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# Effectiveness of Interventions Aimed at Reducing Screen Time in Children

## *A Systematic Review and Meta-analysis of Randomized Controlled Trials*

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**Objective:** To evaluate the impact of interventions focused on reducing screen time.

**Data Sources:** Medline, Embase, Cochrane Central Register of Controlled Trials, PsycINFO, ERIC, and CINAHL through April 21, 2011.

**Study Selection:** Included studies were randomized controlled trials of children aged 18 years or younger with interventions that focused on reducing screen time.

**Intervention:** Efforts to reduce screen time.

**Main Outcome Measures:** The primary outcome was body mass index (BMI); the secondary outcome was screen time (hours per week).

**Results:** A total of 1120 citations were screened, and 13 studies were included in the systematic review. Study samples ranged in age (3.9-11.7 years) and size (21-1295 participants). Interventions ranged in length (1-24 months) and recruitment location (5 in schools, 2 in medi-

cal clinics, 1 in a community center, and 5 from the community). For the primary outcome, the meta-analysis included 6 studies, and the difference in mean change in BMI in the intervention group compared with the control group was  $-0.10$  (95% confidence interval [CI],  $-0.28$  to  $0.09$ ) ( $P = .32$ ). The secondary outcome included 9 studies, and the difference in mean change from baseline in the intervention group compared with the control group was  $-0.90$  h/wk (95% CI,  $-3.47$  to  $1.66$  h/wk) ( $P = .49$ ). A subgroup analysis of preschool children showed a difference in mean change in screen time of  $-3.72$  h/wk (95% CI,  $-7.23$  to  $-0.20$  h/wk) ( $P = .04$ ).

**Conclusions:** Our systematic review and meta-analysis did not demonstrate evidence of effectiveness of interventions aimed at reducing screen time in children for reducing BMI and screen time. However, interventions in the preschool age group hold promise.

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**O**VER THE PAST 2 DECADES, the prevalence of overweight and obesity in children has steadily risen around the world.<sup>1-3</sup> It has been suggested that the epidemic of childhood obesity will lead to a phenomenon seen for the first time in recent history whereby children will have a shorter life expectancy than their parents.<sup>4</sup> Unfortunately, successful interventions for the prevention and treatment of childhood obesity have been elusive and complex.<sup>5-7</sup>

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Principles for preventing and treating childhood obesity include reducing energy intake, increasing physical activity, and reducing sedentary behaviors.<sup>1</sup> Sedentary behaviors are activities that do not involve physical exertion, including tele-

vision and computer use, schoolwork, reading, and playing or listening to music.<sup>8</sup> The most prevalent form of sedentary behavior is time spent in front of a screen, *screen time*, which includes television, videos and/or DVD, computer, and videogames. Screen time has steadily increased among youth, and approximately 1 in 4 children living in the United States watch an average of 4 hours of television per day.<sup>1,9</sup> Television viewing has been associated with important health outcomes in children, including delayed language development, aggressive behavior, and cigarette smoking.<sup>10-12</sup> The focus of our study is to review the impact of interventions aimed at reducing screen time on change in body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) in children.<sup>13</sup>

Interventions aimed at reducing screen time have been a focus of childhood obe-

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sity prevention and treatment for the past decade.<sup>8</sup> A systematic review of interventions aimed at reducing sedentary behaviors (including screen time) published in 2007<sup>14</sup> noted great variation in types of interventions and concluded that these interventions were effective in reducing sedentary behaviors and improving indices of body composition. To our knowledge, our systematic review is unique because it focuses on a specific sedentary behavior that has been the focus of many randomized controlled trials (RCTs) in children, namely, screen time. Also, the previously published systematic review did not include a meta-analysis, and several additional RCTs have subsequently been published. A meta-analysis provides a point estimate of a treatment effect and helps to summarize evidence to guide clinicians, researchers, and policy makers.<sup>15</sup> The primary objective of our systematic review and meta-analysis was to evaluate the impact on children of interventions aimed at reducing screen time on the outcome of BMI. The secondary objective was to evaluate the impact of interventions aimed at reducing screen time on screen time itself.

