

A Meta-analysis of Interventions That Target Children's Screen Time for Reduction

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KEY WORDS

obesity, television, mass media, intervention, meta-analysis, program

ABBREVIATIONS

SMD—standard mean difference

CI—confidence interval

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abstract

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BACKGROUND: Screen time, especially television viewing, is associated with risk of overweight and obesity in children. Although several interventions have been developed to reduce children's screen time, no systematic review of these interventions exists to date.

OBJECTIVE: This is a systematic review and meta-analysis of interventions targeting a reduction in children's screen time.

METHODS: Effect sizes and associated 95% confidence intervals (CIs) were calculated by using a random-effects model. Heterogeneity tests, moderator analyses, assessment of bias, and sensitivity analyses were conducted. Reliability was assessed with Cohen's κ .

RESULTS: The systematic search identified 3002 documents; 33 were eligible for inclusion, and 29 were included in analyses. Most reported preintervention and postintervention data and were published in peer-reviewed journals. Although heterogeneity was present, no moderators were identified. Overall Hedges g (-0.144 [95% CI: -0.217 to -0.072]) and standard mean difference (SMD) (-0.148 [95% CI: -0.224 to -0.071]) indicated that interventions were linked with small but statistically significant reductions in screen time in children. The results were robust; the failsafe N was large, and the funnel plot and trim-and-fill methods identified few missing studies.

CONCLUSIONS: Results show that interventions to reduce children's screen time have a small but statistically significant effect. As the evidence base expands, and the number of screen-time interventions increases, future research can expand on these findings by examining the clinical relevance and sustainability of effects, conducting a more thorough analysis of effect modifiers, and identifying critical components of effective interventions. *Pediatrics* 2011;128:e193–e210

Although the American Academy of Pediatrics recommends no more than 2 hours/day of screen time (watching television or videos/DVDs, playing video or computer games, and using a computer for purposes other than school work) for children aged 2 years old and older,^{1,2} 47% of children aged 2 to 15 years spend 2 or more hours/day using screen media.³ A recent study⁴ found that approximately two-thirds of a national sample of 3-year-old children watched ~3 hours/day of television and were exposed to more than 5 additional hours of indirect (ie, in the background) television daily. Contrary to the American Academy of Pediatrics recommendations, 33% of children aged 6 years and younger⁵ and 71% of children aged 8 to 18 years⁶ have televisions in their bedrooms, a characteristic associated with increased viewing.⁵⁻⁷

Time spent watching television is associated with a number of negative health behaviors and outcomes among children, including overweight,⁸⁻¹¹ irregular sleep,¹² insufficient consumption of fruits and vegetables,¹³ and disordered eating.^{14,15} Excessive television viewing has detrimental effects on prosocial behaviors, such as spending time with parents and siblings, doing homework, or engaging in creative play,¹⁶ and is linked with getting lower grades, getting into trouble, and feeling sadness and boredom.⁶ In addition, children who watch more television may be exposed to more content that negatively influences healthy behavior. In particular, television and video-game violence is associated with violence and aggression^{4,17} in thought and deed, and exposure to tragedies and disasters on television negatively impacts children's mental health.¹⁸

Before 1985, when Dietz and Gortmaker¹⁹ published their seminal article linking television viewing to obesity, the majority of the research on media effects on chil-

dren focused on the impact of television content or media policy on children's behavior.^{20-27, 28, 29-41} Recently, research has included developing and testing interventions that attempt to reduce children's screen time.⁴²⁻⁴⁷ Although meta-analysis has been used to study the relationship between media use and weight and physical activity,¹¹ to date no systematic review and meta-analysis of interventions to reduce children's screen time has been completed. In this article we present the results of a systematic review and meta-analysis conducted to identify and examine the effectiveness of interventions to change children's screen time. The broader behavior of screen time was selected because, although television use has remained relatively stable for more than 50 years,⁴⁸ total screen time has increased over the past 10 years,⁶ and the American Academy of Pediatrics recommends limiting children's total screen time.^{2,49}

METHODS

Study Identification

Studies were identified with a systematic search of research databases, review of the table of contents of journals not included in searchable databases, review of the reference lists of relevant publications, and a search of the National Institutes of Health's Computer Retrieval of Information on Scientific Projects (CRISP) funding database (currently "NIH RePORT").

Between November 24 and December 6, 2008, 8 databases available through the State University of New York at Albany Library were searched for the words "television," "media use," "recreational media," and "screen time," combined with "trial," "program," "intervention," and "experiment" (see Appendix 1 for a sample search strategy). Search results were limited to works published after 1985 (the year Dietz and Gortmaker¹⁹ described the associ-

ation between children's television viewing and weight). The Web-based Cochrane Library⁵⁰ and the Centre for Reviews and Dissemination⁵¹ databases also were searched using the terms listed above. The table of contents of 2 journals that have only recently been indexed in Medline, *Cyberpsychology and Behavior* and *Pediatric Exercise Science*, also were searched by accessing the journal's Web site.

The reference lists of the Cochrane Collaboration reviews of obesity interventions^{52,53} and articles selected for inclusion in the meta-analysis were reviewed for eligible references. In an attempt to minimize the impact of the file-drawer problem,⁵⁴ the Academy of Medicine's Gray Literature Report database; the National Institutes of Health's funding database, CRISP; and the Web site worldwidescience.org were searched. Researchers identified in the CRISP search were contacted and asked to provide information about their National Institutes of Health-funded project if they believed it met the meta-analysis inclusion criteria.

Identification of Eligible Studies

Articles identified by the systematic search were screened for eligibility using a 2-step process. First, references were identified as eligible for full review if the title or abstract-stated screen time was measured and targeted for change. If no abstract was available, the complete reference was reviewed. Second, articles eligible for full review were screened to determine eligibility for inclusion in the meta-analysis using the PICO (populations, interventions, comparisons, and outcomes) framework.⁵⁵ A study was eligible for inclusion if it met all of the following criteria: (1) described an intervention or program to change behavior in children between the ages of 0 and 18 years; (2) outlined the results

of an intervention to reduce screen time; (3) compared a nontreatment control, comparison group, or preintervention period with an intervention group or period; (4) included screen time (watching television or videos/DVDs, playing video or computer games, and using a computer for purposes other than school work alone or in combination) as an outcome variable; and (5) measured television viewing alone or with any combination of video viewing, computer time, or video-game use. Only articles published in English were eligible for inclusion in the meta-analysis.

Data Extraction and Coding

Information extracted from each article included sample characteristics (age, race/ethnicity, gender, and study location), intervention setting (home, school, or other), theoretical framework, intervention components (eg, goal setting, behavioral monitoring, and policy change), and behavior targeting (see Table 2). Study design information extracted included sampling and group-assignment procedures, timing of assessment, type of comparison group, and whether a validated instrument had been used to measure the outcome (see Table 3). An instrument was considered valid if the author stated that the instrument was validated or on the basis of a previously validated instrument. Whether the study targeted high-risk individuals also was recorded; studies targeting high-risk individuals only included participants with high BMI and/or excessive screen-time behavior. The sample size at group assignment and each assessment point and the number of subjects included in the analysis also were recorded. Finally, information about study outcomes, including means and associated SDs and mean change from baseline to posttest, were extracted for use in calculating effect sizes. Data were extracted using a

standard data extraction instrument developed specifically for this study. The instrument was based on the Community Guide methods and instrument,^{56–60} other review instruments,^{55,61–64} and accepted methodologies.^{65,66} A copy of the data collection tool and associated code book are available on request.

