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Systematic Review of Effective Strategies for Reducing Screen Time Among Young Children

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Screen-media use among young children is highly prevalent, disproportionately high among children from lower-income families and racial/ethnic minorities, and may have adverse effects on obesity risk. Few systematic reviews have examined early intervention strategies to limit TV or total screen time; none have examined strategies to discourage parents from putting TVs in their children's bedrooms or remove TVs if they are already there. In order to identify strategies to reduce TV viewing or total screen time among children <12 years of age, we conducted a systematic review of seven electronic databases to June 2011, using the terms "intervention" and "television," "media," or "screen time." Peer-reviewed intervention studies that reported frequencies of TV viewing or screen-media use in children under age 12 were eligible for inclusion. We identified 144 studies; 47 met our inclusion criteria. Twenty-nine achieved significant reductions in TV viewing or screen-media use. Studies utilizing electronic TV monitoring devices, contingent feedback systems, and clinic-based counseling were most effective. While studies have reduced screen-media use in children, there are several research gaps, including a relative paucity of studies targeting young children ($n = 13$) or minorities ($n = 14$), limited long-term (>6 month) follow-up data ($n = 5$), and few ($n = 4$) targeting removing TVs from children's bedrooms. Attention to these issues may help increase the effectiveness of existing strategies for screen time reduction and extend them to different populations.

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INTRODUCTION

The American Academy of Pediatrics has recommended that children over 2 years of age use screen media for no more than 2 h per day (1), yet US children use screen media (e.g., TV, videos, DVDs, video games, and/or computers) for about 7 h per day, on average (2). Most time with media is spent watching TV, with children watching 4½ h per day, and infants watching 1–2 h per day (2,3). There is substantial tracking of TV viewing over childhood, such that heavy viewing in the preschool age group predicts greater TV viewing in later childhood and adolescence (4–6). Additionally, over one-third of children under the age of 6 years (7) and more

than half of middle school-age children have TVs in their bedrooms (2). Research indicates that having a TV in the room where a child sleeps predicts greater TV use (8–10) and that once TVs are placed in a child's bedroom, they are not often removed (11).

Several studies reveal a dose–response relationship between the average hours of TV young children watch and prevalence of obesity (4,12–16). Children who watch commercial TV are exposed to more food and beverage advertisements, which increase obesity risk (17,18). They are also more likely to eat when the TV is on, and sometimes in larger amounts, because satiety cues are often disregarded while viewing (19–21).

Few studies have independently examined relationships between obesity and video game use, computer use, or total screen-media use. Some show an association, while others do not (22–28). This may be because some video games and Internet sites contain food and beverage advertisements, product placements, or "advergaming" (in which an advertised product is embedded in a game (29,30)), but many do not. Video game play has also been associated with both increased calorie consumption after gaming (31) and energy expenditure/calorie burning during gaming, especially when children play active games, like those made for *Nintendo's Wii* gaming system (32,33).

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A major public health problem, obesity puts children at risk for heart disease (34), type 2 diabetes (35), asthma (25,36), and depression (34) and is associated with higher morbidity and mortality in adulthood (37,38). Since it is very challenging to reduce obesity once established, early intervention may prove essential for prevention of childhood obesity and its associated complications (39,40). Intervention strategies could include limiting TV or screen time, discouraging parents from putting TVs in their children's bedrooms, or removing the TVs if they are already there.

Many interventions have aimed to prevent or treat obesity by reducing TV viewing, or total screen time, in children (39,41,42). While some have reduced viewing, others have not been successful. To our knowledge, few systematic reviews have solely examined early intervention strategies to limit TV or total screen time, discourage parents from putting TVs in their children's bedrooms, or remove TVs if they are already there. In addition, although prevention efforts may have the largest impact for children <6 years of age, a paucity of studies summarizes what is known about media reduction programs for infants or preschool-aged children. Hence, the purpose of this review was to identify and summarize studies that reduce TV viewing or screen time in children 6–12 years of age, as well as birth to <6 years of age, in order to identify effective strategies for future interventions with these populations and to develop future research priorities based on gaps in the current literature.

METHODS AND PROCEDURES

Literature search

We conducted a systematic review of the published literature on intervention studies to reduce TV viewing in children, from 1947 through June 2011, using the terms “intervention” and “television,” “media,” or “screen time,” to identify relevant studies. Databases searched included MEDLINE/PubMed, Academic Search Premier, RePort, ERIC, NHS EED, the Cochrane Database of Systematic Reviews, and the Cochrane Register of Controlled Trials. We also reviewed reference lists of included papers and other relevant reviews and meta-analyses.

Inclusion criteria

Eligible intervention studies were broadly defined as research studies that aimed to reduce TV viewing, or total screen-media use, in children. Studies that did not directly aim to influence screen-media use but aimed to modify behaviors related to overweight or obesity, physical activity, or nutrition and recorded some measure of frequency of TV viewing/screen-media use, as a primary or secondary outcome were also eligible for inclusion. Eligible studies had to include children under age 12, be peer reviewed, and in English. Case studies and theses were excluded. Studies were not excluded because of their designs, durations, or settings.

One author (M.E.S.) read all the titles and abstracts identified in the initial searches. Since our search criteria were very broad, a large number of studies were excluded because it was obvious from their titles that they did not fit our inclusion criteria. Many studies also repeated across databases. After reviewing all of the study titles, one author (M.E.S.) reviewed all the remaining abstracts, and another author (A.O.) separately reviewed all the abstracts of the papers selected for inclusion by the first author to verify eligibility. Of 144 possible titles, 47 were selected for inclusion. Decisions about excluding studies were based on thorough reading of the selected papers by one author, and, if necessary, discussion among the other authors. Common reasons for exclusion included no intervention component (e.g., correlation studies), results not reported, child TV viewing not a measured outcome, not an original article, case studies, or no participants under age 12.

RESULTS

Tables 1, 2, and 3 show the characteristics of the 47 intervention studies selected for inclusion, categorized by age group and study setting. Almost all studies included a home component and most took place in more than one setting. For this review, we categorized studies into settings based on where the intervention program was primarily delivered. Settings included schools, homes, community settings, and clinics.

Among included studies, a wide variety of strategies were used to reduce children's TV viewing. These included educational sessions, physical activity sessions, resources/curricula for teachers, resource kits for parents, parent newsletters, electronic TV time monitors (e.g., TV Allowance, Mindmaster, Miami, FL), incentives, open- or closed-loop contingent systems, activity programs, and community advertising. Most interventions (35 of 47, or 74%) were randomized controlled trials and

lasted less than one year (32 of 47, or 68%). Only 11 (23%) evaluated follow-up effects beyond the end of the intervention period. In all, 29 of 47 studies (62%) reported statistically significant reductions in TV viewing or total screen time after intervention.

In the subheadings below, studies are reviewed in greater detail, within setting categories and age groups. Special attention is given to intervention strategies and their outcomes. Given the many differences across cultures in nutrition, physical activity, and educational systems, results are separated into United States and international studies in the tables; however, all programs that share settings and ages are reviewed together.

Early education and school-based studies

Almost all school-based studies involved some kind of in-class instruction about nutrition, physical activity, and/or media use; some programs also included a physical education program, teacher training, and/or school food service modifications. Only four programs were found for children <6 years of age. Most school-based studies had large sample sizes, with participants 8 years of age or older. The majority of programs lasted between 6 months and 1 year; only three lasted 2 years or longer.

Early education and school-based studies, children under 6 years. As reported in Table 1, four school-based studies with children under 6 years of age were included in our review, and only one of these significantly reduced TV viewing. One additional study reduced total screen time. All took place in the United States and were randomized controlled trials. Three lasted for 14 weeks, and one lasted for 7 weeks; three had sample sizes under 500. Three of the interventions were specifically designed to target racial/ethnic minority children (43–45).