## METHODS

### STUDY SELECTION

We searched 6 databases through April 21, 2011: OVID-Medline (from 1948), EMBASE (from 1980), Cochrane Central Register of Controlled Trials (from first quarter 2011), Psycinfo (from 1967), ERIC (from 1965), and EBSCOHost-CINAHL (from 1982). The strategy used terms customized for the database, including RCTs and derivations of the terms Television\* OR Videogame\* OR Computer\* AND Overweight\* OR Obesity\* OR Physical activity\* (eTables 1-6, <http://www.archpediatrics.com>). To identify unpublished studies, databases of registered clinical trials ([clinicaltrials.gov](http://clinicaltrials.gov)) and conference proceedings (PapersFirst and ProceedingsFirst) were hand searched. Reference lists of all retrieved manuscripts were searched for any relevant articles not previously identified. Two of us (G.W. and C.S.B.) independently reviewed articles for eligibility, and disagreements were resolved through discussion with a third reviewer (P.C.P.). The inclusion criteria were RCT (study design), participants aged 18 years or younger (population), and interventions that included a reduction of screen time (ie, television, videogames, and/or computer use). Two of us (G.W. and C.S.B.) screened all study titles and abstracts, and full-text articles were retrieved for any studies deemed relevant. The same 2 investigators (G.W. and C.S.B.) assessed articles for eligibility, and a  $\kappa$  coefficient was calculated to reflect the measure of agreement between the reviewers.<sup>16</sup>

### DATA ABSTRACTION AND ANALYSES

Two of us (G.W. and C.S.B.) independently abstracted information, in duplicate, from eligible manuscripts using standardized data collection forms. Information was collected on characteristics of study populations, interventions, and outcomes. The primary outcome of interest was body composition, as measured by BMI, which is considered an appropriate measure of adiposity in children.<sup>17,18</sup> The secondary outcome was amount of screen time, as measured by reported hours per week. For the purpose of our meta-analyses, we used the outcomes reported at the end of the study intervention period in the analyses. We contacted the authors of the trials included in the systematic review to obtain further data if the study did not report outcome measures in a manner that could be combined with other trials.

Pooled analyses were conducted with the measure of effect size as the unadjusted difference in mean (SEM) change in BMI and screen time between the intervention and control groups. For studies in which results were not reported as the difference in mean change, we used the published literature to identify appropriate correlation coefficients to calculate the variance needed for this calculation. For example, we assumed a correlation coefficient of 0.9 for BMI as used by previous authors.<sup>5,19</sup> For screen time, we calculated the variance assuming a correlation coefficient and performed a sensitivity analysis using values of 0.4 and 0.7.<sup>20</sup> A generic inverse method was used to account for the pooling of appropriately analyzed cluster randomized trials with trials that randomized at the level of the individual.<sup>20,21</sup> The summary estimate for difference in mean change of BMI and screen time was calculated using a generic inverse method, random-effects meta-analyses. A random-effects model is conservative because it calculates the error term by taking into account between-study and within-study differences.<sup>20</sup> Weights were assigned to the studies included in the meta-analyses based on the inverse variances of their effect estimates, as described by Higgins et al.<sup>20</sup> For example, studies with less precise results, and therefore wider confidence intervals, are given less weight.<sup>20</sup>

Heterogeneity was defined by statistical measures of  $\chi^2$  and  $I^2$ . Heterogeneity is the variability among studies that is due to true differences between studies rather than sampling error.<sup>22</sup> A priori, we defined  $P < .10$  as significant heterogeneity; for  $I^2$ , we defined 25% as low heterogeneity, 50% as moderate heterogeneity, and 75% as high heterogeneity.<sup>20,22</sup> We established a priori hypotheses for heterogeneity among studies, including both population (age, baseline BMI) and intervention (setting, presence of cointerventions). If significant heterogeneity was observed, subgroup analyses and tests of interactions were planned. RevMan software, version 5.0.18 (The Cochrane Collaboration, Oxford, England) was used for all pooled analyses.