Statistical Analysis

Whenever possible, preintervention and postintervention means (SD) were used to calculate the study effect size. When unavailable, postintervention means (SD), mean change in each group, or adjusted differences after the intervention were used to calculate the study effect size. If an exact *P* value was not provided, a conservative approach of using an estimate closest to the significance level provided was used (eg, if *P* < .01 was provided, *P* = .009 was used to calculate the effect size).^{63,67}

Given that the intent of the meta-analysis was to determine the overall effectiveness of the interventions, a mean study effect size was calculated when multiple effect-size statistics could be calculated^{55,68} (for example, when data were presented from several subsamples within a study or when multiple screen-time measures were presented). When key information was missing from an article, as was the case in 19 of 31 eligible studies, 3 attempts were made to reach the corresponding author via e-mail before using the available data or eliminating the study from the analysis.

Because of the subjectivity and the difficulty with assessing the overall quality of each study (because of insufficient information), a single index of study quality was not included in the analyses. Instead, study characteristics that are reflective of study quality (eg, number of groups, random assignment to groups) were examined as potential moderators, as outlined in

greater detail below. An assessment of the heterogeneity of effect sizes was conducted to confirm the appropriateness of a random-effects model. Sensitivity and publication bias analyses also were conducted to improve accuracy and assess the robustness of the results.

Reliability Analyses

A random 25% subsample of articles (*n* = 8) eligible for inclusion in the meta-analysis was reviewed by a second reviewer to assess coding reliability. κ was calculated by using Stata 9.2 (Stata Corp, College Station, TX) to determine coder agreement beyond chance.^{69,70} The percentage of agreement between coders also was calculated. All items included in the analyses had at least an 80% coder agreement or a κ value of >0.70. A κ value of >0.60 has been deemed good^{69,71} and 0.80 has been deemed acceptable in many situations.⁷⁰ Any disagreements were settled via consensus. After data entry, all studies were reviewed a second time to verify data extraction and entry.

Effect-Size Calculations

Data were entered into and analyzed with Comprehensive Meta-analysis 2 (Biostat, Englewood, NJ).⁷² Two measures of effect, the SMD and Hedges *g*, and associated 95% confidence intervals (CIs) were calculated. The data were coded such that a negative effect size indicated a greater reduction in screen time in the intervention group relative to the control or comparison group or preintervention period. A generally accepted criteria for effect-size magnitude was adopted (0.2 = small; 0.5 = medium; 0.8 = large).^{55,73,74}

A random-effects model was used.^{55,75} Separate models were calculated for studies that measured the amount of screen time during the intervention period (*n* = 5) and studies that re-

ported postintervention data ($n = 27$). Three studies were included in both data sets. When data were provided for multiple time points after the intervention (eg, immediately after and 6 months after the intervention), data from the time point most proximal to the intervention period were included in the analyses. At least 10 studies are required for moderator analyses to be conducted.⁵⁵ Because too few studies reported data collected during the intervention period ($n = 5$) moderator analyses were conducted only with studies that reported postintervention data.

Heterogeneity and Moderator Analyses

To assess heterogeneity and identify possible moderator variables, effect-size estimates were calculated for subgroups and associated CIs were examined for overlap. The between-groups Q test, with a significance level of $P \leq .05$, was used to assess significant differences between subgroups. Potential moderators were determined a priori^{68,76} and included age, gender, racial distribution (up to 50% nonwhite, >50% nonwhite), country, type of data (adjusted, raw), number of study groups, population risk, use of a television control device, outcome (screen time, television alone), intervention setting (school, home, other), and theoretical model. Because the Q statistic does not provide an assessment of the magnitude of heterogeneity,⁷⁷ the I^2 value^{68,78–80} was calculated to assess the proportion of variance that reflects real difference in effect sizes.^{68,79}

Publication Bias

Publication bias was assessed using 3 techniques, the funnel plot,⁸¹ failsafe N ,⁸² and the Duval and Tweedie trim-and-fill method.^{83,84} In the absence of publication bias, the distribution of effect sizes in the funnel plot are symmetrical and take on an inverted funnel shape.^{63,85} The failsafe N or file-

drawer number estimates the number of studies that would need to be included in the meta-analysis to change the overall results.^{55,82} The Duval and Tweedie trim-and-fill method assumes that the most undesirable studies are missing.⁸⁶ An asymmetric appearance of many missing studies suggest publication or small-sample bias.⁵⁵

Sensitivity Analyses

Several sensitivity analyses were conducted to assess the robustness of the results: the SMD and Hedges g were compared; the impact of including adjusted data was assessed; and the impact of individual studies was determined.⁵⁵ To assess the impact of including studies that provided an ad-

justed value for changes in television viewing behavior or postintervention means, the effect size was calculated with and without studies that provided adjusted data ($n = 4$). The overall effect size also was calculated repeatedly, with 1 study excluded each time to determine whether the overall effect size was strongly influenced by 1 particular study.

RESULTS

Systematic Literature Search

Fourteen databases were searched, resulting in 3002 potential studies. Thirty-three studies were eligible for inclusion in the meta-analysis (Fig 1). Four studies were excluded from the

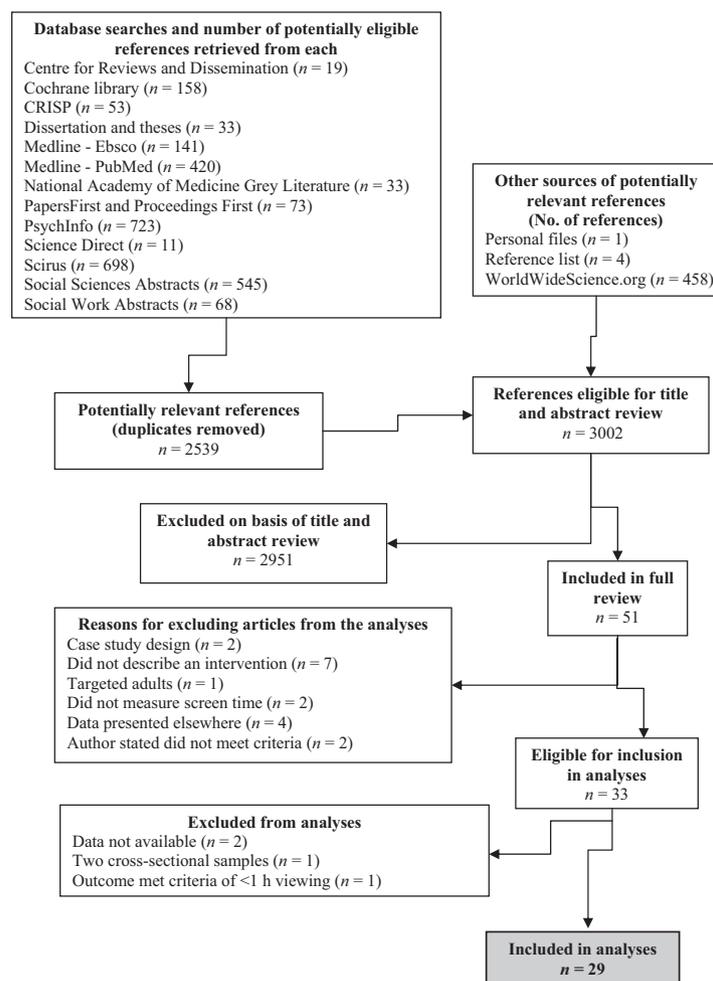


FIGURE 1
The study-identification process.

