Electronic Media–Based Health Interventions Promoting Behavior Change in Youth

A Systematic Review

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Importance: Little research has been done on the efficacy of electronic media–based interventions, especially on their effect on health or safety behavior. The current review systematically identified and evaluated electronic media–based interventions that focused on promoting health and safety behavior change in youth.

Objective: To assess the type and quality of the studies evaluating the effects of electronic media–based interventions on health and safety behavior change.

Evidence Review: Studies were identified from searches in MEDLINE (1950 through September 2010) and PsycINFO (1967 through September 2010). The review included published studies of interventions that used electronic media and focused on changes in behavior related to health or safety in children aged 18 years or younger.

Findings: Nineteen studies met the criteria and focused on at least 1 behavior change outcome. The focus was interventions related to physical activity and/or nutrition in 7 studies, on asthma in 6, safety behaviors in 3, sexual risk behaviors in 2, and diabetes mellitus in 1. Seventeen studies reported at least 1 statistically significant effect on behavior change outcomes, including an increase in fruit, juice, or vegetable consumption; an increase in physical activity; improved asthma self-management; acquisition of street and fire safety skills; and sexual abstinence. Only 5 of the 19 studies were rated as excellent.

Conclusions and Relevance: Our systematic review suggests that interventions using electronic media can improve health and safety behaviors in young persons, but there is a need for higher-quality, rigorous interventions that promote behavior change.

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More established forms of electronic media, such as television and radio, have been shown to encourage behavior change. Previous studies have demonstrated that their use can increase physical activity[1] and reduce disruptive behavioral problems.[2] However, other types of media, such as computer or video games, may be more effective in producing behavior change because they encourage active engagement and processing of information from the child. On any given day, 60% of young persons play video games, including 47% who play on a handheld player or a cell phone and 39% who play on a console player. Moreover, 99% of teenage boys and 94% of teenage girls play video games.[3] Given their widespread use and interactive capabilities, computer and video games are an increasingly popular type of electronic media used in health interventions and have been a successful tool for health promotion and management of chronic medical conditions in children and adolescents.[4,5] Although they did not meet the strict criteria for the present review, 2 articles[6,7] describe how video game interventions target smoking cessation and asthma in adolescents.

Electronic media–based interventions lend themselves to experiential learning and, when created according to established health promotion and instructional design principles, offer distinct advantages over conventional methods of health education.[4] Because of their repetitive nature, these interventions can better expose individuals to educational content and reinforce learning. Furthermore, electronic media–based interventions can be personalized through the creation of avatars and virtual identities. Finally, these interventions have interactive capability that can provide immediate feedback and increase player engagement. Accordingly, they may be an ideal platform for

improving health outcomes for adolescents. However, little research has been done on the efficacy of electronic media–based interventions, especially on their effect on health or safety behavior.

The aim of this study is to systematically review the literature to identify and evaluate electronic media–based interventions focused on promoting health and safety behavior change in youth. Although several recent systematic reviews[8-10] have been conducted to evaluate the effectiveness of electronic media–based interventions on health outcomes, these reviews were limited to video games as the only form of intervention[11,12] or to only a single specific health outcome. In addition, many reviews did not include safety behavior outcomes,[8-10,12,13] or youth populations.[8] The present review expands on previous reviews by including studies that specifically focus on youth, use electronic media–based interventions as part of the study, and examine both health and safety behavior outcomes.

METHODS

SEARCH STRATEGIES

On September 29, 2010, we searched the electronic databases MEDLINE (from 1950 through September 2010) and PsycINFO (from 1967 through September 2010) for published studies. Keywords used to locate the studies included the specific medical subject headings, terms, and text words used in MEDLINE and PsycINFO (**Table 1**) to describe concepts of multimedia/games and health behavior. We used the search terms included in the domains of health behavior, multimedia/games, and children. Our search was limited to the English language, randomized clinical trials, and children aged 18 years or younger.