Only Dennison *et al.* significantly reduced TV viewing (~3 h per week), via a 7-session, weekly TV reduction-focused intervention program, which also provided participants with a variety of materials for parents and children to use at home. Video/computer game play, measured separately, was not

Table 1 Summary of school-based studies: design, duration, participants, sample, primary exposures/outcomes, intervention, and results*

Author, design, duration, location	Final sample size, participants, setting	TV-related measures	Intervention	TV and weight-related outcomes
US studies, preschools, children under 6 years				
Dennison, B <i>et al.</i> , 2004 (46), RCT, 7-weeks, Upstate NY	N = 77, 2.6–5.5 years; 16 preschool and/or daycare centers	TV/video viewing, computer/video game play, TV in bedroom, days child ate dinner with TV on, snacking with TV (parent report)	Intervention: Child education on reducing TV (7 lessons, 1/week) led by program staff, materials for teachers Parent involvement: Materials sent home with children (e.g., calendar, book, lists of alternatives to TV), 1-week TV turnoff campaign, 1-week viewing diary Control: Safety and injury prevention program	Reduction in TV viewing (adjusted difference –4.7 h/week, 95% CI: –8.4, –1.0, P = 0.02) for intervention group (–3.1 h/week vs. +1.6 h/week for control) No change in video/computer game play No significant differences in BMI
Fitzgibbon, M <i>et al.</i> , 2005 (43), RCT, 14 weeks, with 1- and 2-year follow-up, Chicago, IL	N = 300, 3–5 years; 12 Head Start sites; >90% Black	TV viewing (parent report)	Intervention: Child education on nutrition, physical activity, and decreasing sedentary behavior; physical activity sessions (3/week) Parent involvement: Weekly newsletters and homework assignments Incentives: Grocery coupon for parents for completing weekly homework assignments (\$5/assignment) Control: General health intervention	No significant change in TV viewing Smaller increases in BMI for intervention group children at 1 year (P = 0.01) and 2 year (P = 0.02) follow-up
Fitzgibbon, M <i>et al.</i> , 2006 (44), RCT, 14 weeks, with 1- and 2-year follow-up, Chicago, IL	N = 331, 3–5 years; 12 Head Start sites; >80% Latino	TV viewing (parent report)	Intervention: Child education on nutrition and physical activity and decreasing sedentary behavior, physical activity sessions (3/week) Parent involvement: Weekly newsletters and homework assignments Incentives: Grocery coupon for parents for completing weekly homework assignment (\$5/assignment) Control: General health intervention	No significant changes in TV viewing or BMI
Fitzgibbon, M <i>et al.</i> , 2011 (45), RCT, 14 weeks, Chicago, IL	N = 589, 3–5 years; 18 Head Start sites; >80% Latino	TV, DVD, videotape viewing and video games or computer use (parent report)	Intervention: Child, culturally adapted education on nutrition and physical activity and decreasing sedentary behavior, physical activity sessions (2–3/week), teacher training, Parent involvement: Weekly newsletters, homework assignments, and CD with teacher's lessons Incentives: Grocery coupon for parents for completing weekly homework assignment (\$5/assignment) Control: General health intervention (1/week) and newsletter	Reduction in total screen time (–27.8 min/day, P = 0.05) No change in TV viewing No change in BMI
US studies, schools, 6- to 12-year-olds				
Gortmaker, SL <i>et al.</i> , 1999 (51), RCT, 2 years, Boston, MA	N = 1,295, 6th and 7th graders; 10 schools	TV/video viewing and video and computer games (child report)	Intervention: Child education (16/year) on nutrition, physical activity, and reducing TV, physical activity materials and 5-min sessions (30/year), teacher training Parent involvement: 2-week “power down” household TV reduction campaign Incentives: \$400–\$600 for intervention schools, in response to teacher submitted proposals, teacher/staff wellness sessions Control: Usual health education	Greater reduction in TV/video viewing for intervention group girls (adjusted difference –0.58 h/day, P = 0.001, –0.7 vs. –0.11) and boys (adjusted difference –0.40 h/day, P < 0.001, –0.7 vs. –0.35), compared to controls Reduced obesity (composite of BMI and TSF, triceps skinfold thickness) prevalence in intervention girls (P = 0.03) TV viewing reduction predicted reduced obesity prevalence in girls (OR = 0.85, 95% CI: 0.75, 0.97, P = 0.02)

Table 1 Continued on next page

Table 1 (Continued)

Author, design, duration, location	Final sample size, participants, setting	TV-related measures	Intervention	TV and weight-related outcomes
Gortmaker, SL <i>et al.</i> , 1999 (47), quasi-experimental field trial, 2 years, Baltimore, MD	<i>N</i> = 479, 4th and 5th graders; 14 schools; 91% Black; low SES	TV viewing and video/computer games (child report)	Intervention: Child education (13/year in class, plus 5 in PE in year 2) on nutrition, physical activity, and reducing TV, "Eat Well" cards to tie lessons to food service, teacher training, campaigns to decrease TV, walking clubs Parent involvement: Information sent to parents through school newspaper, parent coalition Incentives: Staff wellness meetings Control: Usual health education	Marginal reduction in TV viewing (<i>P</i> = 0.06) BMI outcomes not measured
Robinson, TN, 1999 (56), RCT, 6-month duration, San Jose, CA	<i>N</i> = 192; 3rd and 4th graders; 2 schools	TV viewing, videotape viewing, video game play, eating in front of TV (child report, parent report)	Intervention: Child education (18 sessions) on decreasing media use, teacher training Electronic monitor: Yes, optional (42% reported installing it), available for all TVs in home (27% requested more than 1), (TV Allowance, Mindmaster, Miami, FL) Parent involvement: Ten-day TV turnoff, asked to encourage 7 h/week TV budget, newsletters Control: Usual health education	Reduction in child-reported TV viewing (adjusted difference -5.53 h/week, 95% CI: -8.64, -2.42, <i>P</i> < 0.001) Reduction in parent-reported TV viewing (<i>P</i> < 0.001) Reduction in child-reported video game play (<i>P</i> = 0.01) Greater reductions for intervention group in BMI (<i>P</i> = 0.002), TSF (<i>P</i> = 0.002), and frequency of meals eaten in front of TV (<i>P</i> = 0.01)
Jones, D <i>et al.</i> , 2008 (57), RCT, 1.5 years, Central Texas	<i>N</i> = 606, 6th and 7th graders; 12 schools; girls	Daily TV and video viewing, daily computer/video games, total daily sedentary activity (child report)	Intervention: Child education on nutrition and physical activity, including some physical activity (16 sessions, 3/week, in 6th grade; science-based lessons during science in 7th grade), behavioral journalism program (school newsletter with role model stories), physical activity sessions, modified school food service (promote calcium rich foods) Control: Usual health education	Reduction in daily TV/video viewing (adjusted difference -12.11 min/day, 95% CI: 11.74-12.48, <i>P</i> = 0.05) in intervention group (-16.7%), compared to controls (+17.9%) Reduction in total sedentary activity (<i>P</i> < 0.05) No reduction in computer/video game use BMI outcomes not measured
Spruijt-Metz, D <i>et al.</i> , 2008 (48), RCT, 5-7 days, with 3-month follow-up, California	<i>N</i> = 459, middle school girls, mean age 12.5; 7 schools; 73% Latina	Sedentary behavior (watching TV or movies, playing video games, surfing the Internet), (child report)	Intervention: Classroom sessions (1/day for 5 days) on increasing physical activity, reducing time with TV or computer, children create public service announcements on increasing physical activity Control: Usual education	Reduction in sedentary behavior time (<i>P</i> < 0.05) No significant change in BMI
Gentile, D <i>et al.</i> , 2009 (58), RCT, 6 months, with 6-month follow-up, Lakeville, MN and Cedar Rapids, IA	<i>N</i> = 992, 3rd, 4th, and 5th graders; 10 schools	Screen time (includes TV viewing and playing video games), (parent report, child report)	Intervention: Classroom materials to teachers, including materials on nutrition, physical activity, and reducing screen time, community advertising (e.g., billboards) Control: Usual health education	Reduction in parent-reported screen time (<i>t</i> (8) = -2.15, Cohen's <i>d</i> = 1.26, <i>P</i> < 0.05) at 6 months and at 6-month follow-up (<i>t</i> (8) = -2.06, <i>d</i> = 1.38, <i>P</i> < 0.05) No significant change in child-reported screen time No significant change in BMI
International studies, schools, 6- to 12-year-olds				
Burke V <i>et al.</i> , 1998 (103), RCT, 20 weeks, with 6-month follow-up, Western Australia	<i>N</i> = 720, 11-year-olds; 18 schools	TV viewing (child report)	Intervention: Child education (6 lessons) on physical activity, nutrition classes (1/week), teacher materials, activity diaries and goal-setting with teachers (for enrichment/high risk group only) Parent involvement: Materials sent home, asked to monitor activity diary completion and encourage physical activity (for enrichment/high risk only) Incentives: Booklet with stickers, chart, and certificate Control: Usual health education	No significant change in TV viewing at intervention end Reduction in TV viewing 6 months after the end of the intervention only (-17.7 min/week vs. controls 22.8 min/week, <i>P</i> = 0.014), for enrichment group boys (high risk group) No significant change in BMI