TABLE 1 Description of Interventions Eligible for Inclusion in the Meta-analysis

Author (Year)	Intervention Name	Intervention Description	Summary of Intervention Effectiveness Based on the Authors' Results
Interventions included in the meta-analysis Angelbauer ⁸¹ (1998)	The Switch Apparatus	The intervention consisted of family counseling, including an educational component, television planning, an activities menu and a contract with rewards for behavior. Participants were provided a television-control device.	Television viewing was reduced from ~30 h/wk during baseline to slightly more than 10 h/wk after the intervention.
Chin et al ⁴⁴ (2008)	DOT (Dutch Obesity Intervention in Teenagers)	The intervention consisted of a behavioral component (11 lessons for biology and physical education classes to raise awareness and facilitate positive health behaviors) and an environmental component (encouraging additional physical education classes and changes in the school cafeteria).	No significant change in screen-viewing behavior occurred.
Denmon et al ⁴² (2004)	Brocodile the Crocodile	The intervention increased awareness by using media diaries and included activities in child care centers. Children were encouraged to turn off the television and were actively involved in identifying alternatives to watching television.	Significant differences between groups; the intervention group decreased television and video viewing while the control group increased time spent viewing television and videos.
Eisenmann et al ⁴⁵ (2008)	Switch What You Do, Chew, and View	A multilevel (community, school, and family) intervention to modify physical activity, screen time, and nutrition behaviors. The community-based component consisted of a campaign to increase awareness and knowledge of preventing childhood obesity. The school-based component included a school-wide kickoff event and a teacher packet with materials for classroom display and distribution to the children and ideas for integrating materials into the curricula. The family component included information on strategies for creating a family environment supportive of healthy behaviors.	Significant differences in parent-reported screen time immediately after and 6 mo after the intervention were seen in the intervention group. Change in child-reported screen time was not significant but was lower after the intervention.
Epstein et al ⁴³ (2008)	Television allowance	Weekly budgets for screen time were set and budgets reduced by 10% per month until the budget was 50% of baseline. When the budget was reached, the television set could not be turned on. Rewards were earned for staying under budget. Parents also were provided with tips to reduce sedentary behavior.	The intervention resulted in a statistically significant and sustained reduction in television viewing and computer use.
Faith et al ¹¹² (2001)	Television cycle	During the intervention, television viewing was contingent on pedaling an exercise cycle at or above a prescribed intensity level.	Among the treatment group, television-viewing time significantly decreased from baseline to weeks 3 to 5, and among the control group television viewing increased. During the 12-wk period, television viewing declined in both groups, with greater declines in the intervention group.
Ford et al ⁹² (2002)	Television allowance	A clinical intervention that provided families with brief counseling about the problems associated with excessive media and 15- to 20-minute discussions about setting television budgets. Parents received a television-control device (television allowance) to help budget television time.	Both groups reported decreases in screen time. Differences between groups were not significant. The families who used the television-control device generally reported greater changes.
Foster et al ⁴⁷ (2008)		The intervention included a school self-assessment, nutrition education and policy, social marketing, and parent outreach. School staff were provided with Planet Health and Know Your Body curricula and supporting materials; they also received nutrition and physical activity theme packets to be integrated into classroom lessons, cafeteria promotions, and parent outreach. The family outreach component consisted of the 2-1-5 challenge, during which children were challenged to be less sedentary and more physically active.	Time spent watching television decreased in the intervention group and increased in the control group.
Golan et al ⁸⁵ (1998)		The intervention used parents as the agent of change. Parents participated in group session originally held weekly, then biweekly, then once every 6 wk (during this time families also attend five 15-min individual sessions). At all sessions parents were taught to alter the family's sedentary lifestyle.	No reduction in television viewing time occurred.

TABLE 1 Continued

Author (Year)	Intervention Name	Intervention Description	Summary of Intervention Effectiveness Based on the Authors' Results
Goldfield et al ⁸⁶ (2006)	Token television	Screen time (television/VCR/DVD) was controlled by an electronic device (token television). When tokens were inserted into the device, the television was activated. Children wore a pedometer that provided them with feedback about their physical activity. Tokens were earned by being physically active.	Screen time decreased in the intervention group and increased in the control group. The differences between groups were significant.
Gortmaker et al ⁸⁴ (1999)	Planet Health (Power Down)	A school-based intervention that incorporated intervention material into major subject areas and physical-education classes. Materials included curriculum standards so skills and competencies are used to convey the Planet Health messages. A total of 16 core lessons were delivered each of the 2 y. An additional lesson developed a 2-wk campaign to reduce television viewing in households (Power Down).	After adjusting for baseline covariates, the No. of hours of television per day was reduced in the intervention schools compared with students in control schools.
Gortmaker et al ⁸⁵ (1999)	Eat Well and Keep Moving Program	A multicomponent school-based intervention that consisted of classroom materials that were integrated into math, science, language arts, and social studies classes. The intervention also included activities at home to involve family members.	There was a nonsignificant reduction in television and video viewing.
Harrison et al ⁸⁶ (2006)	Switch Off Get Active	A 10-lesson 16-week health-education intervention that emphasized 2 key messages: the need to minimize screen time and the need to increase physical activity.	There was a decrease in screen time in the intervention group but postintervention viewing was not significantly different from the control group.
Jason ⁸⁷ (1987)		A token-activated device was attached to the television set. Children had to earn tokens by participating in prosocial activities. Unused tokens could be exchanged for nontelevision rewards (eg, money).	The No. of hours of television viewing decreased during and after the intervention.
Jason et al ⁸⁸ (1995)	The Switch Apparatus	A device was attached to the television to control electricity to the set and associated devices; parents controlled turning the switch on and off, thereby controlling television viewing.	The lock was effective in reducing time spent viewing television.
Jones et al ¹¹³ (2008)	IMPACT (Incorporating More Physical Activity and Calcium in Teens)	The intervention used learning and environmental reinforcement to affect behavior change. It included a health curriculum that included classroom lessons and behavioral journalism, reporting role model stories, a physical education program, and a school food service component. The intervention materials were incorporated into the health and physical education curricula.	Total screen time was significantly lower in the intervention group compared to the control group.
Kipping et al ¹⁰⁸ (2008)	Active for Life (Year 5)	This intervention was an adaptation and abbreviated form of the Eat Well Keep Moving intervention, which consisted of 16 lessons on healthy eating, increasing physical activity, and reducing television viewing.	The intervention group spent less time on screen viewing activities than the control group, but the difference was not significant.
Mauriello et al ¹¹⁴ (2006)	Health in Motion	The intervention was tailored to participant's stage of change. Participants' stage of change was assessed and they received feedback from a computerized program tailored to their stage. The computer program begins with an introduction to the Health in Motion program and then proceeds with alternating assessments and feedback about target behaviors.	The treatment group reported significantly less television viewing.
McCanna ¹¹⁰ (1988)		The intervention consisted of attaching a television-control device (token-actuated timer to the television); in order to use the television, tokens were inserted into the timer. Participants received television tokens for participating in physical activity.	The intervention was most effective for 1 excessive television viewer; for the below-average viewers' television-viewing rates were minimally affected.
Nemet et al ⁹⁸ (2005)		Children and parents were provided counseling and invited to lectures. The intervention included dietary counseling and a twice-weekly exercise program. In addition, participants were encouraged to reduce sedentary activity and report walking or other physical activity to their coaches weekly.	Screen time did not change significantly for the intervention or control subjects.
Niemeyer ¹⁰⁰ (1988)	Books and Beyond	The program was designed to promote recreational reading and discriminate television viewing. Students were awarded prizes for reading a specified No. of pages of books. The intervention incorporated home activities, including charting time spent reading and viewing television and learning to self-monitor television viewing through a critical television-viewing skills curriculum. Parents were provided materials about discriminate television-viewing habits to read and discuss with children.	There was no significant difference between the intervention and comparison groups.