Table 1. Specific Controlled Vocabulary Terms and Text Words Used in MEDLINE and PsycINFO to Describe Concepts of Multimedia/Games and Health Behavior

Concept	Terms	Text Words
	MEDLINE	
Multimedia/games	*Video games*	Video game$, multimedia game$, computer game$, interactive game$, educational game$, health game$, online game$, learning game$, exergame, interactive computer, interactive game
Health behavior	*Risk reduction behavior, health promotion, health behavior, health education, consumer health information, patient education as topic, sex education*	Risk$ reduction, risk$ behavior, risk$ prevent$, health promot$ behavior
	PsycINFO	
Multimedia/games	*Simulation games, role-playing games, computer simulation, computer games*	Video game$, multimedia game$, computer game$, interactive game$, educational game$, health game$, online game$, learning game$, exergame, interactive computer, interactive game
Health behavior	*Health behavior, health promotion, behavior change, health education, risk taking*	Health promot$, health behavior, risk$ reduction, risk$ behavior, risk prevent$

INCLUSION CRITERIA

Published studies were included if they met all of the following 5 criteria: (1) English language; (2) human subjects; (3) youth sample (≤18 years old for MEDLINE and ≤17 years old for PsycINFO); (4) focus on health behavior change, safety, or education; and (5) incorporation of an electronic media–based intervention.

Through an electronic review process, 4 reviewers (K.H., E.J.E., D.R.C., and L.E.F.) independently applied these criteria to all abstracts. If it was not clear from the abstract alone whether the study met inclusion criteria, the full article was reviewed by the team. Selected bibliographies were reviewed for additional articles. To assess reviewer agreement with the abstract review process, each author independently conducted a 10% random review of the abstracts (n = 41). This determined a simple κ statistic of 0.66, indicating fair to good agreement between reviewers.[14] In addition to this κ score, in cases of disagreement, the reviewers opted to examine the full articles, reaching 100% consensus on whether an article should be included in the overall review.

DATA EXTRACTION

We piloted and revised extraction forms as a group before applying them to extract data from all publications. The following data were extracted by the 4 reviewers: target health condition, target health change, type of electronic media, demographics, treatment setting, length of follow-up, and descriptions of interventions and outcomes. When reported, quantitative data were extracted, including appropriate statistical test results for outcomes. We defined electronic media as interactive content accessed electronically, including content in computer and video console games, video clips, CD-ROM, and the Internet. Data also included changes in behavior as they related to health or safety measures.

QUALITY OF EVIDENCE

We used the Jadad Scoring System, also known as the Oxford Quality Scoring System,[11] to evaluate the quality of each study. This 3-item instrument was developed specifically to assess the quality of randomized clinical trials and has been used in many studies.[12,13,15] Advantages of this scale include its ease of use, its established reliability and external validity, and its inclusion of many important elements that have been shown to correlate with bias.[7] Each researcher independently evaluated each study by allocating points for quality related to randomization, blinding, and inclusion of a description of participants who withdrew or dropped out of the study. Studies with a score of 0 through 2 were considered poor, and those with a score of more than 2 were considered excellent.

RESULTS

The search identified 516 abstracts. After exclusion of duplicates (n = 110), 406 abstracts remained. Fourteen additional articles were identified through review of bibli-

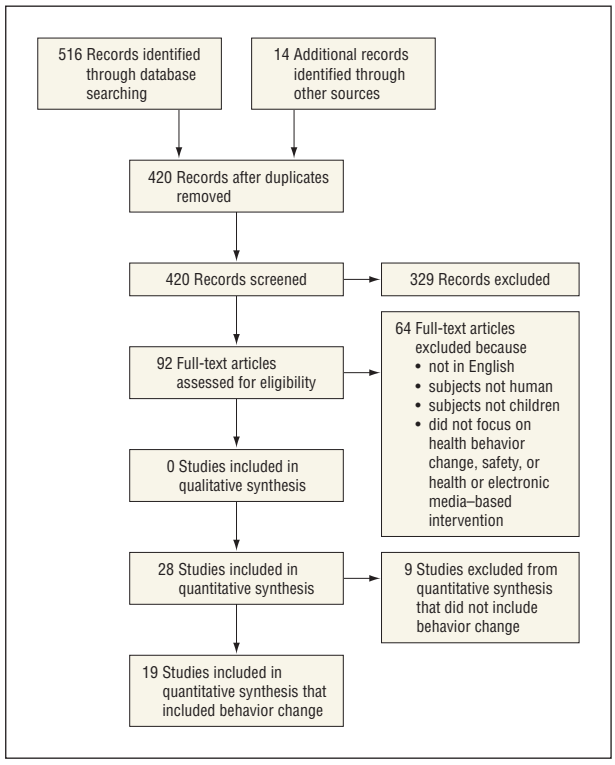

Figure. Flowchart documenting the article selection process.

ographies, for a total of 420 articles. Of the 420 abstracts, we excluded those for studies that were not in English (n = 15), had nonhuman subjects (n = 1) or subjects who were not children (n = 43), had no health or safety behavior change– or health education–targeted intervention (n = 309), or had an intervention that was not electronic media based (n = 25), for a total of 393 excluded abstracts.