Table 1 Continued on next page

Table 1 (Continued)

Author, design, duration, location	Final sample size, participants, setting	TV-related measures	Intervention	TV and weight-related outcomes
Muller, M <i>et al.</i> , 2001 (40), RCT, first year of ongoing 8-year study, with 1-year follow-up, Kiel, Germany	N = 297, 5–7 years; 6 schools	TV viewing (child report)	Intervention: Child education (8-h course) on nutrition, physical activity ≥ 1 h/day, TV < 1 h/day, teacher training; for obese only (20% of sample), 3–5 home counseling sessions, 6-month, 2/week sports program Parent involvement: Parent education (1 school meeting); for obese only, home counseling and food and activity monitoring by parent Control: Usual health education	Reduction in TV viewing (1.9–1.6 h/day, <i>P</i> < 0.05) at 3 months At 1-year follow-up, control schools children showed greater increase in percentage fat mass of overweight children (<i>P</i> < 0.05) and median TSF (<i>P</i> < 0.01) No significant change in BMI
Sahota, P <i>et al.</i> , 2001 (104), RCT, 1 year, Leeds, UK	N = 595, 7- to 11-year-olds; 10 schools	Sedentary behavior (watching TV and playing on the computer), (child report)	Intervention: Teacher training, school meals changes, curriculum/PE education changes via “school action plans” developed by schools Control: Usual school curriculum	No overall difference in sedentary behavior (TV and computer use) Increase (33%) in sedentary behavior in overweight intervention children (0.03 weighted mean difference, 95% CI, 0.0–0.7) vs. overweight controls No significant change in BMI
Simon, C <i>et al.</i> , 2004 (55), RCT, first 6 months of 4-year study, Bas-Rhin, France	N = 859, 11.7 ± 0.6 years; 8 schools	Sedentary activity time (TV viewing and computer/video games), (child report)	Intervention: Child education on physical activity and sedentary behaviors (>2 classes), expanded physical activity offerings in and after school Parent involvement: Meetings and regular contact with teachers and parent/sport organizations Control: Usual health education	Significant decrease in proportion of children spending >3 h/day in sedentary activity for intervention group for girls (24%–17%, OR = 0.54, <i>P</i> < 0.001) and boys (44%–41%, OR = 0.52, <i>P</i> < 0.001), compared to controls BMI not assessed in first 6 months
Paradis, G <i>et al.</i> , 2005 (49), pre-post design with a comparison community, 2 years, with 6-year cross-sectional follow-up, Mohawk community of Kahnawake, Canada	N = 449, 1st through 8th graders; 2 schools in Aboriginal Mohawk population	TV watching and video playing (parent report for grades 1–3, child report for grades 4–6)	Intervention: Child education (10 lessons/year, per grade) on diabetes, nutrition, and physical activity, community ads and promotional events, staff training, construction of community walking path, junk food ban in schools Control: Nonequivalent comparison community	On school days, marginal reduction in TV and video watching in intervention group relative to comparison (<i>F</i> (1 189) = 2.67, <i>P</i> = 0.10); no difference on Saturdays No change in BMI Smaller increase in TSF in intervention group (<i>P</i> < 0.01) In cross-sectional analyses, TV decreased years 1–5, but increased to baseline by year 8
Harrison, M <i>et al.</i> , 2006 (52), quasi-experiment with control, 16 weeks, Southeast Ireland	N = 284, 10.2 ± 0.7 years; 9 schools; low SES	Screen time (TV, videotape/DVD, computer game use), (child report)	Intervention: Child education (10 lessons) on reducing TV and computer game use and increasing physical activity, teacher training and resources, student workbooks and diaries Parent involvement: One-night TV turnoff, activity points system for budgeting TV and physical activity (part of school homework/parents sign off on diaries) Control: Usual health education	No significant change in screen time No significant change in BMI
Salmon, J <i>et al.</i> , 2008 (53), RCT, 1 year, with 6- and 12-month follow-up, Melbourne, Australia	N = 268, 10-year-olds; low SES	TV viewing, computer use, electronic games use (child report)	Intervention: <i>Behavioral Modification Group (BM)</i> : Child education (19 lessons, over 1 year) on reducing/budgeting screen time and increasing physical activity; <i>Fundamental Movement Skills Group (FMS)</i> : Child physical education (19 lessons, over 1 year); <i>Combined BM/FMS</i> All of the above; all lessons delivered by same specialist PE teacher Parent involvement: Parents sign off on contract to reduce TV viewing (turn off 1 TV program/week until 4 programs), parent newsletter Control: Usual health education	Greater increase in TV viewing (+229 min from baseline to postintervention, and at 6- and 12-month follow-up) in BM intervention over control (<i>P</i> < 0.05) No significant change in TV viewing for BM/FMS or FMS groups No significant changes in computer use or electronic game use Reduced BMI for BM/FMS group postintervention and at 6- and 12-month follow-up (<i>P</i> < 0.05)

Table 1 Continued on next page

Table 1 (Continued)

Author, design, duration, location	Final sample size, participants, setting	TV-related measures	Intervention	TV and weight-related outcomes
Colin-Ramirez, E <i>et al.</i> , 2010 (50), RCT, 1 year, Mexico City, Mexico	N = 498, 8- to 10-year-olds; 10 schools; low SES	Sedentary activities (TV, video movies, computer, video games, arcade games) (child report)	Intervention: Child education (1/week for 20 weeks) on physical activity, by health teams, classroom exercise breaks for 2–10 min, substitute high energy output exercise in PE for regular exercise (30 min, 2/week), program manuals for staff Parent involvement: Home materials (book of activities and exercises to do at home with parents), recommended to decrease child's time with sedentary media activities Control: Not specified	No change in TV viewing or computer use (effects only measured in subgroup of children who spent >3 h/day in sedentary activities) Among children who spent >3 h per day playing video games at baseline, reduction in video game play (P = 0.01) BMI not measured
Salmon, J <i>et al.</i> , 2010 (54), RCT, 7 weeks, Melbourne, Australia	N = 908, 9- to 12-year-olds; 15 schools; low SES	TV viewing, computer use, electronic games use, self-efficacy, behavioral capability, for reducing TV (child report)	Intervention: Child lessons (6 lessons) on reducing/budgeting screen time, with an emphasis on TV, and increasing physical activity, contract to reduce TV viewing (turn off 1 TV program/week until 4 programs) Control: Usual health education	Significant decrease in weekend screen time (sum of TV, computer, and video games), (–20 min/week difference in change scores over time) for intervention boys only (–0.62, 95% CI: –1.15, –0.10, P = 0.02) Increase in self-efficacy (P < 0.05) and behavioral capability (P < 0.01) for reducing TV viewing BMI not measured

Tables 1, 2, and 3 report only those aspects of each study that relate to media use or BMI as these were the goals of our review. The intervention strategies, measures, and outcome variables, listed in these tables are not comprehensive, but are specifically limited to those related to TV viewing. CI, confidence interval; RCT, randomized controlled trials; SES, socioeconomic status.

reduced (46). Three other school-based studies with preschool-aged participants tested the same intervention program (“Hip Hop to Health”) among Black and Latino children (43–45). Although the “Hip Hop to Health” program did not reduce TV viewing in any of the studies, total screen time was reduced, by just under 28 min per day, in one study (45).

The Dennison *et al.* study specifically targeted reducing TV viewing or promoting alternatives to TV viewing, like reading. Further, the Dennison *et al.* intervention included two “TV turnoff week” components, and parents were provided with materials and incentives to facilitate achieving their child’s TV reduction targets. In contrast, the “Hip Hop to Health” interventions primarily targeted diet and physical activity, and devoted only 1 week of each of the 14-week programs to reducing TV viewing.

School-based studies, 6- to 12-year-old children. Fifteen studies implemented in grade schools were selected for inclusion, as detailed in **Table 1**. Six took place in the United States, and nine took place internationally. Most school-based studies with 6- to 12-year-old children

were randomized controlled trials and had over 500 participants. Almost half lasted for 1 year or longer. Three of 15 studies specifically recruited ethnic minorities (47–49); five studies specifically recruited from low socioeconomic status (SES) schools (47,50,52–54).