TABLE 1 Continued

Author (Year)	Intervention Name	Intervention Description	Summary of Intervention Effectiveness Based on the Authors' Results
Nova et al ¹⁰¹ (2001)		The intervention occurred in a family practice office. Children and parents were interviewed about activity and eating habits and given a specific diet and detailed guidelines regarding physical activity. Active parental commitment was requested. Follow-up clinical visits were performed regularly during the intervention (at 1, 2.5, 4, 6, 9, 12, 15, 18, and 24 mo). During follow-up visits parents and children reported the child's behaviors since the last visit.	No significant variations in computer or television use were noted within each group from 0 to 12 mo.
Robinson ¹⁰² (1999)		The intervention included eighteen 30- to 50-min lessons that were incorporated into the standard curriculum followed by a television turnoff. Parents were provided newsletters designed to motivate them to help children stay within time budgets. The newsletters also suggested strategies for limiting screen time. Families were given a television allowance to help with budgeting.	The intervention significantly decreased children's television viewing compared with control children. The intervention group children also reported significantly greater reductions in video-game use than control children.
Robinson et al ¹⁰³ (2005)	Stanford GEMS (GEMS Jewels and START—Sisters Taking Action to Reduce Television)	GEMS Jewels dance classes were offered 5 d/wk (classes started with a snack followed by homework period and then the dance sessions followed by discussions about the importance of dance in the community and culture). START consisted of 5 lessons delivered during home visits. Television-viewing goals were set and strategies for reaching the goal discussed. Families were given a television allowance to help with budgeting and newsletters to reinforce the lessons and provide updates on dance classes.	Compared with control children, the treatment group reported less media use and a significant decrease in total household television use at follow-up.
Robinson et al ¹⁰⁴ (2006)	SMART (Student Media Awareness to Reduce Television) Classroom Curriculum	The intervention included budgeting screen time and limiting physical access to screen media. A total of 18 30- to 50-min classroom lessons plus weekly 5- to 10- min boosters were delivered. The curriculum consisted of 4 sections focusing on television awareness, television turnoff, developing skills to resist television viewing, and helping others decrease television viewing. A television-control device (television allowance) was provided to help budget television. Children were provided incentives for maintaining their weekly media use budget.	Compared with control children, the intervention group significantly decreased weekday television viewing and weekday and Saturday video-game playing. There were no significant differences between groups in change in self-reported weekday or Saturday time spent playing on a computer.
Salmon et al ¹⁰⁵ (2008)	Switch-Play	The behavioral modification component of the intervention included nineteen 40- to 50-min lessons delivered in the classroom. The lessons aimed to increase awareness of current behavior and alternatives and the benefits of physical activity. Children completed a weekly contract to undertake switching off 1 television program per week over a 4-wk period.	Children in the intervention group watched significantly more television on average compared with those in the control group after the intervention and at 6 and 12 mo follow-up. No significant effects were seen for electronic game playing or computer use.
Sege et al ¹⁰⁶ (1997)		Health care providers were given a 1-h training session that included a review of the parent materials to be handed out, discussions of the theoretical background of each intervention, and the opportunity to discuss implementation details. Providers were to distribute information cards to parents and discuss the material on the card with them at the time of a child's health visit.	There was no significant change in weekday television-viewing habits and a trend toward reductions in weekend television viewing (the intervention group was slightly more likely to report reductions in weekend television viewing compared with the control group).
Simon et al ¹⁰⁷ (2006)	ICAPS (Intervention Centered on Adolescents' Physical Activity and Sedentary Behavior)	The intervention was a multilevel program that included an educational component focusing on physical activity and sedentary behaviors. The intervention also included new opportunities for physical activity during and after the school day.	Intervention students had a greater reduction over time of television and video viewing than control subjects.
Weintraub et al ¹¹¹ (2008)	SP0RT (The Stanford Sports to Prevent Obesity Randomized Trial)	The intervention included 4 (originally 3) d/wk of coed soccer. One day/week was a game and the other days practice; sessions included a 2.25-h-long homework period followed by an activity period.	Inconsistent results were seen for screen time.

TABLE 1 Continued

Author (Year)	Intervention Name	Intervention Description	Summary of Intervention Effectiveness Based on the Authors' Results
Interventions excluded from the analyses because of the unavailability of data			
Epstein et al ⁸⁹ (1995)		The intervention consisted of reinforcing children for certain behaviors. All groups received written information on the positive effects of increased physical activity and the negative effects of sedentary behaviors. Participants in the sedentary behavior group were reinforced for decreasing the amount of time spent in sedentary activities and participants in the exercise group were reinforced for increasing physical activity.	Information about changes in sedentary behaviors was not available.
Epstein et al ⁹⁰ (2000)		Participants in the decreased sedentary activity group were reinforced for reducing sedentary behaviors, including watching television and videotapes and playing computer games.	Targeted sedentary behaviors showed a significant decrease from baseline at 6 and 24 mo.
Johnson et al ⁸⁷ (2005)	Healthy Habits	A statewide intervention in women, infants, and children clinics. The intervention consisted of 2 modules each consisting of background materials, staff training materials, posters, interactive handouts for clients, bookmarks, vouchers, coloring materials, and detailed plans for group sessions and other supportive materials.	Between the baseline and the 6-mo surveys, the proportion of families who met recommendations for television viewing increased.
Johnston et al ⁸⁸ (2006)	Healthy Steps	Parents received parenting classes, developmental and behavioral advice, risk factor screening, postnatal home visits, telephone support, developmental assessments, and the Reach Out and Read literacy program.	Compared with the control group, parents in the intervention group were less likely to allow their children more than 1 h of daily television viewing.

analyses; 1 study was excluded because it presented data on 2 cross-sectional samples,⁸⁷ 1 study was excluded because the outcome was binary (<1 hour/day of television)⁸⁸ compared with all the other studies that presented continuous data (eg, hours per week of screen time), and 2 studies were excluded because data were unavailable.^{89,90} Twenty-nine studies were included in the analyses. Although 1 of the predefined exclusion criteria was non-English language, no articles written in a language other than English were identified. Fifteen authors were sent e-mails requesting additional information, and all but 1 responded. Eight authors provided data, 4 authors were unable to provide the data requested, and 2 authors stated that their work did not meet the study inclusion criteria. Search of the CRISP database identified 53 records that included the search terms. Only 4 of these studies were eligible for inclusion; 1 author responded to the request for additional information stating that data were not available at the time. The vast majority ($n = 26$) of studies were published in peer-reviewed journals, and 3 studies were doctoral dissertations.

Sample and Intervention Characteristics

Table 1 briefly describes the interventions eligible for inclusion in the meta-analysis and summarizes the study outcomes specifically related to screen time ($n = 33$). Table 2 provides additional information about the sample and intervention characteristics for interventions included in the analyses ($n = 29$). More than one-half of the interventions included in the analysis (18 of 29) were theory based (social cognitive theory was used most frequently). The school was the most common intervention setting (13 of 29), followed by the home (8 of 29). Many programs included both parents

TABLE 2 Sample Characteristics and Intervention Components for Studies Included in the Meta-analysis