Of the 28 remaining articles, 1 described 2 distinct studies[16] and 2 articles described the same study, resulting in the identification of 28 unique eligible studies (**Figure**). Because we were interested in studies that included actual behavior change outcomes, we restricted our analysis to studies that included at least 1 behavior change outcome, defined as an outcome that included an observable and measurable modification of an action by a person that promoted health or safety. Of the 28 eligible studies, 19 studies[17-35] included at least 1 health or safety behavior change outcome. The other 9 studies[16,36-42] included related outcomes that did not specifically involve changes in behavior, such as knowledge, self-efficacy, attitudes, and perception.

STUDIES WITH BEHAVIOR CHANGE OUTCOMES

The 19 studies that included a behavior change outcome varied substantially in target condition, study design, and outcome measures (**Table 2**). To maximize clarity, we organized our findings by health or safety condition. A complete table is available online (eTable; http://www.jamapeds.com). In summary, the studies included 7 (37%)[29-35] on interventions aimed to improve physical activity and/or nutrition, 6 (32%)[23-28] on asthma or lung function, 3 (16%)[20-22] on safety behaviors, 2 (11%)[18,19] on sexual risk behaviors, and 1 (5%)[17] on diabetes mellitus. The study setting was clinical in 7 studies, school in 7, home in 3, and other in 2. Seventeen studies (89%) reported the age range of subjects, from 3 years[23] to 18 years.[19,31,32] Two studies reported the mean age of subjects (12.5 years[33] and 13 years[18]) and stated that the subjects were middle school students. The studies ranged in size from 5 participants[20] to 1876 participants.[29] Eleven studies (58%)[20-23,25-29,34,35] used computer games or a simulator as the media structure for the intervention; 3 (16%),[17,24,31] console video games; 2 (11%),[30,32] an Internet-based program, game, or virtual reality world; 2 (11%),[19,33] video clips or an interactive video; and 1 (5%),[18] other computer-based elements. Follow-up durations ranged from 1 week[20,22] to 15.6 months.[28]

TARGET CONDITIONS

Nutrition and Physical Activity

Seven studies[29-35] reported behavior change outcomes related to nutrition and physical activity. Three (43%) of these studies used a computer-based game, and 1 (14%) each used a console video game, an Internet-based program, an Internet game, or integrated video clips. Five studies included a control group. Outcomes evaluating dietary intake included consumption of fruit, vegetables, 100% juice, dairy, sweets or sugars, carbohydrates, fat, protein, and fiber. Other outcomes related to nutrition included nutrition self-care practices and nutritional status. Two studies reported significant mean (SD) increases in fruit[34] and vegetable[29] consumption in experimental vs control subjects (fruit, 0.26 [0.05] [$P < .001$]; vegetables, 0.16 [0.05] [$P < .01$]; and fruits and vegetables, 80.4% vs 76.1% [$P = .05$]). One study[34] also found a statistically significant increase in 100% juice consumption in experimental compared with control subjects ($P < .05$). One study[33] reported an increase in daily consumption of dairy products ($P = .001$) and a decrease in daily consumption of sweets or sugars ($P < .001$). Another study[29] found significant mean differences in dietary intake between experimental and control groups, including more carbohydrate (46.4% vs 45.7%; $P < .05$), less fat (37.1% vs 37.6%; $P < .05$), less protein (16.5% vs 16.7%; $P < .05$), less saccharose (11.5% vs 12.2%; $P < .001$), more calcium (771 vs 731 mg; $P < .001$), and more fiber (12.6 vs 12.1 mg; $P < .05$) intake in the experimental group. One study[30] reported significant differences in nutrition self-care behaviors before and after the intervention ($P < .05$).