### METHODOLOGIC QUALITY AND QUALITY OF EVIDENCE

The Cochrane Collaboration checklist was used for assessing risk of bias.<sup>20</sup> Components of the assessment included sequence generation, concealment of allocation, blinding of participants and outcome assessors, and percentage of participants lost to follow-up. Recruitment bias is a form of bias unique to cluster-randomized trials and therefore was considered in those trials.<sup>20</sup> A summary score has been shown to be inaccurate when used among qualitative scales; therefore, it was not included in our risk of bias assessment.<sup>23,24</sup>

The Grading of Recommendations Assessments, Developments and Evaluation (GRADE)<sup>25</sup> was used to provide a systematic approach to the assessment of the quality of evidence and strength of recommendations. It is a widely accepted tool endorsed by many organizations, including the World Health Organization and the Cochrane Collaboration.<sup>26</sup> Criteria for consideration included assessment of methodology, precision and consistency of results, directness, and risk of publication bias.<sup>25</sup>

## RESULTS

### SELECTION OF ELIGIBLE TRIALS

We identified 1120 potentially eligible articles from the 6 databases (PsycINFO, 125; Embase, 300; ERIC, 128; Medline, 184; Cochrane CENTRAL, 239; and CINAHL, 144). There were 226 duplicate articles, and 804 were excluded as not relevant after title and abstract review. Ninety full-text articles were retrieved and independently as-

**Table 1. Description of the 13 Included Studies**

Source	Design	Mean Age, y	Participants, No.	Country of Origin	Recruitment Setting	Intervention			Cointervention <sup>a</sup>		
						Duration, mo	Sessions, No.	Type	Diet	PA	None
Dennison et al, <sup>12</sup> 2004	Cluster	3.9	77	United States	Preschool	18.0	7, 1 h each	Classroom-based health promotion curriculum			X
Epstein et al, <sup>37</sup> 1995	Parallel	10.1	61	United States	Community	4.0	1/wk for 4 mo	Individual counseling for parents and children	X	X	
Epstein et al, <sup>38</sup> 2000	Parallel	10.5	90	United States	Community	6.0	20, 1 h each	Individual counseling for parents and children	X	X	
Epstein et al, <sup>39</sup> 2008	Parallel	5.9	70	United States	Community	6.0	NA	Automated monitor controlling screen time			X
Escobar-Chaves et al, <sup>33</sup> 2010	Parallel	8.2	202	United States	Subspecialty medical clinic	6.0	1, 2 h	Intervention mapping workshop and newsletter			X
Ford et al, <sup>34</sup> 2002	Parallel	9.5	28	United States	Community clinic	1.0	1, half hour	Family counseling and automated monitor controlling screen time			X
Gortmaker et al, <sup>31</sup> 1999	Cluster	11.7	1295	United States	School	24.0	33, 45 min each	Classroom-based Planet Health curriculum	X	X	
Kipping et al, <sup>21</sup> 2008	Cluster	9.4	679	United Kingdom	School	5.0	16	Classroom-based health promotion curriculum	X	X	
Ni Mhurchu et al, <sup>36</sup> 2009	Parallel	10.4	29	New Zealand	Community	1.5	NA	Automated monitor controlling screen time			X
Robinson, <sup>8</sup> 1999	Cluster	8.9	192	United States	School	6.0	18, 50 min each	Classroom-based health promotion curriculum			X
Robinson et al, <sup>35</sup> 2010	Parallel	9.4	261	United States	Community center	24.0	24	Home-based screen time reduction intervention		X	
Salmon et al, <sup>32</sup> 2008	Cluster	10.8	128	United States	School	8.0	19	Classroom-based health promotion curriculum			X
Todd et al, <sup>40</sup> 2008	Parallel	9	21	United States	Community	5.0	1 seminar; weekly phone calls	Seminar; automated monitor controlling screen time			X

Abbreviations: NA, not applicable; PA, physical activity.

<sup>a</sup>An X indicates the cointervention was present; blank table cell means the intervention was absent.

essed for inclusion criteria. After full-text articles were assessed, 73 additional articles were excluded. Seventeen articles met eligibility criteria, but only 13 were unique trials, and 4 articles<sup>27-30</sup> were secondary publications reporting outcomes not previously addressed in the primary publications. None of these 4 articles identified outcomes of interest for the purposes of this review. The chance-adjusted, between-reviewers agreement ( $\kappa$ ) on the application of study inclusion criteria to full-text articles was 0.92; almost perfect agreement.<sup>16</sup>

### CHARACTERISTICS OF INCLUDED STUDIES

Descriptions of the 13 included trials<sup>8,12,21,31-40</sup> are listed in **Table 1**. The average age of participants in trials ranged from 3.9 to 11.7 years. The sample sizes of the included studies ranged from 21 to 1295 participants (median sample size, 90 participants), for a total of 3133 participants in the 13 trials. The duration of the interventions ranged from 1 to 24 months (median duration, 6 months). The settings varied: 5 trials recruited from schools<sup>8,12,21,31,32</sup>; 2 recruited from medical clinics<sup>33,34</sup>; 1 from a community center<sup>35</sup>; and 5 recruited from community settings.<sup>36-40</sup> There were 5 cluster-randomized trials and 8

parallel-group RCTs. All of the cluster-randomized trials accounted for this study design in the analysis.