Author (Year)	Sample Characteristics			Intervention Characteristics				
	r, Age Range, y, Nonwhite, % Male, %	Location	Targets a High-Risk Group	Setting	Television-Control Device Used	Theory Used in Program	Intervention Components	Behavior(s) Targeted for Change
Angelbuer ⁹¹ (1998) Chin et al ⁴⁴ (2008)	6; 5–11; unclear; >50% 821; 12–18; unclear; ≤50%	United States Netherlands	Yes, screen No	Home School	Yes No	Other TRA/TPB, other	B, C, INFO, M, R CU, G, INFO, M, PA	Television ST, consumption of SSB, dietary behavior, active commuting to school
Dennison et al ⁴² (2004)	77; <5; ≤50%; ≤50%	United States	No	School	No	Other	INFO, R	ST, snacking while watching television
Eisenmann et al ⁴⁵ (2008)	20; 5–11; unclear; ≤50%	United States	No	Home	No	EST	INFO, M, R	ST, PA, dietary behavior
Epstein et al ⁴³ (2008)	67; 5–11; ≤50%; >50%	United States	Yes, weight; yes, screen	Home	Yes	Other	B, INFO, R	ST
Faith et al ¹¹² (2001)	10; 5–11; unclear; >50%	United States	Yes, weight; yes, screen	Home	No	Other	Contingent	Television (contingent on PA)
Ford et al ⁹² (2002)	28; 5–11; >50%; ≤50%	United States	No	Other	Yes	SCT	B, INFO	ST, eating breakfast and dinner with television on, PA
Foster et al ⁴⁷ (2008)	689; 5–11; >50%; ≤50%	United States	No	School	No	Other	INFO	Television, dietary behaviors, PA
Golan et al ⁸⁵ (1998)	50; 5–11; unclear; ≤50%	Israel	Yes, weight	Unclear	No	Other	INFO	Television, nutritional behaviors, PA, eating while standing, in front of television, when stressed, while performing other activities
Goldfield et al ⁴⁶ (2006)	30; 5–11; unclear; ≤50%	Canada	Yes, weight; yes, screen	Home	Yes	Other	R, M	ST, snack intake while watching television, PA
Gortmaker et al ⁹⁴ (1999)	1225; 12–18; ≤50%; >50%	United States	No	School	No	SCT, BCT	CU, G, INFO, M	Television, nutritional behaviors, PA
Gortmaker et al ⁹⁵ (1999)	336; 5–11; >50%; ≤50%	United States	No	School	No	SCT	CU, INFO	Television, nutritional behaviors, PA
Harrison et al ⁹⁸ (2006)	312; 5–11; unclear; >50%	Ireland	No	School	No	SCT	B, CU, G, INFO, M	ST, PA
Jason ⁹⁷ (1987)	2; 12–18; ≤50%; >50%	United States	Yes, screen	Home	Yes	Other	R	Television
Jason et al ⁹⁸ (1993)	2; 5–11; ≤50%; ≤50%	United States	No	Home	Yes	SCT, TTM	B	ST
Jones et al ¹¹³ (2008)	608; 12–18; ≤50%; ≤50%	United States	No	School	No	SCT, TTM	CU, INFO	ST, PA
Kipping et al ¹⁰⁸ (2008)	323; 5–11; unclear; ≤50%	England	No	School	No	SCT, TTM	CU, INFO, M	ST, nutritional behaviors, PA
Mauriello et al ¹¹⁴ (2006)	655; 12–18; ≤50%; ≤50%	United States	No	Unclear	No	SCT, BCT	Stage	Television, nutritional behavior, PA
McCanna ¹¹⁰ (1989)	5; 5–11; ≤50%; ≤50%	United States	No	Home	Yes	TTM	Stage	Television, alternative activities (homework, reading, playing, chores, sports)
Nemet et al ⁹⁹ (2005)	46; 5–11; unclear; >50%	Israel	Yes, weight	Unclear	No	Other	INFO, PA	ST, nutritional behavior, PA
Niemeyer ¹⁰⁰ (1988)	235; not provided; unclear; unclear	United States	No	School	No	Other	B, M	Television, reading
Nova et al ¹⁰¹ (2001)	140; 5–11; unclear; >50%	Italy	Yes, weight	Other	No	Other	INFO	ST, PA, nutritional behavior
Robinson ¹⁰² (1999)	192; 5–11; unclear; >50%	United States	No	School	Yes	School	B, CU, INFO, M	ST, eating meals and snacking in front of the television
Robinson et al ¹⁰³ (2003)	60; 5–11; ≤50%; ≤50%	United States	Yes, weight	Other	No	SCT	B, G, INFO, PA	ST, eating breakfast and dinner with the television on, nutritional behaviors, PA
Robinson et al ¹⁰⁴ (2006)	181; 5–11; unclear; >50%	United States	No	School	Yes	SCT	B, CU, INFO, M, R	ST
Salmon et al ¹⁰⁵ (2008)	119; 5–11; unclear; ≤50%	Australia	No	School	No	SCT	B, C, CU, INFO, M, R	ST, PA
Sege et al ¹⁰⁶ (1997)	243; <5; unclear; ≤50%	United States	No	Other	No	SCT, BCT	INFO	Television
Simon et al ¹⁰⁷ (2006)	954; 12–18; unclear; ≤50%	France	No	Other	No	Other	INFO, PA, Policy	ST, PA
Weintraub et al ¹¹¹ (2008)	21; 5–11; >50%; unclear	United States	Yes, weight	School	No	EST	PA	ST, PA

Theories used in program development: BCT, behavioral choice theory; EST, ecological systems theory; SCT, social cognitive theory; TRA/TPB, theory of reasoned action/theory of planned behavior; TTM, transtheoretical model. Intervention components: B, budget; C, contract; Contingent, television use contingent on another behavior; CU, incorporated into curriculum; G, goal setting; INFO, provision of information; M, monitoring of behavior; PA, physical activity opportunities; Policy, study included a policy change component; R, rewards/reinforcements; Stage, the intervention is based on the individual's stage of readiness. Targets a high-risk sample: Yes, weight, the intervention targets overweight children; Yes, screen, the intervention targets children that exceed a screen time recommendations. Behavior(s) targeted for change: ST, screen time; television, television only; SSB, sugar-sweetened beverages; PA, physical activity; nutritional behaviors, dietary habits (eg, fat and calorie intake, fruit and vegetable consumption).

and children in the intervention. With regard to intervention components, approximately one-third (9 of 29) of the interventions facilitated behavior change by controlling the environment with a television-control device. Many interventions facilitated behavior change by setting goals and planning media use; often children participated in this process. Another common feature of the interventions was a behavioral contract in which children agreed to a specified amount of time in front of a screen. Often, a reward was provided if screen-time targets were met. Several interventions included increasing awareness by having children monitor and record their own screen time. Finally, only 1 intervention made television viewing contingent on physical activity.

The primary outcome in the majority of interventions (19 of 29) was screen time (television, video/DVD, computer, or video-game use alone or in combination). In approximately one-half of the studies (14 of 29), television only was the primary outcome. Only 5 of the interventions measured other screen-related behaviors, such as eating while watching television or having a television in the bedroom (Table 2).

With regard to sample characteristics (see Table 2), the majority of the interventions targeted children between the ages of 5 and 11 years (20 of 29). When demographic information was available, most study populations included 25% to 50% nonwhite participants and 25% to 50% male children. Ten studies targeted high-risk children. Eight studies limited participation to children who were overweight or obese, and 5 excluded children who did not use a predetermined amount of screen time. Most studies (20 of 29) were conducted in the United States.

Design Characteristics

As shown in Table 3, the vast majority of the studies included an intervention

TABLE 3 Study Design Characteristics of Studies Included in the Meta-analysis

Author (Year)	No. of Study Groups	Random Allocation to Groups	Time Point of Data Collection in Relation to Intervention ^a			Valid Data-Collection Tool Used
			During	After	Follow-up	
Angelbuer ⁹¹ (1998)	1	No	X	X		No
Chin et al ⁴⁴ (2008)	2	Yes		X		Yes
Dennison et al ⁴² (2004)	2	Yes		X		No
Eisenmann et al ⁴⁵ (2008)	2	Yes		X	X	Yes
Epstein et al ⁴³ (2008)	2	Yes		X		Yes
Faith et al ¹¹² (2001)	2	Yes	X			Yes
Ford et al ⁹² (2002)	2	Yes		X		Yes
Foster et al ⁴⁷ (2008)	2	Yes		X		Yes
Golan et al ⁹³ (1998)	2	Yes		X		Yes
Goldfield et al ⁴⁶ (2006)	2	Yes	X			Yes
Gortmaker et al ⁹⁴ (1999)	2	Yes		X		Yes
Gortmaker et al ⁹⁵ (1999)	2	No		X		Yes
Harrison et al ⁹⁶ (2006)	2	Yes		X		Yes
Jason ⁹⁷ (1987)	1	No		X		No
Jason et al ⁹⁸ (1993)	1	No	X	X		No
Jones et al ¹¹³ (2008)	2	Yes		X		Yes
Kipping et al ¹⁰⁹ (2008)	2	Yes		X		Yes
Mauriello et al ¹¹⁴ (2006)	2	Yes		X		No
McCanna ¹¹⁰ (1989)	1	No	X	X		Yes
Nemet et al ⁹⁹ (2005)	2	Yes		X		No
Niemeyer ¹⁰⁰ (1988)	2	Yes		X		No
Nova et al ¹⁰¹ (2001)	2	Yes		X		No
Robinson ¹⁰² (1999)	2	Yes		X		Yes
Robinson et al ¹⁰³ (2003)	2	Yes		X		Yes
Robinson et al ¹⁰⁴ (2006)	2	Yes		X		Yes
Salmon et al ¹⁰⁵ (2008)	2	Yes		X		Yes
Sege et al ¹⁰⁶ (1997)	1	No		X		No
Simon et al ¹⁰⁷ (2006)	2	Yes		X		Yes
Weintraub et al ¹¹¹ (2008)	2	Yes		X	X	Yes