Outcomes related to physical activity included changes in sedentary behavior, physical activity, body mass index (BMI), and systolic blood pressure. Two studies found that experimental subjects increased their physical activity ($P < .001$[32] and $P = .011$[33]) and decreased their sedentary behaviors (television or DVD watching, $P = .024$[32]; computer use, $P = .002$[32]; and all sedentary behaviors, $P = .051$[33]). Finally, 1 study[35] reported a significant treatment effect for obesity reduction in girls (mean [SD] BMI, 0.69 [0.04] in the control vs 0.62 [0.04] in the interven-

Table 2. Summary of Studies Using Electronic Media for Health or Safety Behavior Change

Source (Quality Score)	Setting; No. of Subjects (Age, y)	Media Type	Research Design	Intervention	Control	Results and Conclusions[a]
Nutrition and Physical Activity						
Cullen et al,[34] 2005 (2)	School; 1578 (8-12)	Computer game	RCT-cluster design	Game play: Ten 25-min sessions for 5 wk	No game	Intervention group consumed more fruit, juice, and vegetables; fruit servings; 100% juice
Dunton et al,[33] 2009 (1)	School; 683 (mean, 12.5)	Video clips	Pilot with pretest and posttest comparison	Teacher-delivered curriculum with video clips for 8 sessions	NA	Intervention group had increased physical activity and daily dairy consumption; decreased television or DVD viewing, video game playing, non–school-related computer use, and intake of sweets or sugar
Goran and Reynolds,[35] 2005 (2)	School; 209 (8.8-11)	Computer game	RCT-cluster design	Game play and educational lessons for 8 wk	Educational CD-ROM	Intervention group had decreased body mass index in girls but not boys
Jago et al,[32] 2006 (2)	Boy Scouts; 473 (9-18)	Internet	RCT	Internet-based program twice weekly for 9 wk	Fruit and vegetable intervention	Intervention group had increased light physical activity and decreased sedentary behavior
Madsen et al,[31] 2007 (0)	Home; 30 (9-18)	Video game	Pilot with pretest and posttest comparison	Video game 30 min/d, 5 d/wk for 2 mo	NA	No significant changes in body mass index
Moore et al,[30] 2009 (0)	School; 126 (9-11)	Internet game	Quasi-experimental pilot with pretest and posttest comparison	Game play for 6 classes during 3-mo period	Didactic presentation of game	Intervention group had increased pregame and postgame measures of self-care behavior, physical activity, and mean systolic blood pressure
Turnin et al,[29] 2001 (1)	School; 1876 (7-12)	Computer game	RCT	Game play and nutritional teaching, 2 h/wk for 5 wk	Teaching only	Intervention group consumed more carbohydrates, less fat, less protein, less saccharose, more calcium, more fiber
Asthma or Lung Function						
Bartholomew et al,[28] 2000 (2)	Clinic; 133 (7-17)	Computer game	Randomized trial with pretest and posttest comparison	Game play at visits, 40 min	Usual care	Intervention group had lower posttest symptom scores, moderated by asthma severity
Huss et al,[27] 2003 (3)	Home; 148 (7-12)	Computer game	RCT	Game play and education	Education only	No statistically significant changes in asthma symptoms
McPherson et al,[26] 2006 (3)	Clinic; 101 (7-14)	Computer game	RCT	Game play and asthma booklet, 90 min	Asthma booklet only	Intervention group had less oral steroid use
Rubin et al,[25] 1986 (3)	Clinic; 65 (7-12)	Computer game	RCT	Game play, 45 min every 6 wk for 10 mo	Non–asthma-related computer game	Intervention group had higher asthma behavioral child assessment scores
Shames et al,[24] 2004 (2)	Home; 119 (5-12)	Console video game	RCT	Disease management program with video game	Usual care and commercial video game	No statistically significant changes in asthma symptoms or clinical outcomes
Vilozni et al,[23] 2001 (2)	School; 112 (3-6)	Computer game	RCT with crossover	Game play for 1 session of 5-10 min	Candle-blowing simulation	Successful spirometry in intervention group

(continued)

tion group), and 1 study[30] reported a significant mean effect for systolic blood pressure (before vs after the intervention, 113.9 vs 108.0 mm Hg) (Cohen $d = 0.578$; $P < .001$).

In the 4 studies that focused on increasing physical activity in youth, reducing sedentary behavior was discussed, including reducing activities involving electronic media, such as computer use and playing video games. The authors of 1 study,[31] which used an interactive dance video as its intervention to reduce BMI in youth, acknowledged that video games may also increase sedentary time. Although that study did not find an association between game play and BMI reduction, 2 others[32,33] reported a statistically significant reduction in sedentary behaviors (data not shown).