As measured at the end of the intervention programs, eight of 15 school-based intervention programs significantly reduced TV and/or screen-media use. Robinson *et al.* reported the largest reductions (~1 h per day) in screen-media use (56), followed by Gortmaker *et al.* (~40 min per day (51)) and Muller *et al.* (20 min per day, TV only) (40). Jones *et al.* (57), Sprujit-Metz *et al.* (48), and Salmon *et al.* (54) all reported reducing screen media by less than 20 min per day. Gentile *et al.* reported a 2-h per week reduction in screen time, but only according to parent, and not child, report (58). One additional study, by Simon *et al.*, reduced the proportion of children spending >3 h per day in sedentary activity, by 7% in girls and 3% in boys (55).

All but one of these programs specifically focused on screen-media reduction or had content on reducing screen media as a major part of classroom lessons.

Like Dennison *et al.*, many also utilized household TV reduction campaigns, e.g., Robinson included a 10-day TV turnoff campaign (56) and Gortmaker *et al.* included a 2-week “power down” campaign (51). The use of electronic TV time monitors was a unique component of the Robinson trial that reported the largest statistically significant reductions in screen media (56).

Home-based studies

A variety of intervention programs have been tested in homes, including contingent feedback systems, TV time monitors, and parent education programs. Most home-based studies lasted less than 6 months and had less than 50 participants. Unlike school-based programs, most home-based interventions reviewed here specifically recruited obese or overweight participants (59–62), and/or participants who watched above average amounts of TV (60,62–64). No home-based studies specifically recruited ethnic minorities or low-SES participants. Only two home-based interventions included children under 6.

Home-based studies, children under 6 years. As shown in **Table 2**, two

Table 2 Summary of home- and community-based studies: design, participants, sample, primary exposures/outcomes, intervention, and results

Author, design, duration, location	Final sample size, participants	Intervention targets	Intervention	TV & Weight-related Outcomes
US studies, homes, under 6 years				
Epstein, LH <i>et al.</i> , 2008 (59), RCT, 2 years, Buffalo, NY	N = 67, 4- to 7-year-olds; BMI ≥75th %; TV viewing ≥ 14h/week; unlimited TV access	TV viewing and computer game use (electronic device)	Intervention: Electronic TV monitors set to TV budget (10% less per month to 50% of baseline), home visits, monthly newsletters Electronic monitor: Yes, on all TV and computers in home (TV Allowance, Mindmaster, Miami, FL) Parent involvement: Monthly newsletters Incentives: \$.25 for every half-hour TV time under budget/day, up to \$2.00/week, star chart Control: Free access to TV and computer games, monthly newsletter with parenting tips, \$2.00/week not linked to TV viewing	Greater reduction in TV viewing and computer games in the intervention group (-17.5 h/week) than control (-5.2 h/week), <i>P</i> < 0.001 Greater reduction in BMI z-score (<i>P</i> < 0.05)
Essery, EV <i>et al.</i> , 2008 (65), RCT, 12 weeks, Denton, TX	N = 90, 2- to 5-year-olds	Media time (time spent viewing TV or playing on the computer), (parent report)	Intervention: Weekly newsletters or one, 52-page booklet on child feeding practices and physical activity for preschoolers Parent involvement: All; newsletters or booklet Control: No intervention materials until after the study	No significant change in media time BMI not measured
US studies, homes, 6- to 12-year olds				
Faith, M <i>et al.</i> , 2001 (60), pilot RCT, 12 weeks, New York, NY	N = 8, 8- to 12-year-olds; BMI > 85th %; TV viewing > 2h/day; no regular physical activity	TV viewing (TV cycle computer)	Intervention: Contingent TV placed in child's home (stationary cycle ergometer), parent controlled locks on other TV sets Incentives: \$10/month Control: TV viewing not contingent on cycling	Intervention group (1.6h/week) watched less TV than the control (21 h/week), <i>t</i> = -6.42, <i>P</i> = 0.006. In intervention group, TV viewing decreased from baseline (22.8h/week) to weeks 9-12 (1.1 h/week, <i>t</i> = -7.14; <i>P</i> < 0.0001) No significant change in BMI
Todd, MK <i>et al.</i> , 2008 (64), RCT, 20 weeks, Harrisonburg, VA	N = 21, 8- to 11-year-olds; males; TV > 3.5h/day; media > 5.8h/day	Electronic media use (TV, DVD, and computer use), (child report)	Intervention: TV and computer monitors, suggest media ≤ 90 min/day, logbooks for children's media use, activity, and food eaten during media use Electronic monitor: TV (up to 2 for family), and computer monitors (TV Allowance, Mindmaster, Miami, FL and ENUFF software) Parent involvement: Family education (1 seminar, 90 min, on TV reduction), daily follow-up with child about logbooks, 3 newsletters, weekly phone calls Control: Same self-report instructions but no intervention components	Significant treatment by time interaction (<i>P</i> < 0.05) for media use; from 153 min/day at baseline to 81 (10 weeks) or 82 (20 weeks) min/day Meals or snacks eaten while using electronic media/day decreased (-70%) in the intervention group (<i>P</i> < 0.05) Significant treatment by time interaction for body fat (<i>P</i> < 0.05) No reduction in BMI
International studies, homes, 6- to 12-year-olds				
Golan, M <i>et al.</i> , 1998 (61), RCT, 1 year, Rehovot, Israel Public school system	N = 60, 6- to 11-year-olds; obese (20% over ideal weight)	Television viewing (parent report)	Intervention: Parent education only Parent involvement: Fourteen group sessions with a dietitian, five individual sessions on parenting skills, diet, and behavioral modification Control: Child education only (30 group sessions with a dietitian) on diet, physical activity, self-monitoring, restricted calorie diet	No difference in TV viewing among groups Greater weight reduction in experimental vs. control group (<i>P</i> < 0.05)
Goldfield, GS <i>et al.</i> , 2006 (62), RCT, 8 weeks, Ottawa, Canada	N = 30, 8- to 12-year-olds; BMI > 85%; TV ≥ 15h/week; physical activity <30min/day	Sedentary behavior (TV/VCR/DVD/video game playing time), (child report)	Intervention: Open-loop feedback plus reinforcement; TV time earned with PA (pedometer counts, 400 counts of PA = 1h TV/VCR/DVD time) Electronic monitor: Yes, TV Token device (Stokes, St. Mazomanie, WI) on every TV in home Parent involvement: Carry out reinforcement plan, biweekly meetings with staff Incentives: \$10 for attending baseline and biweekly meetings, \$20 at follow-up Control: Participants wear activity monitors only	Sedentary behavior reduced by 116.1 min/day (-72%) in the intervention group (vs. +14.3 min/day in the control, <i>P</i> < 0.001). Greater improvements in BMI in intervention group (<i>P</i> < 0.05)

Table 2 Continued on next page

Table 2 (Continued)