We were unable to include several trials in the meta-analysis for the following reasons: 4 trials did not measure the outcome of interest (BMI or screen time)<sup>33,34,37,38</sup>; 3 reported results as the difference in the proportion of patients at particular BMI percentiles<sup>31,37,38</sup> and hours of screen time<sup>31,38</sup>; 1 reported change in age- and sex-standardized BMI<sup>39</sup>; and 1 reported only adjusted analyses.<sup>21</sup>

**Table 2** summarizes the assessment of methodologic quality (Cochrane Collaboration checklist for assessing risk of bias). Among 9 of the 13 trials, sequence generation was adequate. Allocation concealment was adequate in 6 trials. Blinding of participants or outcome assessors was not reported in 11 trials. Two trials lost greater than 20% of participants to follow-up. Two of the 5 cluster-randomized trials reported adequate recruitment methods.

### OUTCOMES

**Table 3** highlights the reported outcomes of all 13 studies included in the systematic review for both primary and secondary outcome.

**Table 2. Assessment of Risk of Bias of Included Trials**

Source	Sequence Generation	Allocation Concealment	Blinding of Participants	Blinding of Outcome Assessors	Participants Lost to Follow-up, %	Recruitment Bias
Dennison et al, <sup>12</sup> 2004	Adequate	Adequate	NR	NR	24.5	NR
Epstein et al, <sup>37</sup> 1995	NR	NR	NR	NR	NR	NA
Epstein et al, <sup>38</sup> 2000	Adequate	Adequate	NR	NR	15.6	NA
Epstein et al, <sup>39</sup> 2008	Adequate	Adequate	NR	NR	4.3	NA
Escobar-Chaves et al, <sup>33</sup> 2010	NR	NR	NR	NR	2.9	NA
Ford et al, <sup>34</sup> 2002	Adequate	Adequate	NR	NR	10.7	NA
Gortmaker et al, <sup>31</sup> 1999	Adequate	NR	NR	NR	17	NR
Kipping et al, <sup>21</sup> 2008	Adequate	Adequate	NR	Adequate	30.4	NR
Ni Mhurchu et al, <sup>36</sup> 2009	Adequate	NR	NR	NR	7	NA
Robinson, <sup>8</sup> 1999	NR	NR	NR	NR	3	Adequate
Robinson et al, <sup>35</sup> 2010	Adequate	NR	NR	NR	13.8	NA
Salmon et al, <sup>32</sup> 2008	NR	NR	NR	Adequate	10.6	Adequate
Todd et al, <sup>40</sup> 2008	Adequate	Adequate	Inadequate	NR	4.5	NA

Abbreviations: NA, not applicable; NR, not reported.

**Table 3. Reported Outcomes of Adiposity Measure and Screen Time From Included Trials**

Study	Outcome <sup>a</sup>	
	Adiposity	Screen Time
Dennison et al, <sup>12</sup> 2004	0	↓
Epstein et al, <sup>37</sup> 1995	↓	NM
Epstein et al, <sup>38</sup> 2000	0	NM
Epstein et al, <sup>39</sup> 2008	↓	↓
Escobar-Chaves et al, <sup>33</sup> 2010	NM	0
Ford et al, <sup>34</sup> 2002	NM	0
Gortmaker et al, <sup>31</sup> 1999	↓	↓
Kipping et al, <sup>21</sup> 2008	0	0
Ni Mhurchu et al, <sup>36</sup> 2009	0	0
Robinson, <sup>8</sup> 1999	↓	↓
Robinson et al, <sup>35</sup> 2010	0	0
Salmon et al, <sup>32</sup> 2008	0	↑
Todd et al, <sup>40</sup> 2008	0	↓

Abbreviations: NM, not measured; ↓, intervention decreased adiposity or screen time; ↑, intervention increased adiposity or screen time; 0, no effect seen.

<sup>a</sup> Outcome based on adjusted analysis.