Asthma or Lung Function

Six studies[23-28] reported behavior change outcomes related to asthma or lung function. Five (83.3%) used a computer-based asthma game as part of the intervention, and 1 (16.7%) used a console video game. All 6 studies included a control group. Outcomes evaluated included asthma self-management skills, asthma symptoms, physician visits, hospital visits, oral steroid use, school absence, and spirometric performance. Two studies[25,28] reported significant increases in asthma self-management skills in the experimental group compared with the control group (mean [SD] for the intervention vs control groups, 64.1 [7.7] vs 57.8 [8.8]) ($P = .008$; effect size, 0.44). One study[28] found that experimental sub-

Table 2. Summary of Studies Using Electronic Media for Health or Safety Behavior Change (continued)

Source (Quality Score)	Setting; No. of Subjects (Age, y)	Media Type	Research Design	Intervention	Control	Results and Conclusions[a]
			Safety Behaviors			
Coles et al,[22] 2007 (1)	Clinic; 32 (4-10)	Computer game	Randomized pilot with pretest and posttest comparison	Game play until mastery of skills (<30 min)	NA	No statistically significant differences associated with fire and street safety game play
Fisher et al,[21] 2002 (0)	Drivers' education course; 45 (16-17)	Computer simulator program	Controlled study	Computer-based training and driving simulator, 90-min session	No training	Intervention group successfully applied the brakes in simulator
Padgett et al,[20] 2006 (0)	Clinic; 5 (5-7)	Computer game	Pilot with pretest and posttest comparison	Game play until mastery of skills	NA	No statistically significant changes associated with fire safety game play
			Sexual Risk Behaviors			
Downs et al,[19] 2004 (3)	Clinic or hospital; 300 (14-18)	Interactive video	RCT	Interactive video, 30-min session	Content-matched book or brochure	Intervention group reported more complete sexual abstinence, fewer condom failures, or fewer sexually transmitted infections
Tortolero et al,[18] 2010 (3)	School; 907 (mean, 13)	Computer-based program	RCT	Computer-based activities, twelve 45-min lessons; 6 homework activities	Regular health classes	Intervention group less likely to have had oral, vaginal, or anal sex by the ninth grade
			Diabetes Mellitus			
Brown et al,[17] 1997 (1)	Clinic; 59 (8-16)	Console video game	RCT	Game play at home, (unrestricted game play)	Non–health-related game	No statistically significant differences in diabetes outcomes

Abbreviations: NA, not applicable; RCT, randomized clinical trial.
[a] Only statistically significant ($P < .05$) and medium to large effects are reported.

jects, compared with the control group, had lower asthma symptom scores after the intervention ($t_{116} = -1.96$; $P = .02$), a significantly lower clinical appointment return rate ($P = .04$), and fewer hospitalizations in children younger than 12 years. One study[26] reported less use of oral steroids in the intervention group than in the control group (odds ratio [OR], 2.96 [95% CI, 1.014-8.612]; $P = .03$). Finally, 1 study[23] reported more successful spirometric performance in the experimental group than in the control group ($P = .002$).

Safety Behaviors

Three studies[20-22] examined behavior change outcomes related to safety behaviors. Two (66%) of them used a computer-based game about fire and/or street safety skills as part of the intervention, and 1 (33%) used a computer driving simulator program. One study included a control group.[21] Outcomes evaluated included street and fire safety behavior skills and driving performance on a computer simulator. One study[20] reported that all 5 children in the study reached 100% accuracy on completing each of the fire safety skills 1 week after playing the video game. Another study[22] reported that 87.5% and 81.3% of subjects performed 3 of 4 steps correctly immediately after the learning sessions on fire and street safety skills, respectively, compared with 81.3% and 75.1%, respectively, 1 week later. One study[21] found that computer-based training improved the driving skills of younger, inexperienced drivers.