Author, design, duration, location	Final sample size, participants	Intervention targets	Intervention	TV & Weight-related Outcomes
Ni Mhurchu, C <i>et al.</i> , 2009 (63), pilot RCT, 6 weeks, Auckland, New Zealand	<i>N</i> = 27, 9- to 12-year-olds; TV > 20h/week	TV viewing, total screen time (TV, computer, video game use), number and location of TV sets (child report)	Intervention: Electronic TV monitors, suggest TV viewing <1 h/day Electronic monitor: Yes, up to 2 per family (Time Machine by Family Safe Media) Parent involvement: Parent education (1 in-home discussion) on how to use monitor and manage TV viewing Control: Verbal advice on reducing TV viewing	No significant change in TV viewing No significant change in total screen time No change in BMI
US studies, community settings, 6- to 12-year-olds				
Robinson, TN <i>et al.</i> , 2003 (66), RCT, 12 weeks, Oakland, CA and East Palo Alto, CA	<i>N</i> = 60, 8- to 10-year-olds; girls; African American; BMI ≥ 50% for age, and at least one overweight parent	TV viewing, videotape viewing, & video game use (child report), household TV use (parent report), days/week ate meals with the TV on (child report)	Intervention: Child education (5 in-home lessons on reducing television, videos, and video game use, led by a mentor—for child and any available family members), after-school dance classes (5/week), optional TV time monitors, 2-week TV turnoff Electronic monitor: Yes, TV Allowance (TV Allowance, Mindmaster, Miami, FL) made available to families (82% of families hooked up at least one monitor) Parent involvement: Possible attendance at in-home lessons, five newsletters Incentives: \$25 after baseline, \$75 after follow-up Control: Health education program on diet and PA, monthly lectures, newsletters to parents and children	Reduced household television viewing among intervention group (−0.56 h/week, 95% CI: −0.95, −0.17, <i>P</i> = 0.007) and fewer dinners eaten while watching TV (<i>P</i> = 0.03). No significant change in total TV, videotape, and video game use No significant change in BMI; trend toward lower BMI for intervention group
Weintraub, D <i>et al.</i> , 2008 (67), RCT, 6 months, Near Palo Alto, CA Schools, clinics, and community centers	<i>N</i> = 21, 4th and 5th graders; BMI ≥ 85th %; 86% Hispanic, 9% Black, 5% Pacific Islander	Screen time (TV viewing, videotape viewing, video game use), (child report)	Intervention: 3–4 days/week after-school soccer program Parent involvement: Soccer matches with children and coaches Incentives: Certificates of accomplishment and medals at program completion Control: Twenty-five session nutrition and health education intervention weekly after school	No significant change in screen time Baseline BMI z-scores by treatment interactions at 6 months (<i>P</i> = 0.04) for soccer group, with decreases in BMI for soccer group
Escobar-Chaves, SL <i>et al.</i> , 2010 (102), RCT, 6 months, Houston, TX	<i>N</i> = 196, families with children 6- to 9-year-old; 28% African American, 17% Latino, 11% Asian	TV, DVD, video game, computer use, handheld games, total media use, snacking while watching TV, TV on while no one is watching (parent report)	Intervention: Family education (1 workshop) on reducing TV viewing and other media, bimonthly newsletter Parent involvement: Family education and newsletters Control: Not specified	Intervention group less likely to report the TV being on while nobody was watching (<i>P</i> < 0.05), eating while watching TV (<i>P</i> < 0.05), and less likely to have a TV in the child's bedroom (<i>P</i> < 0.01). Trend toward less media use in the intervention group (nonsignificant) BMI not measured
Robinson, TN <i>et al.</i> , 2010 (68), RCT, 2 years, Oakland, CA Schools, community centers/events, churches	<i>N</i> = 225, families with 8- to 10-year-old girls; African American; low income; BMI > 25, <35, and/or one overweight guardian	TV viewing, videotape viewing, video game use, computer use, frequency of eating with TV on, (child report), household TV viewing (parent report)	Intervention: After-school dance program (5/week); family counseling on reducing screen-media use (up to 24 lessons) Parent involvement: Mentors meet with parents in home about TV viewing Incentives: Dance performances, including awards Control: Health education program on nutrition, physical activity, and reducing cardiovascular and cancer risk, 24 newsletters to girls and their parents, and lectures (4/year)	No significant reduction in media use No significant change in BMI

Table 2 Continued on next page

Table 2 (Continued)

Author, design, duration, location	Final sample size, participants	Intervention targets	Intervention	TV & Weight-related Outcomes
Sepulveda, MJ <i>et al.</i> , 2010 (71), nonrandom, pre-post design, 12 weeks, United States, Employees of IBM	N = 11,631, employees with 2- to 18-year-old children	Entertainment screen time (parent report)	Intervention: Online employee education on healthy eating and family meals, physical activity, healthy parental role modeling, and reducing screen time, family behavior inventory, action goal setting and weekly monitoring, follow-up inventory, access to online resource center Parent involvement: Parent education program Incentives: \$150 cash rebate on program completion	Program completers were more likely to have children who watch <1 h of entertainment screen time per day after the program (22.4% to 30.7%, <i>P</i> < 0.001) BMI not measured
International studies, community settings, 6- to 12-year-olds				
Sacher, P <i>et al.</i> , 2010 (69), RCT, 6 months, with 6-month follow-up, London, UK	N = 82, 8- to 12-year-old (N = 41 at 12 months—intervention only); BMI ≥ 98 %	Sedentary activities e.g., TV, computer, (parent and child report)	Intervention: Family education (18 sessions, 2/week, on behavior change and nutrition), 16 PA sessions, 12-week free swimming pass, staff training, educational materials Parent involvement: Family education and physical activity, swimming Control: Waiting list control (intervention delayed 6 months)	Reduction in sedentary activity (<i>P</i> = 0.01), (21–16h/week in intervention, vs. 20.9–21.7 in control) Reduction in BMI z-score (<i>P</i> < 0.0001) Within-subject analysis of intervention group only showed reduction in BMI at 6-month follow-up (<i>P</i> < 0.0001), no reduction in sedentary activity
de Silva-Sanigorski, AM <i>et al.</i> (2010) (70), quasi-experiment with comparison sample, 2 years, Victoria, Australia Daycares, preschools, Maternal/Child Health and Immunization Services, community health centers	N = 1,040, 0- to 5-year-olds	Time with TV, DVD, videos, or computer games (parent report)	Intervention: Community-wide program on play, nutrition, and reducing screen time; resources for parents and teachers, training of early childhood workers, demonstrations for families, promotional materials Parent involvement: Resources for parents, parents attend demonstrations Incentives: Gifts of lunch bags and water bottles Control: Comparison sample	Media use significantly less in intervention group than comparison group at follow-up (−0.3, 95% CI: −0.04, −0.02, <i>P</i> < 0.001) No significant reduction in media use from baseline to study end in intervention group Lower BMI in 3.5-year-old subsample and lower prevalence of obesity in 2- and 3.5-year-old subsamples (<i>P</i> < 0.05)

RCT, randomized controlled trials.

home-based studies included children under age 6. Only Epstein *et al.* successfully reduced screen-media use by using TV Allowance devices, monetary incentives, and sticker charts to reward children for reducing their TV time to 50% of baseline. After 6 and 24 months, children in the intervention group recorded 17.5 fewer hours of TV and computer use per week (59). In contrast, the second home-based study for children under 6, by Essery *et al.*, utilized weekly newsletters or a 52-page booklet to improve preschoolers' feeding practices and physical activity (65). Reducing TV viewing was recommended in the newsletter/booklet; however, the program did not specify particular goals for reducing TV viewing, nor was TV reduction its primary focus.

Home-based studies, 6- to 12-year-old children. Three of five home-based studies significantly reduced TV viewing, or screen-media use, in 6- to 12-year-old children (see Table 2). Faith *et al.* employed a “closed-loop” feedback system to reduce TV viewing in school-age children and recorded the largest reductions (~20h per week) among home-based studies. Participants could only watch TV while they pedaled a custom-made stationary bicycle, attached to a home TV, at a prescribed level of intensity (60). Goldfield *et al.* also used a contingent feedback system, albeit an “open-loop” one, in which intervention participants' TV access was made contingent on their level of physical activity—for each 400 counts of physical activity on a pedometer, they could watch

1 h of TV/VCR/DVDs, as managed by an electronic device. Goldfield reduced TV/VCR/DVD/video game playing time by ~2h per day (62). Using electronic TV time monitors, TV time budgets, and TV viewing diaries, Todd also reduced screen-media use, by about 1 h per day (64).