^a All studies collected data at baseline.

and a comparison group. Five interventions used 1 group with a pretest-posttest design. Among studies with 2 groups of participants, most used randomization to assign group membership. All studies reported baseline values of the outcome variable, 5 studies reported data collected during the intervention period, and only 2 studies reported follow-up data. Four of the studies included in the analyses reported adjusted postintervention data. Most (20 of 29) studies reported using a valid data collection tool.

Heterogeneity and Moderator Analyses

Table 4 contains the effect-size estimates calculated with a random-effects model for the 2 main groupings of studies, those reporting data col-

lected during the intervention period and those reporting data collected after the intervention. The within-group variability was greater than would be expected by chance, signifying possible heterogeneity within each group. The between-groups *Q* statistic did not support the assumption of homogeneity; no moderators were identified. To assess the magnitude of heterogeneity present within each level of the potential moderators, the *I*² statistic was calculated for each subgroup (ie, level) (Table 4). In general, *I*² values were moderate to high, using generally accepted *I*² values of 25, 50, and 75 (low, medium, and high, respectively).^{77,79} The presence of heterogeneity within subgroups and the nonsignificance in between-groups χ^2 (*Q*)

TABLE 4 Effect Sizes (95% Confidence Limits) and Between-Group Tests of Heterogeneity (I^2), Assessment of the Amount of Variability Caused by Random Error (P), and Tests of Moderators for Studies Included in the Meta-analysis

Variable	No. of Studies	SMD (Random-Effects Model)			Heterogeneity Within Subgroups				Between-Groups χ^2 Test (I^2) of Moderators
		Point Estimate	95% CLs		Within-Groups χ^2 Test (I^2)	P			
			Lower	Upper		Estimate, %	95% CLs Lower, %	Upper, %	
Subgroup									
All studies included	29								
Time point of data collection ^a									
During intervention	5	-1.904	-3.041	-0.767	13 ^a	69.28	21.25	88.02	
After intervention	27	-0.148	-0.224	-0.071	50 ^a	47.79	18.21	66.67	
Studies with postintervention data	27								
Type of data									
Adjusted	4	-0.243	-0.401	-0.085	7 ^a	57.88	0.00	86.00	
Raw	23	-0.112	-0.189	-0.035	32	31.65	0.00	58.91	2.123
Comparisons									
Before vs after the intervention	5	-1.349	-2.601	-0.097	18 ^a	77.52	45.74	90.69	
Treatment vs control	16	-0.101	-0.157	-0.044	12	0.00	0.00	48.68	
Treatment vs controladjusted data	4	-0.243	-0.401	-0.085	7	57.88	0.00	86.00	
Treatment 1 vs treatment 2	2	-0.032	-0.857	0.222	1	27.24	0.00	71.79	6.985
Outcome									
Television only	17	-0.108	-0.171	-0.045	16	0.00	0.00	0.00	
Total screen time	10	-0.211	-0.369	-0.054	31 ^a	70.97	44.60	84.79	1.436
Where study was found									
Literature search	23	-0.156	-0.238	-0.074	45 ^a	51.11	21.09	69.71	
Reference list of another article	3	-0.17	-0.579	0.24	3	33.33	0.00	77.98	2.608
Personal files	1	0.148	-0.213	0.509	0	0.00			
Publication type									
Journal article	24	-0.135	-0.209	-0.062	41 ^a	48.78	16.02	68.76	
Thesis/dissertation	3	-0.968	-2.204	0.269	10 ^a	80.00	36.76	93.68	1.734
Age group									
<5 y	2	-0.105	-0.483	0.273	2	50.00	0.00	87.15	
5-11 y	18	-0.125	-0.241	-0.008	28 ^b	39.29	0.00	65.41	
12-18 y	6	-0.176	-0.304	-0.049	18 ^a	72.22	35.86	87.97	0.501
Not provided	1	-0.192	-0.449	0.064	0				
Nonwhite									
>50%	4	-0.091	-0.211	0.029	3	0.00	0.00	0.00	
≤50%	9	-0.256	-0.386	-0.126	13	38.46	0.00	71.68	
Unclear	14	-0.098	-0.199	0.004	23 ^b	43.48	0.00	69.82	4.345
Male									
Unclear	2	-0.002	-0.587	0.584	2	50.00	0.00	87.15	
>50%	9	-0.225	-0.423	-0.027	23 ^a	65.22	29.15	82.92	
≤50%	16	-0.105	-0.162	-0.047	15	0.00	0.00	0.00	1.454
Country									
United States	19	-0.189	-0.294	-0.084	37 ^a	51.35	17.70	71.24	
Non-United States	8	-0.074	-0.153	0.004	7	0.00	0.00	0.00	2.956
Overweight									
Not specified	11	-0.212	-0.363	-0.06	19 ^b	47.37	0.00	73.78	
>50%	4	0.002	-0.268	0.272	3	0.00	0.00	0.00	
≤50%	12	-0.129	-0.229	-0.029	27 ^a	59.26	23.02	78.44	1.963
High-risk sample									
No	19	-0.142	-0.213	-0.071	32 ^b	43.75	3.36	67.26	
Yes	8	-0.269	-0.665	0.126	20 ^a	65.00	25.40	83.58	0.039
Television-control device									
No	19	-0.124	-0.199	-0.049	34 ^a	47.06	9.61	68.99	
Yes	8	-0.3	-0.725	-0.035	15 ^b	53.33	0.00	78.99	2.021
Theory based									
No	11	-0.156	-0.349	0.037	16	37.50	0.00	69.26	
Yes	16	-0.145	-0.231	-0.059	35 ^a	57.14	25.19	75.45	0.01
Setting of intervention									
School	13	-0.15	-0.239	-0.061	26 ^a	53.85	13.56	75.36	
Home	6	-0.933	-1.933	0.067	16 ^a	68.75	26.29	86.75	
Other (includes unclear)	8	-0.109	-0.195	-0.024	7	0.00	0.00	0.00	2.891

TABLE 4 Continued

Variable	No. of Studies	SMD (Random-Effects Model)			Heterogeneity Within Subgroups				Between-Groups χ^2 Test (<i>Q</i>) of Moderators
		Point Estimate	95% CIs		Within-Groups χ^2 Test (<i>Q</i>)	Estimate, %	<i>I</i> ²		
			Lower	Upper			Lower, %	Upper, %	
Interventionist									
Researcher	4	-0.384	-1.121	0.354	12 ^a	75.00	30.64	90.99	
Other (includes unclear)	23	-0.138	-0.21	-0.066	39 ^b	43.40	7.27	65.46	0.421
Screen time is the primary outcome									
Yes	14	-0.134	-0.267	0	24 ^b	45.83	0.00	70.95	
No	13	-0.156	-0.252	-0.06	25 ^b	52.00	9.67	74.49	0.071
Used valid data collection tool									
No	9	-0.165	-0.393	0.064	21 ^a	61.90	21.32	81.56	
Yes	18	-0.151	-0.23	-0.073	30 ^b	43.33	1.17	67.51	0.011
Source of the data									
Document	20	-0.2	-0.306	-0.095	38 ^a	50.00	16.27	70.14	
Document and/or authors	7	-0.08	-0.154	-0.006	6	0.00	0.00	0.00	3.378
Random allocation to groups									
No	6	-0.464	-0.974	0.047	18 ^a	72.22	35.86	87.97	
Yes	21	-0.142	-0.213	-0.071	33 ^b	39.39	0.00	64.05	1.496
No. of study groups									
1	5	-1.349	-2.601	-0.097	18 ^a	77.78	46.48	90.77	
2	22	-0.146	-0.213	-0.079	33 ^b	36.36	0.00	61.97	3.54

Three studies^{91,97,110} provided data during and after the intervention and are included in the calculation of the effect-size estimates both during and after the intervention.

