMI. One advantage of a school-based Internet obesity prevention program is the capability of the program to be a stand-alone program or an adjunct to a multi-level program that may include parental, school, or community components [15].

The majority of the authors did not examine moderators or mediators of outcomes. This finding may be related in part to the fact that positive outcomes were modest and focused on health behavior change, which has the potential to mediate effects on weight and BMI. It is critical to examine primary outcomes and their moderators, as well as the mediation effect of health behavior change, to be able to link the aspects of the programs with behavior changes leading to specific outcomes. Only then will investigators and clinicians be able to design effective programs that lead to sustainable positive health outcomes.

CONCLUSION

School-based Internet obesity prevention programs have been successful in reaching high risk students and changing behaviors in the short-term, but incomplete reporting, brief duration of follow-up, and a high risk of bias make it difficult to assess the true success of these programs. Further research that follows students for periods greater than 6 months and assess key anthropomorphic measures (e.g., BMI, waist circumference, and percent body fat) are needed to determine the true impact of Internet-based obesity prevention programs in school settings. Additionally, improved reporting of study design including intervention protocol, implementation process and actual dosage of intervention are required to not only accurately assess the efficacy of programs but to allow researchers to tailor, adapt and build on existing effective programs, and improve the evidence base for future research and program development.

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