### PRIMARY OUTCOME: BMI

Six studies were included in the pooled analysis for the primary outcome.<sup>8,12,32,35,36,40</sup> The difference in mean change in BMI in the intervention group compared with the control group was  $-0.10$  (95% confidence interval [CI],  $-0.28$  to  $0.09$ ) ( $P=.32$ ). (Figure 1). The heterogeneity observed in the pooled estimate was demonstrated by an  $I^2=38\%$  and  $P=.20$ . Since insignificant heterogeneity was observed, the subgroup analyses set a priori to explain heterogeneity were not explored.

### SECONDARY OUTCOME: SCREEN TIME

Nine studies were included in the pooled analysis for the secondary outcome.<sup>8,12,32-36,39,40</sup> Six studies reported amount of screen time.<sup>12,33,35,36,39,40</sup> Five studies reported amount of television viewed.<sup>8,32,34-36</sup> For the purpose of the pooled analysis, the results of the trials were combined, and dif-

ference in mean change in screen time is reported. The unit of measure for screen time was converted to hours per week if reported in other units. The results of the pooled difference in mean change from baseline in the intervention compared with the control group was  $-0.90$  h/wk (95% CI,  $-3.47$  to  $1.66$  h/wk) ( $P=.49$ ) (Figure 2). The pooled estimate showed a high amount of statistical heterogeneity ( $I^2=66\%$ ,  $P=.003$ ). However, when the trials were grouped based on age, there was a statistically significant reduction in screen time among preschool children (younger than 6 years;  $n=2$  trials) in the intervention group compared with the control group ( $P=.04$ ) (Figure 3).

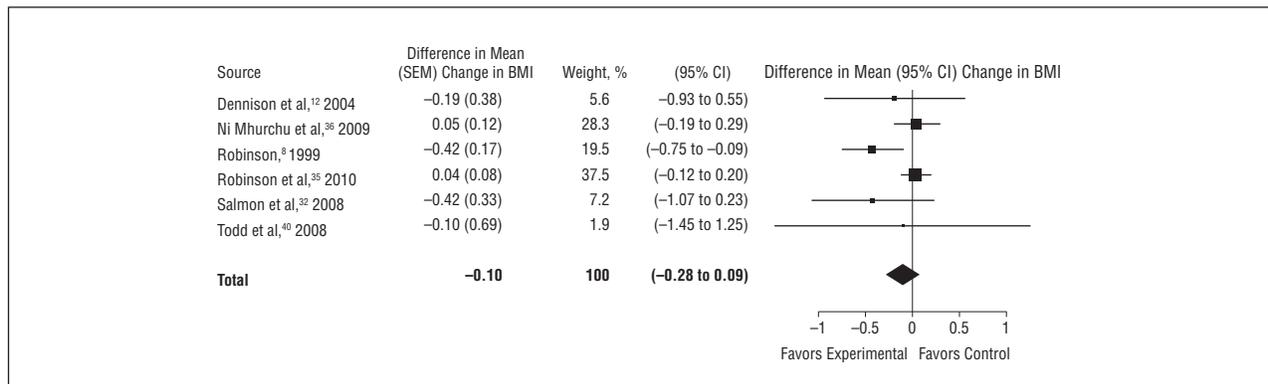
### QUALITY OF EVIDENCE

Using the GRADE score,<sup>25</sup> we found low-quality evidence for both primary and secondary outcomes, BMI and screen time viewing (Table 4). A rating of low-quality evidence implies that future research findings might impact the certainty of the results and change the estimate.<sup>25,41</sup> The limitations that impact the quality assessment for this meta-analysis include uncertainty of allocation concealment, uncertainty of blinding of participants and outcome assessors, and number of participants lost to follow-up, as summarized in Table 2. The indirectness of results describes the qualitative differences in the sample populations and interventions across studies. The quality of evidence for the secondary outcome of screen time was further degraded by the inconsistency of results as demonstrated by a significant amount of heterogeneity observed in the pooled analysis.