^a *P* ≤ .01.

^b *P* ≤ .05.

test supported combining studies using a random-effects model.

Overall Measure of Effect

When intervention effects were assessed after the intervention, most studies showed a small favorable effect of the intervention (Fig 2A). Individual intervention effects ranged from -3.98⁹¹ to 0.466.¹¹¹ Several interventions had large effects with large CIs, likely because of the small sample size. These did not greatly impact the overall mean effect size. The overall mean effect of all interventions included in the analysis was small yet statistically significant. After the intervention, the overall SMD in means effect size was -0.148 (95% CI: -0.224 to -0.071) (Fig 2A) and Hedges *g* was -0.144 (95% CI: -0.217 to -0.072) (data not shown).

During the intervention period (ie, while the intervention was being delivered), the effect was large and statistically significant (SMD: -1.904 [95% CI: -3.041 to -0.767]) (Fig 2B). Like-

wise, Hedges *g* was -1.807 (95% CI: -3.069 to -0.545) (data not shown). Because of a lack of variance, 2 studies (identified with “a” in Fig 2) could not be included in the analyses to calculate Hedges *g*. Because the SMD and Hedges *g* differed only slightly and 2 studies could not be included in calculations of Hedges *g* because of a lack of variance, only the SMDs are presented.

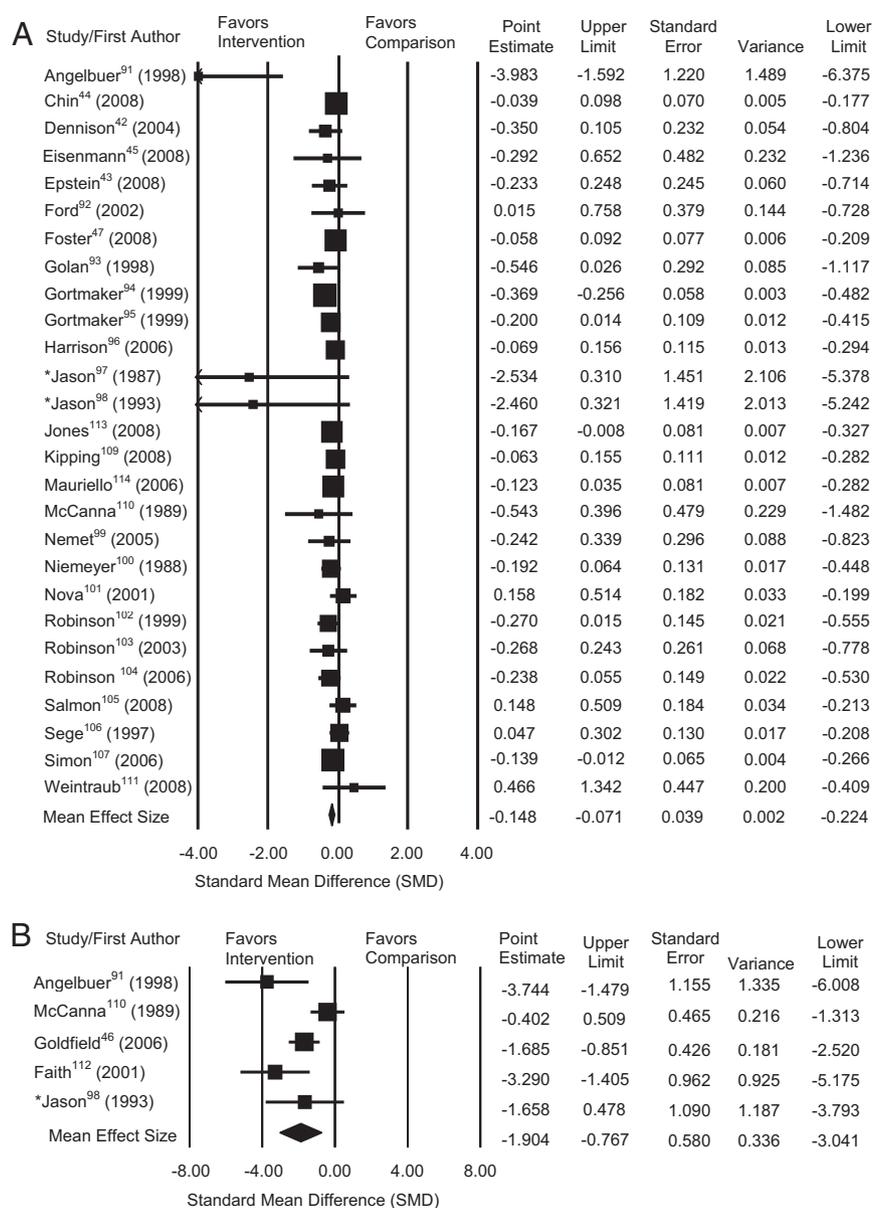
Publication Bias

Visual inspection of the funnel plots (Figs 3 and 4) show potential publication bias. On the basis of the Duval and Tweedie trim-and-fill method, 4 studies are missing (illustrated by filled circles in Fig 3). If the missing studies were included in the calculation of the overall postintervention mean effect size, the SMD (95% CI) would be -0.133 (-0.218 to -0.047), which is still small but significant. The trim-and-fill method did not identify any missing studies among the group of studies representing data during the intervention period (Fig 4). Assessment of pub-

lication bias with the failsafe *N* further supports the conclusion that the real effect size is not 0. For the group of studies presenting postintervention data, an additional 255 studies reporting no effect would have to be located and included in the analyses to nullify the existing results. For the second set of studies, those presenting data collected during the intervention period, the failsafe *N* was 40. Sensitivity analyses did not identify any decisions or studies that greatly impacted the overall conclusions.

DISCUSSION

This meta-analysis shows that interventions to reduce children’s screen time have a small but statistically significant effect after the intervention and a large statistically significant effect during the intervention. Although studies included in the meta-analysis were heterogeneous, there was variability greater than would be expected by chance, no significant moderators were identified to explain this variabil-

**FIGURE 2**

Forest plot of the mean overall SMD (95% CI) and the SMD and associated 95% confidence limits and the associated SEs and variance for each study included in the analysis. The individual study effect sizes are represented by the center of the square symbol associated with the study, a study's contribution toward the overall mean effect size (or weight) is represented by the symbol size, and the precision of the study is represented by the length of the line associated with each symbol. A negative effect size denotes a program that favored the intervention group (eg, a significantly greater decrease in screen time in the intervention group compared with the treatment group). Generally accepted criteria for effect-size magnitude are 0.2 = small, 0.5 = medium, and 0.8 = large.^{73,74}

ity. It is possible that because of the number of studies included in the analysis, there was insufficient power to detect effect moderators. It also is possible that including studies with varied primary outcomes impacted the ability to detect moderators. The decision to include all interventions that targeted

screen time instead of interventions that only targeted screen time is worthy of further discussion. We hypothesized that the majority of interventions, especially those developed earlier, were developed to address childhood obesity using screen-time reduction as a mechanism to decrease

weight status. Although our broad inclusion criteria limit our ability to understand specific mechanisms of how television time uniquely impacts body fatness (ie, using an effect-modifier model), it increases the generalizability and clinical utility of the findings because attempts to reduce body fatness are almost always going to be multi-component. Thus, it was important to not exclude studies that had a screen-time reduction strategy simply because other strategies also were used. This reflects our philosophical position that it is of greater public health value to know that including a screen-time reduction strategy is efficacious for reducing body fatness than it is to know simply that screen-time reduction works as a stand-alone strategy. These points notwithstanding, the ability to test potential moderators will improve as the evidence base on screen-time interventions grows.