Community-based studies

A variety of intervention programs were conducted at the community level, including family workshops, an after-school dance program, and an employee wellness program. Seven interventions were delivered in community settings, and all targeted children over 6 years of age. Five were conducted in the United States, while two occurred in the United Kingdom and in Australia. Most had

Table 3 Summary of clinic-based studies: design, participants, sample, primary exposures/outcomes, intervention, and results

Author, design, duration, location	Final sample size, Participants	Intervention targets	Intervention	TV and weight-related outcomes
US studies, clinics, under age 6				
Johnson, D <i>et al.</i> , 2005 (78), prospective study, 6 months, Washington state WIC program	N = 8,977 parents; 59% white, 25% Hispanic	TV viewing; TV viewing during meals (parent report)	Intervention: Staff training, staff materials, banners/posters, print materials for clients, in family meal module and physical activity module (both include TV reduction) Parent involvement: Educational sessions Control: No control	Increase in proportion of WIC families reporting watching 2 h or less of TV per day (70.5% vs. 64.2%, $P < 0.001$) Increase in proportion of WIC families who report they do not usually or never watch TV during meals (69% vs. 65%, $P < 0.001$) BMI not measured
Johnston, BD <i>et al.</i> , 2006 (79), concurrent comparison, randomized controlled trial, 30 months, Pacific Northwest	N = 343 pregnant women at 16- to 20-week gestation; age < 45 years old	Parenting practices, including limiting TV viewing (parent report)	Intervention: Home visits with program specialist, parenting classes, and intervention and screening for risk behaviors (not related to media), three prenatal home visits Parent involvement: Educational sessions Control: Standard package of well-child pediatric care.	Intervention group parents were less likely to allow more than 1 hour of TV viewing/day (34% vs. 50%; adjusted risk ratios: 0.75, (95% CI, 0.62–0.90), $P < 0.05$) BMI not measured
Barkin, SL <i>et al.</i> , 2008 (80), Cluster RCT, 2–3 min, with 1- and 6-month follow-up, 41 US states, Canada, and Puerto Rico	N = 4,890 parents/caregivers of children 2–11 years old	Media use (TV, video games, computer games, electronic handheld devices) (parent report)	Intervention: Physician counseling, using motivational interviewing, at well-child visit on discipline, reducing media use, and firearms access, provision of tools (e.g., timers) and community resources Parent involvement: Counseling Control: Reading aloud passive educational program	Increase in parents limiting media use to <120 min/day at 6 months (5.7% for intervention group, 1.6% for control), ($P = 0.02$) Media time reduced by 30 min/day in intervention group, ($P = 0.01$) BMI not measured
Whaley <i>et al.</i> , 2010 (75), matched comparison, controlled trial, 12 months, Pomona, CA WIC program	N = 589 children 1–5 years old; 93% Hispanic, low SES	TV viewing (parent phone survey)	Intervention: Individual educational sessions, using “motivational interviewing” techniques (2 sessions) on nutrition, physical activity, or reducing TV, participants choose a “change goal” every 6 months, staff training Parent involvement: Interviews with WIC staff Control: Standard WIC program	For children under 2, significant effect of intervention for TV viewing, $P < 0.05$ (from 2.3h/day to 2.6h/day for intervention group, from 2.3h/day to 2.9h/day for control) For children 2 and older, no significant effect of intervention BMI not measured
Davison, KK <i>et al.</i> , 2011 (72), pre-post quasi-experiment, nonequivalent comparison sample, 12 months, Central New York state WIC program	N = 900 WIC parents with children >18 months, >50% Black or Hispanic, low SES	TV viewing, parent TV viewing, parenting practices including limiting TV viewing, self-efficacy to reduce TV viewing (parent report)	Intervention: Counseling by WIC staff on benefits of increasing physical activity and reducing TV, provision of community resource guide with outdoor locations and calendar Parent involvement: Interviews with WIC staff Control: Standard WIC program	Intervention parents more likely to report that child watches <2 h/day ($P = 0.02$) Intervention parents more likely to report watching <2 h/day ($P < 0.001$) Increased parent self-efficacy for limiting TV ($P < 0.01$) No change in TV in bedrooms BMI not measured
Mendelsohn, AL <i>et al.</i> , 2011 (74), RCT, 6 months, New York, NY	N = 410 mother–infant dyads enrolled after birth; low SES, >90% Hispanic	TV, video/DVD, movies, video game exposure, content of exposure (parent report)	Intervention: <i>Video Interaction Project (VIP) group</i> : individual sessions (30–45 min.) specialist on primary care visit days, sessions focus on shared reading, verbal interactions, and daily routines, review of videotapes of parent and child, learning materials, and pamphlet, <i>Building Blocks(BB) group</i> : parenting materials (mailed monthly), age-specific newsletters with suggested activities Parent involvement: VIP: sessions with child development specialist, materials, BB: materials and newsletters Control: Usual well-child care	Media exposure reduced for children in VIP group (131.6 min/day) compared to BB (151.2 min/day) and control (155.4 min/day) groups, ($t = 2.62$, $P = 0.009$) VIP group first exposed to media 2 weeks later than other groups ($P = 0.01$) Greater percentage of VIP group had very low exposure (<30 min/day) to media (20.6%) compared to BB (10.9%) and control (11.2%) groups ($P < 0.05$) BMI not measured

Table 3 Continued on next page

Table 3 (Continued)

Author, design, duration, location	Final sample size, Participants	Intervention targets	Intervention	TV and weight-related outcomes
Tavares, EM <i>et al.</i> , 2011 (77), Cluster RCT, 1 year, Boston, MA	N = 445, 2- to 6-year-olds, BMI > 95% or between 85% and 95% and one overweight parent	TV and video viewing (parent report)	Intervention: Training for all practice staff, changes in care delivery system, motivational interviewing by nurse practitioner on reducing TV, decreasing fast food and/or sugar-sweetened beverages, four in person visits (25 min) and three phone calls (15 minutes), waiting room posters, local resources information, web site Electronic monitor: For interested families only Parent involvement: Counseling Incentives: \$20 for participation, water bottles, books, snack containers Control: Usual well-child care	Decrease in TV or video viewing in intervention group (-0.36 h/day, P = 0.01) No change in TV in bedroom No significant effect on BMI
US studies, clinics, 6- to 12-year-olds				
Ford, BS <i>et al.</i> , 2002 (73), pilot RCT, 4 weeks, Atlanta, GA Primary care visits	N = 25, 7- to 12-year-olds; African American, low income	Hours of TV, video games, and videotape use; overall household television use, meals eaten by child while watching TV (parent and child report)	Intervention: 20–30 min counseling, in primary care setting, on media reduction, three brochures with specific steps Electronic monitor: Yes (TV Allowance, Mindmaster, Miami, FL); 10 reported ever using it, five for the full 4 weeks Parent involvement: Counseling Control: Media counseling alone	Nonsignificant reduction in TV, video games, and video tape use among intervention and control (-13.7 and -14.1 h/week) BMI not measured
Roemmich, JN <i>et al.</i> , 2004 (105), RCT, 6 weeks, Buffalo, NY	N = 18, 8- to 12-year-olds; BMI < 90%; TV and video game use > 15 h/week	Television time (movies on VCR, or DVD, video games on TV), recreational computer use, handheld video games, total targeted sedentary time (above, plus reading and phone time) (child habit book)	Intervention: TV time earned with physical activity, as recorded on a physical activity monitor (BioTrainer; Individual Monitoring Systems, Baltimore, MD), weekly meetings with children and parents Electronic monitor: Yes (TV Allowance, Mindmaster, Miami, FL), on every TV in home Parent involvement: Parents assist with monitor, attend weekly meetings Control: Child wears accelerometer, but gets no reinforcement for activity	In nonintent to treat analysis (includes only subjects who finished the entire trial), intervention group watched less TV (P = 0.04); no significant change in intent to treat analysis No change in total sedentary time in either analysis Change in TV time related to change in BMI z-score (P = 0.002)
Perrin, EM <i>et al.</i> , 2010 (76), Pre-post design, 2–3 minutes, with 1- and 3-month follow-up, Chapel Hill, NC	N = 60, 4- to 12-year-olds; 65% Black, low SES	Screen time (TV, video, computer games) (parent report)	Intervention: Counseling by pediatric residents on nutrition, physical activity, and screen time reduction, pediatric resident 1-h training and provision of toolkit, with BMI charts, assessment and counseling instrument Parent involvement: Counseling directed to parent	More parents report that children use <2 h of screen time per day at 1 month (61.7% vs. 48.9% at baseline, P < 0.01) and 3 months (67% vs. 45% at baseline, P < 0.01) No change in BMI
Stahl, C <i>et al.</i> , 2010 (84), nonrandom controlled study, 4 weeks, Chicago, IL	N = 383, 2- to 18-year-olds; Patients of pediatric residents	Interval change in TV time (parent or teen report)	Intervention: Web-based training program for pediatric residents (<60 min), flyers and counseling sheets on nutrition, physical activity, and screen time reduction Parent involvement: Message delivered to parent and child Control: No resident training	More parents of patients of trained residents reported having reduced TV viewing (36% vs. 24%, P < 0.01) BMI not measured
International studies, clinics, 6- to 12-year-olds				
Deforche, B <i>et al.</i> , 2004 (81), pre-post design; no control, 10 months, De Haan, Belgium; participants in residential treatment program	N = 24, 13.5 ± 2.1 years old; BMI ≥ 95th %	Total time in TV viewing and video game play (child report)	Intervention: Restricted calorie diet, physical activity (4/week with physiotherapist, 2/week in school), 2 h/day games and activities outside of school, medical supervision, counseling, exercise diaries, restricted television Control: No control	TV viewing decreased during program (from 131 to 8.6 min/day; P < 0.001) Return to near baseline levels after program ended (P < 0.001) At 6-month follow-up, TV viewing was lower than before the program in 62% of subjects compared to before the program Reduction in BMI (P < 0.0001)