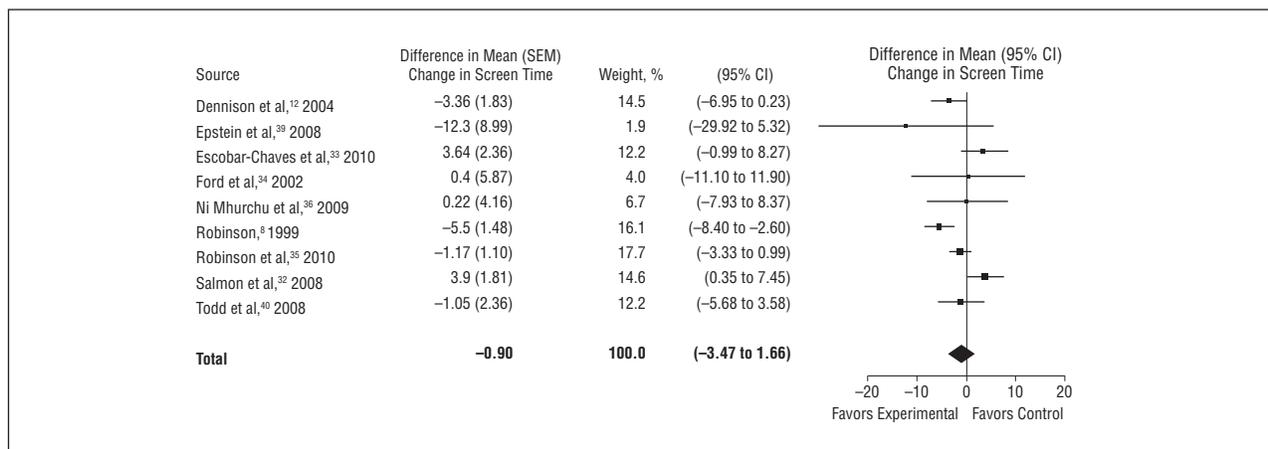
### COMMENT

#### STATEMENT OF FINDINGS

This systematic review and meta-analysis of RCTs aimed at reducing screen time among children included 13 trials, a substantial number of RCTs in the field of child health research.<sup>42</sup> Quantitative pooling of the data for the pri-



**Figure 1.** Forest plot of primary outcome, unadjusted difference in mean change in body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared). Heterogeneity,  $\tau^2=0.02$ ;  $\chi^2_5=8.05$  ( $P=.15$ );  $I^2=38\%$ . Test for overall effect,  $Z=1.0$  ( $P=.32$ ). CI indicates confidence interval.



**Figure 2.** Forest plot of secondary outcome, unadjusted difference in mean change in screen time measured in hours per week. Heterogeneity,  $\tau^2=8.45$ ;  $\chi^2_8=23.69$  ( $P=.003$ );  $I^2=66\%$ . Test for overall effect,  $Z=0.69$  ( $P=.49$ ). CI indicates confidence interval.

primary outcome showed no apparent effect of the interventions on reduction of BMI or reduction of screen time overall. However, we did observe a statistically significant reduction in screen time in the subgroup analysis of trials that focused on preschool children.