Several methods were used to increase confidence in the study results. On the basis of the results of the sensitivity analyses, the decision to calculate SMD instead of Hedges *g* did not impact the conclusion. Although an attempt was made to identify unpublished works, none were identified. Visual observation of funnel plots, the Duval and Tweedie trim-and-fill method, and the failsafe *N* were used to assess the robustness of this study's conclusion. The funnel plot and the trim-and-fill method identified few possible missing studies and the failsafe *N* was large. Collectively, these methods support the validity of the primary finding.

The Guide to Community Preventive Services⁵⁹ groups interventions into several categories: interventions that include provision of information only (interventions that try to change knowledge, attitudes, or norms); behavioral interventions (those that try

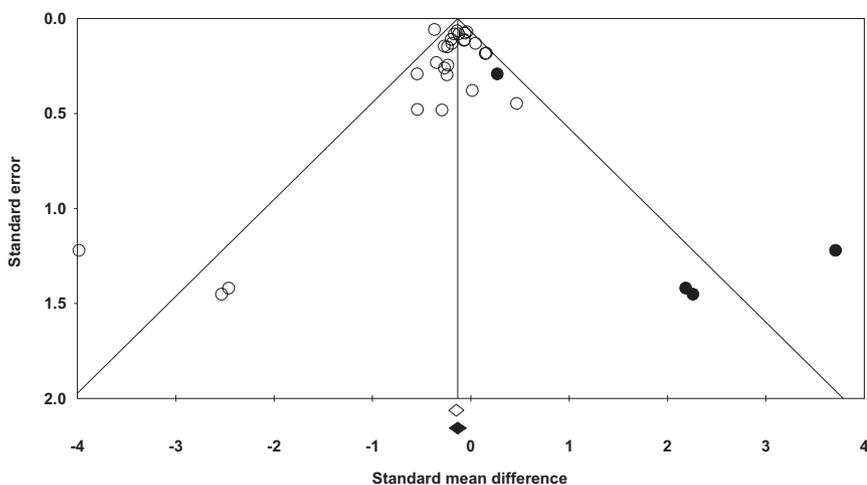


FIGURE 3

Funnel plot of the SE by SMD of studies reporting data from during and after the intervention. Observed studies are indicated by open circles, and the imputed studies are indicated by filled circles.

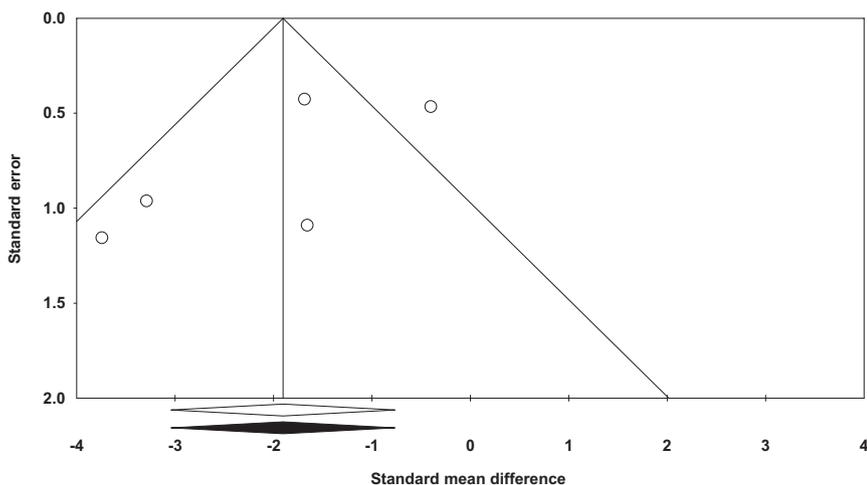


FIGURE 4

Funnel plot of the SE by SMD of studies reporting data during the intervention. Observed studies are indicated by open circles. No missing studies were identified.

to change behavior by providing skills or materials); environmental interventions (those that try to change the physical and/or social environment); and policy or regulatory interventions. Most of the interventions reviewed include an information provision component.^{42–45,47,91–107} This strategy has been recommended by Dennison and Edmunds¹⁰⁸ as a means to change behavior. The majority of the interventions are behavioral interventions. They increase skills by having the child and/or parent develop a television-viewing budget or plan, set screen-time goals

or monitor viewing,* or have the child identify alternative activities.^{42,96,100,109}

Several of the interventions attempted to change behavior by modifying the environment by restricting access to the television or computer using a television-control device† or by providing opportunities for physical activity.^{99,103,107,111} It is worth noting that 4^{91,97,98,110} of 5 interventions with large effect sizes after the intervention used a television-control device to help bud-

*Refs 44, 91, 95, 96, 98, 100, and 102–104.

†Refs 43, 46, 91, 92, 97, 98, 102–104, and 110.

get screen time. Although the majority of adolescents (aged 8–18 years) have media devices in their bedrooms,⁶ and 33% of children aged 6 years and younger have televisions in their bedrooms,⁵ only 1 intervention⁴² reported changes in the proportion of study subjects with televisions in the bedroom. Finally, none of the interventions included in this review attempted to change children's behavior through regulation. However, 1 intervention,¹⁰⁷ included policy makers in the change process by requesting that they provide supportive environments for physical activity in the form of low- or no-cost physical activity opportunities. Given that most interventions used a combination of strategies, intervention strategy was not tested as a moderator.

CONCLUSIONS

Children are able to take with them and use media now more than ever. In fact, 20% of children's media consumption is from mobile devices, such as cell phones, iPods/MP3 players, and video-game players.⁶ Reducing the amount of time children spend with screen media and increasing discriminate media use and media use budgeting are important given the negative health and behavioral implications of excessive screen time. Results from this meta-analysis show that interventions to decrease children's screen time have a small but statistically significant effect. Because excessive screen media use has been associated with many negative behavioral and health consequences, these results support the implementation of screen-time reduction interventions. Many of the interventions reviewed can provide children with the skills needed to decrease screen-media use. Parents and clinicians should incorporate the interventions or the strategies that are common to the effective interventions into their efforts to combat childhood

obesity. Even modest effects could result in a positive change in the health status of the population given the large number of children who use screen media and the increasing amount of

time children spend with media. As the evidence base expands, and the number of screen-time interventions increases, future research can expand on these findings by examining the

clinical relevance and sustainability of effects observed, conducting a more thorough analysis of effect modifiers, and by identifying critical components of effective interventions.

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APPENDIX 1 Example of a Systematic Literature Search Strategy Used to Identify Articles for the Meta-analysis

Search ID	Search Term	Results
S1	Television	9534
S2	Screen time	44
S3	Program	50 400
S4	Trial	690
S5	Intervention	9307
S6	Experiment	560
S7	S1 or S2	9561
S8	S3 or S4 or S5 or S6	60 133
S9	S7 and S8	162
S10	S9 limiters: published date 198601–200812	141

S indicates search number; 198601, January 1986; 200812, December 2008.

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