Sexual Risk Behaviors

Two studies[18,19] reported behavior change outcomes related to sexual risk. One[19] used an interactive video about sexually transmitted infections (STIs) as part of the intervention and the other[18] used computer-based activities as part of a sexual risk reduction program. Both studies included a control group. Outcomes evaluated included sexual initiation, condom use, and STI acquisition. One study[19] found that experimental subjects were more likely to be completely abstinent from sexual activity from baseline to 3 months (OR, 2.50; $P = .027$). This study also found that subjects in the experimental group reported fewer condom failures than controls ($P = .02$) and were less likely to report STI diagnosis (OR, 2.79; $P = .05$). Another study[18] reported that subjects in the control group were more likely than those in the intervention group to have initiated oral, vaginal, or anal sex (29.9% vs 23.4%; adjusted relative risk [ARR], 1.29 [95% CI, 1.02-1.64]), oral sex (17.6% vs 10.0%; ARR, 1.76 [95% CI, 1.21-2.56]), or anal sex (9.9% vs 3.7%; ARR, 2.67 [95% CI, 1.45-4.94]) by the ninth grade.

Diabetes Mellitus

One study[17] reported behavior change outcomes related to diabetes using a console video game as the intervention and compared results in a control group. Although the results did not reach statistical significance, both self-efficacy ratings for diabetes self-care and urgent visits to

physicians for diabetes-related problems improved ($P = .08$). In addition, hemoglobin A_{1C} levels increased in both the experimental and control groups.

QUALITY OF EVIDENCE

Five of the 19 studies received a quality score of 3 of 5 possible points, indicating excellent quality.[18,19,25-27] The remaining 14 studies received a quality score ranging between 0 and 2, indicating poor quality. All 5 studies that received a score of 3 received 1 point each for describing the study as randomized and explaining how the randomization was done and 1 point for reporting subject withdrawals or dropouts. All 6 studies that received a score of 2 received 1 point for describing the study as randomized and 1 point for reporting withdrawals or dropouts. Of the 4 studies that received a score of 1, 3 received 1 point for describing the study as randomized and 1 received 1 point for reporting withdrawals or dropouts. Four studies received a score of 0. None of the studies described blinding. There was generally good agreement between researchers on quality score ranking. When there was not 100% agreement, differences between reviewers were resolved by consensus.

COMMENT

Our review revealed that electronic media interventions have been developed and examined for an array of conditions that are potentially highly relevant and important to the care of youth. Of the 19 studies included in the present review, 17 reported a statistically significant change in health or safety behavior. These results should be interpreted with caution, however, given that the quality assessment found most of these studies to be of poor quality. Of the 5 studies[18,19,25-27] of excellent quality, 4 of them[18,19,25,26] found statistically significant differences between the treatment and control groups. Although our review provides support for using electronic media to change behavior in youth, our quality assessments also indicate that there have been few scientifically rigorous evaluations of such interventions in this age group.

Although electronic media–based interventions can promote health and safety behaviors in youth, there may be some limitations in accessing these interventions outside school. Because youth from lower-income environments are slightly less likely than those from higher-income environments to go online or to report owning a computer,[43] they may have more limited access to Internet- and computer-based interventions. Video games, however, occupy a prominent position in American life that seems to cross demographic lines; 60% of blacks, 61% of whites, and 55% of Hispanics report interactive game playing.[44] Video game playing extends across economic lines as well and is reported by 58% of those with annual household incomes less than $35 000.[3]

Our review has several important limitations. The limited number of randomized clinical trials and heterogeneity of interventions, settings, and behavior change outcomes make it difficult to draw comprehensive conclusions. In our ability to determine the efficacy of the different interventions, we were also limited by the variable quality of the studies. The primary concerns about study quality centered around external validity, such as failure to describe randomization or report withdrawals and dropouts. Notably, none of the studies included in this review were blinded, which also reduced their quality rating. Finally, most of the data collected on behavior change outcomes is based on self-report by the study subjects.

In summary, our study highlights several key gaps in the existing literature. Given their potentially broad applicability, higher-quality evaluations of existing electronic media–based interventions are needed. Of the 5 studies that received an excellent quality rating, 4 studies[18,19,25,26] reported a statistically significant change in asthma- or sexual risk–related behavior. These studies provide excellent models of electronic media–based interventions that created behavior change in youth. Specifically, these interventions were associated with improvement in self-management and risk reduction behaviors in young adolescents, which may be the age group that is most amenable to adopting positive health and safety behaviors. We identified a paucity of studies focused on preventing unintentional injuries or promoting decreased alcohol and drug use among youth, despite the significant morbidity and mortality due to these causes in this demographic. Our review demonstrates a need to assess the effectiveness of electronic media–based interventions in different settings. Given the promise of these interventions for promoting improvements in health and safety behavior among youth in various settings, future research should focus on developing, rigorously evaluating, and implementing electronic media–based interventions.

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