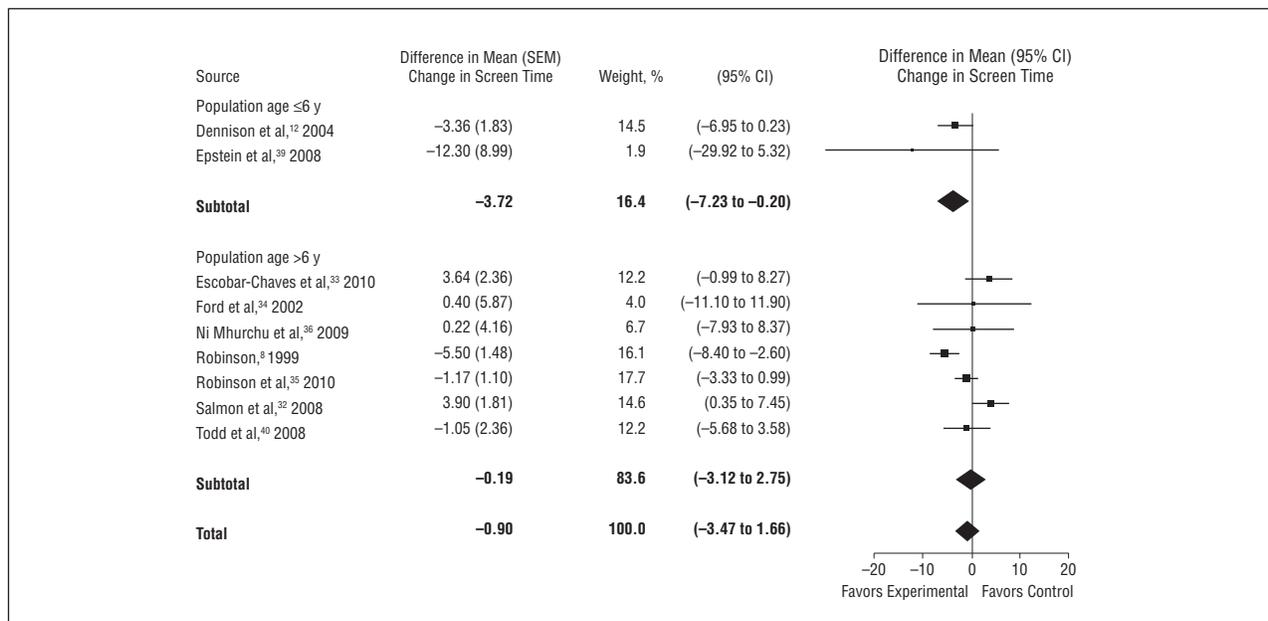
### STRENGTHS AND LIMITATIONS

We applied rigorous approaches to the process of study selection, assessment of methodologic quality, data abstraction, and development of a priori hypotheses for the explanation of heterogeneity. Exploring the methodologic quality and quality of evidence using the GRADE criteria<sup>25</sup> revealed deficiencies in reporting of participant and outcome assessor blinding. This is an area that led to the quality of evidence being downgraded to “low.” Although trials of behavioral interventions in the public health domain may have difficulty blinding participants, we believe that the blinding of assessors of outcome should be consistently reported.

Interventions aimed at reducing screen time had no overall effect on the reduction of BMI. Five of the 6 included trials did not have cointerventions, which suggests that interventions that solely deliver a message of reducing screen time may not be effective. We also note that the lack of an observed effect may be due to the short

duration of the interventions; the median length of included trials was 7 months. Although BMI is only 1 measure of adiposity, with waist circumference or skinfold thickness as other potential measures, BMI was the most consistently reported measure of adiposity across trials. Higher BMI has also been associated with higher rates of mortality among adults.<sup>43</sup> We therefore feel it is the most appropriate outcome to measure as an estimate of change in adiposity. However, there may be other important outcomes on the causal pathway between screen time and obesity that might be affected by these interventions, such as meals in front of the screen and exposure to food advertising. In addition, evaluating other important screen time–related outcomes such as language development may be an important next step in understanding the effects of reducing screen time.

We were unable to include 7 trials in the pooled analysis for BMI, and the estimate of effect might have been further strengthened if data from all available trials were included. Randomized controlled trials were excluded when unadjusted outcomes were unavailable. Also, different scales of measurement between studies, for example continuous (BMI) vs categorical (normal weight and obese) data, prohibited data from being combined across trials. Publication of unadjusted results along with adjusted results in RCTs, as well as consensus on clini-



**Figure 3.** Forest plot of subgroup analysis of secondary outcome, screen time, by age, measured in hours per week. CI indicates confidence interval. For age 6 years or younger, heterogeneity,  $\tau^2=0.00$ ;  $\chi^2=0.95$  ( $P=.33$ );  $I^2=0\%$ ; and test for overall effect,  $Z=2.07$  ( $P=.04$ ). For age older than 6 years, heterogeneity,  $\tau^2=9.61$ ;  $\chi^2=20.58$  ( $P=.002$ );  $I^2=71\%$ ; and test for overall effect,  $Z=0.13$  ( $P=.90$ ). For total heterogeneity,  $\tau^2=8.45$ ;  $\chi^2=23.69$  ( $P=.003$ );  $I^2=66\%$ ; and test for total overall effect,  $Z=0.69$  ( $P=.49$ ). Test for subgroup differences,  $\chi^2=2.16$  ( $P=.14$ );  $I^2=54\%$ .