Table 3 Continued on next page

Table 3 (Continued)

Author, design, duration, location	Final sample size, Participants	Intervention targets	Intervention	TV and weight-related outcomes
Nemet, D <i>et al.</i> , 2005 (82), RCT, 3-month intervention with 1-year follow-up, Kfar-Saba, Israel; Hospital setting	N = 40, 6- to 16-year-olds; BMI ≥ 95th %	Screen time (TV and computer) (family report)	Intervention: Family education on obesity, nutrition, and exercise; meetings with dietician (2/month) on nutrition; physical activity sessions with exercise coach (2/week), encouraged to exercise 30–45 more min/week and to decrease sedentary behavior, including TV Parent involvement: Family education Control: Nutritional consultation only	Significant change in screen time (4.8–4.1 h/day vs. 4.5–4.2 h/day; $P < 0.05$) in the intervention group compared to the control group At 12-month follow-up, no difference between intervention and controls in change scores; screen time reduced in both Reduction in BMI percentiles ($P < 0.05$) in the intervention group at 3 months and 1 year
Nemet, D <i>et al.</i> , 2008 (83), RCT, 3 months, Kfar-Saba, Israel; Hospital setting	N = 22, 8- to 11-year-old; BMI ≥ 95th %; parent BMI ≥ 27 kg/m ²	Screen time (family report)	Intervention: Physical activity sessions (2/week); weekly child session with dietician; weekly movement therapy, encouraged to exercise 30–45 more min/week & to decrease sedentary behavior, including TV Parent involvement: Biweekly parent meeting with dietician Control: Usual health program	Greater reduction in screen time (–2.2 h/day) for intervention, ($P < 0.05$) (+0.1 h/day for control) Greater reduction for intervention in BMI percentiles ($P < 0.05$)

RCT, randomized controlled trial; SES, socioeconomic status; WIC, Women, Infants, and Children.

sample sizes over 100 and lasted less than 1 year. Three studies recruited overweight or obese participants specifically (67–69), and three specifically targeted African American or Hispanic children from low-income communities (66–68). One additional study, by de Silva-Sanigorski *et al.*, was delivered to all children <5 years in an entire community in Australia ($N = 12,000$), via preschools, daycares, community health centers, immunization, and civic programs (70).

Three of seven community-based programs significantly reduced TV viewing or screen-media use. Sacher *et al.* reduced sedentary activity (TV and computer use) by almost 5 h per week, through a family education, physical activity, and provision of a 12-week free swimming pass to families. Participants were all obese at baseline (69). In de Silva-Sanigorski, media use was significantly lower in the intervention as compared to a control community after a community-wide program for children <5 years that trained early childhood workers and provided resources to parents and teachers (70). In Sepulveda *et al.*, 7% more parents who completed an online parent education program offered to employees of a large corporation were more likely, after the program, to report that their children watched <1 h of screen time per day (71).

Clinic- and WIC-based studies

Clinic-based studies relied primarily on parent and child training/counseling (Table 3). Counseling or training was usually offered by health professionals (e.g., doctors, dietitians, Women, Infants, and Children (WIC) staff). Most studies had over 300 participants and lasted less than 1 year. Seven of the 14 clinic-based studies targeted children under 6. Five specifically recruited low-SES, ethnic minority participants (72–76).

Clinic- and WIC-based studies, children under 6 years. Seven of 14 clinic-based studies specifically targeted children <6 years of age. All took place in the United States, and three were part of the Women, Infants, and Children (WIC) program. Half of the studies ranged between 200 and 600 participants; two included over 3,000 participants. Most programs lasted between 6 months and 1 year. Three of seven studies targeted low-SES participants and/or ethnic minorities (72,74,75). Only one targeted overweight or obese participants (77).

All seven clinic-based studies conducted with children <6 years of age reported significant differences in screen-media use or parenting practices around screen-media use. Three were conducted as part of WIC programs.

In Johnson *et al.*, Whaley *et al.*, and Davison *et al.*, families received counseling by WIC staff on reducing TV, physical activity, and/or nutrition. In Johnson and Davison, more intervention parents were likely to report that their children watch <2 h of TV per day after the program (6% and 9 % more parents in Johnson and Davison, respectively (72,78)). In Whaley *et al.*, increases in TV viewing at 12 months were ~6 min less in the intervention group than in the control group (75).

Four studies were based in primary care clinics. In two studies, participants received parenting advice from a program specialist. In Johnston *et al.*, 16% more intervention, compared to control, parents were less likely to allow more than 1 h of TV viewing daily (79). In Mendelsohn *et al.*, media exposure was reduced for children in the intervention group, by about 20 min per day (74). In two other studies, motivational interviewing techniques were used to encourage participants to reduce media use. In Barkin *et al.*, parents received 2–3 min of counseling from a primary care physician, after which media time was reduced by 30 min per day, and parents were more likely to limit media use to <2 h per day (5.7% increase for the intervention group (80)). In Taveras *et al.*, participants received counseling

from a nurse practitioner, and there was a decrease in TV or video viewing, of about 22 min per day, in the intervention group (77).

Clinic-based studies, 6- to 12-year-old children. As reported in **Table 3**, five of seven clinic-based interventions with children over 6 years of age had sample sizes under 50. Four took place in the United States, and three were conducted internationally. Most were of relatively short duration, lasting for 3 months or less. Three programs recruited obese participants (81–83), and two targeted low-SES, ethnic minority children (73,76).

Five of seven clinic-based studies reported statistically significant reductions in TV viewing. Two programs by Nemet *et al.* reduced screen time by about 2 h per day. In both studies, parents and children attended regular meetings with a dietitian, and children participated in regular physical activity sessions. Parents were specifically encouraged to decrease their children's sedentary behavior, including TV viewing (82,83). Deforche *et al.* also significantly reduced screen time, by approximately 2 h per day, via an inpatient residential obesity treatment program, in which TV viewing was restricted (81). In Stahl *et al.*, pediatric residents received web-based training, about a program to encourage healthy eating, physical activity, and screen-media reduction. Twelve percent more parents in the intervention group than in the control group reported reducing their children's TV viewing after the intervention (84). Perrin increased the percentage of children in the intervention group who used less than 2 h of screen media per day by 22% by briefly training and providing toolkits to pediatric residents (76).

DISCUSSION

Reducing TV time is a potential strategy to prevent or treat childhood overweight and obesity. Of the 47 intervention studies we reviewed, 29 (62%) reported statistically significant reductions in children's TV viewing or screen-media use. Of these, 18 measured BMI and 9 reported reductions in BMI. The most effective interventions specifically targeted and

set explicit goals for reduced TV viewing or screen-media use, used electronic monitoring devices, contingent feedback systems or clinic-based counseling, had high levels of parental involvement, and/or recruited participants who were already overweight or obese at baseline.

To our knowledge, few published systematic reviews have summarized effective strategies for reducing TV viewing in young children. A recent meta-analysis by Maniccia *et al.* revealed a small but statistically significant effect of screen-media interventions to reduce children's screen time. Twenty-nine studies were identified as eligible for meta-analysis (85). In a systematic review of interventions to reduce sedentary behavior (defined as recreational screen time) by DeMattia *et al.*, 12 studies were identified to successfully reduce sedentary behavior (86). Similar to the results of our review, DeMattia *et al.* found that study approaches and settings varied. DeMattia *et al.* concluded that targeting sedentary behaviors is an effective way to intervene on obesity and overweight outcomes in children and adolescents (86). Our review updates the literature on reducing TV and video viewing since the publication of DeMattia *et al.* in 2007 and the meta-analysis of Maniccia (which included studies to 2008), and includes older studies not selected by DeMattia *et al.* or not eligible for inclusion in meta-analysis in Maniccia *et al.* We report a similar intervention success rate to DeMattia *et al.*, wherein just over 60% of studies successfully reduced TV viewing in children. Our study also extends Maniccia *et al.*'s and DeMattia *et al.*'s work by reporting additional strategies to reduce TV viewing and providing added narrative detail about which intervention strategies and settings were most effective.

We identified electronic monitoring systems as one strategy that most effectively reduced TV viewing among children. Intervention programs that used electronic TV monitors reported significant, large decreases in TV viewing, from 1.5 to 3 h per day. However, in two studies included in our review, about half of families offered electronic TV time monitors either did not use them (56) or reported,

after using them, that they would not want to use them in the future (63). Thus, while electronic monitors seem to be an effective strategy for TV reduction, further research is needed to understand how to increase their acceptability in households with children. In addition, more research is needed to determine the long-term effectiveness and sustainability of electronic TV time monitors (63).

Another strategy that had considerable effects on the reduction of TV viewing was the use of contingent feedback systems. For example, Faith *et al.* (60) used a closed-loop feedback system where TV viewing was made contingent on stationery cycling and saw a decrease in TV viewing by 20 h per week, one of the largest reductions reported in this review. Another effective contingent feedback system was an open-loop feedback in which TV viewing was made contingent on physical activity, as recorded by pedometer or accelerometer. Goldfield used this open-loop design and reduced TV by 116 min per day (62).

Counseling by physicians, nurse practitioners, or Women, Infants, and Children (WIC) providers also had measurable effects on TV viewing. Twelve of 14 clinic-based studies in this review reported significant findings. Most of these studies (seven of 14) were with children under 6 years. However, only one clinic-based study with children under 6 measured follow-up outcomes (80), and only one measured BMI (77). Since the primary care setting offers unique access to large numbers of parents of young children, and parents may be especially receptive to messages delivered in this setting, further research should examine the role of the primary care provider in TV reduction counseling, particularly with regard to effects on BMI, or other weight-based outcomes (74,88). Future clinic-based research should also measure long-term outcomes, in order to determine whether early intervention can have beneficial effects on long-term TV viewing trajectories.

In **Table 4**, we list screen-media reduction strategies, including but not limited to electronic TV time monitors and feedback systems, that reduced TV/screen media viewing by statistically significant

Table 4 TV reduction strategies that should be considered for future interventions

Intervention strategies

- Electronic TV time monitors to budget child or family TV time
- Contingent feedback systems, e.g., TV viewing is “earned” by engaging in desired healthy behaviors
- Parenting advice, particularly to parents of infants, by Women, Infants, and Children (WIC) providers or by primary care physicians
- School-based student information programs, with or without multiple targets (e.g., media use, physical activity, nutrition), and with or without actual physical activity
- Parent and child family counseling

Table 5 Research priorities and recommendations for intervention planning based on gaps in the current literature

Research priorities	Justification
Test removal of TV sets from children’s bedrooms	No studies have tested whether removing TV sets from the bedroom reduces overall TV viewing. Studies indicate children who have TV sets in their bedrooms watch more TV (2,9) and are at increased risk for obesity (9,86,88).
Test effectiveness of primary care counseling for reducing TV viewing and/or BMI over the long term	Few clinic-based studies measure follow-up outcomes. Few clinic-based studies with young children measure BMI.
Target or include children under 6	Few studies target children under 6. Targeting younger children allows for prevention, vs. treatment, program.
Target or include racial/ethnic minorities	Few studies target racial/ethnic minorities. Studies suggest program outcomes may differ depending on race/ethnicity of target population (38,39).
Include long-term follow-up evaluation/assessment for at least 1–2 years	Few studies offer follow-up measures; of those that do, results often differ at follow-up (69,103).
Explore which combination of various program components is most effective in multifaceted programs	Many different components are offered in multifaceted programs; current research does not differentiate which components are most effective.
Explore long-term feasibility and effectiveness of electronic monitors and contingent systems; explore feasibility with children under 6	Few, if any, studies have examined the long-term feasibility of electronic TV monitors. Only two studies have used electronic TV monitors with children under 6 (59,77).

amounts, across multiple studies. Among the different settings in our review, we noted that the largest reductions in TV viewing occurred in home- or clinic-based settings. This may be because parents are required to be involved in home- and clinic-based programs; prior research suggests that high levels of parental involvement are very important, if not essential, for intervention success (87,89–91). In addition, most of the home- and clinic-based studies in this review specifically targeted overweight or obese children or children who watched large amounts of TV, whereas interventions in other settings were typically delivered to all participants, randomly assigned to intervention groups regardless of weight or TV viewing habits.

Table 5 lists priorities for future research. In general, we recommend future studies include greater recruitment of racial/ethnic minority children and children under 6. Although studies

suggest that electronic TV monitors and feedback systems are the most effective TV reduction strategies, little is known about their long-term feasibility and effectiveness. Furthermore, to our knowledge, only Epstein *et al.* (59) has used electronic TV monitors with children under 6, and no published findings report on the use of open or closed-loop feedback systems in preschool-aged children. Finally, while electronic TV monitors can be effective, they may be prohibitively expensive, at \$60 to \$90 each on average (92), for use in large-scale public health intervention programs.

Studies have shown that time-use diaries or electronic monitoring systems provide the most accurate data on TV viewing (93), yet most studies in this review used global, retrospective estimates of TV use, e.g., “How many hours, on average, do you watch TV per week?” Future research should employ

TV viewing measurement techniques with greater validity, such as electronic monitors, time-use diaries, or momentary sampling (94). An additional limitation to current studies is that only one measured TV content or intervened on specific TV content (74). Since one of the hypothesized mechanisms for associations between TV watching and obesity is increased food intake, either through food and beverage advertising or increased eating during viewing, future research should investigate whether interventions that target specific TV or media content (e.g., food advertising) are effective at reducing TV and/or BMI.

We also were unable to identify any studies that aimed to prevent or treat obesity by specifically reducing computer use or video game use. These kinds of media use have been included in aggregate measures of screen time in intervention studies, but they have not

been independently tested as intervention targets. Future research should also explore the potential for interventions targeting specific media, including new media platforms that deliver TV content and advertising (e.g., Internet, mobile “smart” phones). These have not been well studied.

Numerous studies have indicated that children with TV in their bedrooms watch more TV than children without TV in their bedrooms (9) and are at an increased risk for obesity (9,95,96), sleep problems (97–99), and other health risk behaviors, e.g., smoking (100) and alcohol use (101). Although two-thirds (68 %) of 8- to 18-year-old children have TV in their bedrooms (2), only 10 studies in this review measured whether children had TV sets in their bedrooms (46,52,56,59,66,68,72,73,77,102) and recommending removal of bedroom TV sets was listed as a component of only four intervention programs (76,77,84,102). We recommend future interventions specifically address the removal of TV from children’s bedrooms, both as a behavioral outcome in itself, and in order to reduce overall TV and video viewing.

Limitations

The vast majority of studies in this review were randomized controlled trials. Due to the wide variety of methods, outcomes, and measures reviewed here, a meta-analysis was not possible. Our conclusions are based on qualitative analysis of broad patterns in the body of published literature and are not definite. In particular, the diverse measurement techniques across studies in this review made it very difficult to compare findings. Although research suggests that different kinds of sedentary media behaviors contribute to obesity differently, if at all (25), half of the studies in this review aggregated screen-media use as a single outcome. When intervention programs report aggregate screen-media reductions, it is unclear which specific media are reduced. When BMI is an outcome of interest, aggregate screen-media measures do not distinguish which specific media may be implicated in any BMI changes. Media use or TV

viewing also was variously measured by child report, parent report, or both, and sometimes these measures did not agree (59). For all of these reasons, we were able to draw limited conclusions about the comparative effectiveness of different interventions to reduce TV viewing or screen-media use.

Conclusions

Forty-seven studies have been conducted to reduce TV viewing among children <12 years of age, in various settings, using different strategies, and with variable success. Our findings suggest that electronic TV monitors, contingent feedback systems, and clinic-based counseling were three of the most effective strategies for TV reduction. More work is needed to understand the potential for interventions in children <6 years of age and in low-income and ethnic/minority participants. Future research should also further explore the potential for primary care counseling to reduce children’s long-term media use. Finally, no published research to date has evaluated whether removing TV sets from children’s bedrooms could measurably impact TV viewing. This should be a priority for future research.

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DISCLOSURE

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