**Table 4. GRADE<sup>25</sup> Evidence Profile**

Studies, No.	Quality Assessment						Summary of Findings				
	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other Considerations	Patients, No.		Effect <sup>a</sup>		
							Interventions	Control	Absolute	Quality	Importance
<b>BMI (better indicated by lower values)</b>											
6	Randomized trials	Serious <sup>b</sup>	No serious inconsistency	Serious <sup>c</sup>	No serious imprecision	None	361	347	-0.10 (-0.28 to 0.09)	⊕⊕00 Low	Critical
<b>Screen Time, h/wk (better indicated by lower values)</b>											
9	Randomized trials	Serious <sup>b</sup>	Serious <sup>d</sup>	Serious <sup>c</sup>	No serious imprecision	None	513	495	-0.90 (-3.47 to 1.66)	⊕000 Very low	Critical

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).

<sup>a</sup>Effect size measured as unadjusted difference in mean (SEM) change from between intervention and control groups.

<sup>b</sup>Unclear allocation concealment, blinding of participants and outcome assessors, and more than 20% of participants lost to follow-up (Table 2).

<sup>c</sup>Differences in populations and interventions across studies.

<sup>d</sup>Significant heterogeneity observed.

cally important outcomes for trials with similar foci, would prove useful for providing point estimates of effect in meta-analyses. As an example, the 2 largest studies excluded from the meta-analysis had differing results and, if included, might have altered the result of the meta-analyses. The study by Gortmaker et al<sup>31</sup> (n=1295) showed a significant reduction in television viewing and obesity (measured by a composite measure of BMI and triceps skin folds) in female participants compared with the study by Kipping et al<sup>21</sup> (n=679), in which no differences in adjusted BMI or screen time were found.

The overall pooled analysis did not show a statistically significant reduction in screen time. The lack of effect on screen time overall may be related to the challenges of measurement of screen time. The included trials used self- or parent reporting to measure screen time, and there is no

published validated outcome measure for screen time. Although there is evidence that parent reporting of child screen time provides accurate estimates of television viewing times compared with videotaped observation ( $r=0.70$ ),<sup>44</sup> parent reporting of screen time might have biased the measurement and provide an explanation for lack of observed effect on screen time reduction.

A significant amount of heterogeneity was observed in the quantitative pooling of screen time data. The a priori study characteristics of the populations that were considered to explain heterogeneity included age. Interventions directed to preschool children may be more effective because parents have more control over lifestyle behaviors at this age. The other a priori study characteristics, including setting of intervention, baseline body composition of sample, and presence of cointerventions, were as-

sessed and found not to be significant (data available on request). Heterogeneity in the screen time data, along with differing results for secondary analysis for age subgroups, makes interpretation of this outcome challenging.

#### DIRECTION OF FUTURE RESEARCH

Only 3 trials commented on potential adverse effects of the intervention,<sup>29-31</sup> including issues related to extreme dieting and children's dissatisfaction with body shape. The literature suggests that interventions aimed at reducing weight among adolescents have not been associated with an increased prevalence of eating disorders.<sup>34,38</sup> However, including a measure of harm is important for future trials.

Existing tools for evaluating the quality of evidence in RCTs, such as the GRADE system,<sup>25</sup> were not specifically designed for RCTs that focus on trials of behavioral interventions. We believe, however, that it is important to apply rigorous methods for evaluating RCTs that include behavioral interventions, and that GRADE is a widely adopted existing system for evaluating quality of evidence.<sup>45</sup> In trials of behavioral interventions, where blinding of subjects may not be possible, and measurement of outcomes may rely on self-reporting, it is of utmost importance to use and report all available methods of safeguarding against bias, such as blinding of outcome assessors.

In conclusion, there are a substantial number of RCTs investigating interventions that aim to reduce screen time in children. Reducing screen time is touted as one of the effective interventions to reduce BMI and prevent obesity; however, our meta-analysis did not demonstrate evidence of effectiveness of interventions aimed at reducing screen time in children for reducing BMI and screen time. Although assessing the quality of evidence yielded a result of low quality for both outcomes, this does not dismiss the results as unimportant. This highlights the need for further rigorous investigation and confirms the importance of reporting methods. The interventions in these trials for the most part involved multiple sessions over a prolonged time period, integrated into school curriculum, clinic settings, or home. We propose the evaluation of pragmatic interventions that could feasibly be implemented in fewer sessions, over shorter periods of time, with longer follow-up, and focused on key age groups where behavior change may be sustainable, such as the preschool age group. Given the prevalence of obesity in childhood, and the long-term complications associated with obesity over the life course, testing and implementing effective interventions early in life, including those that focus on screen time, should be a priority for researchers, practitioners, and policy makers.

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