Relationships between media use, body fatness and physical activity in children and youth: A meta-analysis

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Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis.

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Running Head: sedentary behavior, television viewing, body fatness, youth, meta-analysis

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Abstract

Objective: To review the empirical evidence of associations between television (TV) viewing, video/computer game use and: a) body fatness, and b) physical activity.

Design: Meta-analysis.

Method: Published English-language studies were located from computerised literature searches, bibliographies of primary studies and narrative reviews, and manual searches of personal archives. Included studies presented at least one empirical association between TV viewing, video/computer game use and body fatness or physical activity among samples of children and youth aged 3-18 years.

Main outcome measure: Mean sample-weighted corrected effect size (Pearson *r*).

Results: Based on data from 52 independent samples, the mean sample-weighted effect size between TV viewing and body fatness was 0.066 (95% CI = 0.056 to 0.078; total N = 44,707). The sample-weighted fully corrected effect size was 0.084. Based on data from 6 independent samples, the mean sample-weighted effect size between video/computer game use and body fatness was 0.070 (95% CI = -0.048 to 0.188; total N = 1722). The sample-weighted fully corrected effect size was 0.128. Based on data from 39 independent samples, the mean sample-weighted effect size between TV viewing and physical activity was -0.096 (95% CI = -0.080 to -0.112; total N = 141,505). The sample-weighted fully corrected effect size was -0.129. Based on data from 10 independent samples, the mean sample-weighted effect size between video/computer game use and physical activity was -0.104 (95% CI = -0.080 to -0.128; total N = 119,942). The sample-weighted fully corrected effect size was -0.141.

Conclusion: A statistically significant relationship exists between TV viewing and body fatness among children and youth although it is likely to be too small to be of substantial clinical relevance. The relationship between TV viewing and physical activity is small but negative. The strength of these relationships remain virtually unchanged even after correcting for common sources of bias known to impact study outcomes. While the total amount of time per day engaged in sedentary behavior is inevitably prohibitive of physical activity, media-based inactivity may be unfairly implicated in recent epidemiologic trends of overweight and obesity among children and youth. Relationships between sedentary behavior and health are unlikely to be explained using single markers of inactivity such as TV viewing or video/computer game use.

KEYWORDS: television, media use, fatness, children and youth, meta-analysis

Introduction

The World Health Organisation now considers obesity to be a global epidemic[1]. Increases in the prevalence and severity of obesity among children and adolescents have been attributed largely to behavioral and environmental factors[2]. A consistent referent in the academic and lay reporting of secular trends in overweight and obesity among children and youth is that decreases in physical activity and increases in sedentary behavior, particularly TV viewing and video/computer game use, are partly to blame[3-5]. A recent expert panel convened by the American College of Sports Medicine (ACSM)[6] stated unequivocally that "obesity is directly related to the number of hours spent watching television" (p4). Despite these claims, adequate empirical evidence is rarely presented to support these conclusions. The lack of an empirical synthesis of available data concerning these relationships represents a considerable gap in the literature. This paper presents two meta-analytic reviews of literature. The first review examines evidence of a relationship between television viewing, video/computer game use and body fatness among children and youth. The second review examines evidence that these prevalent sedentary behaviors 'displace' physical activity. The displacement of physical activity is one mechanism widely hypothesised to explain possible relationships between sedentary behavior and body fatness.

Methods

Search procedures and inclusion criteria. For both reviews, relevant literature was located from three sources. Firstly, the computerised databases PsychInfo, SportDiscus, MedLine (PubMed), and Ingenta were searched. The following keyword combinations were used: Physical Activity and Sedentary Behavior, Inactivity, Television, Computer, Video, Body Composition, Fatness, Obesity, Overweight, Youth and Adolescence. For the sedentary behavior and body fatness review, all computerised searches were restricted to studies published on or after 1985. This was the date of publication of Dietz and Gortmaker's[4] original study, widely acknowledged as the first empirical examination of these relationships. For the sedentary behavior and physical activity review, a cut-off publication date was not set. However, the maiden date for each computerised search engine was 1887, 1949, 1996 and 1988 (PsychInfo, SportsDiscus, PubMed and Ingenta, respectively). Secondly, reference sections of narrative reviews and primary studies located from the previous two sources were examined. Finally, a manual search was conducted of reprint files (1980-2002) held by the Sedentary Behavior Research Group at Loughborough University.

Only studies with participants less than 18 years of age and published in English as papers or abstracts in peer-reviewed journals were included. While including only English language studies is acknowledged as a limitation of the reviews, it is important to note that 29% and 16% of TV/body fatness and TV/physical activity effects sizes, respectively, were based on samples in which English was not the first language. An independent sample was used as the unit of analysis.

Data extraction. Data were extracted by one reviewer (SJM) using a structured form and were checked for accuracy by a second reviewer (IM). All disagreements were resolved by consensus.

Calculation of effect size. All analyses were conducted using the Pearson correlation coefficient (r) effect size with the adjustment computations proposed by Hunter and Schmidt[7]. Hunter and Schmidt's procedures draw on psychometric theory and are designed to correct for methodological artifacts in primary studies such as sampling error and measurement error. These techniques were preferred over other meta-analytic methods because instruments designed to measure TV viewing, body fatness and physical activity are prone to variance produced by artifacts. These procedures fit random-effects models to the data that are consistent with assumptions about sources of variability in this research domain.

Where data other than Pearson coefficients were presented in primary studies (e.g., Cohen *d* values, Odds Ratios, t-values, etc.) standard transformations[8] were applied to estimate the Pearson correlation. Where primary studies presented only p-values and sample sizes, the maximum possible Pearson correlation was computed. While this method is likely to overestimate the true effect size, it reduces the likelihood of making Type II errors[7]. Pearson *r* values of 0.1, 0.3 and 0.5 represent small, medium and large effects, respectively[9]. All calculations were performed using syntax macros written by SJM using SPSS v11.0 for Windows.

<u>Correcting for artifactual variance</u>. The present study corrected for four main study artifacts: sampling error, measurement error in the independent variable, measurement error in the dependent variable and dichotomization of a continuous dependent variable (body fatness). These artifacts attenuate the population correlation and artificially inflate its variance[7]. It was particularly important to correct for dichotomization of body fatness variables because primary studies often report effect sizes comparing obese and non-obese samples on measures of TV viewing and physical activity. Each study correlation was weighted by its sample size. The variance of the mean of these sample-weighted correlations was then corrected for sampling error because sampling error also adds to the variance of correlations across studies[7]. Dichotomization of the body fatness variables was corrected at the individual study level. A meta-analysis was then performed on these partially corrected correlations. The mean effect size (and variance) from this analysis was then further corrected for measurement unreliability in the independent and dependent variables. These corrections were based on the distribution of

reliability coefficients in other studies that used the same measures. Artifact distributions were used because not all primary studies reported reliability coefficients for their measures. This technique is referred to as artifact distribution meta-analysis and has been written about extensively elsewhere[7]. Because effect sizes were corrected both at the individual level and at the group level, corrected effect sizes cannot be reported at the individual study level (e.g., forest plots).

Credibility and confidence intervals. For each sample-weighted and corrected mean correlation, 95% credibility and confidence intervals were computed. Credibility and confidence intervals are often used and interpreted incorrectly in the meta-analytic literature[10]. Credibility intervals provide information about validity generalization, or the extent to which moderators may be influencing the effect estimate. Confidence intervals are used to estimate the accuracy of the corrected effect size in representing the true population parameter.

Omnibus tests for homogeneity of effects. The homogeneity of mean corrected effect sizes were examined to determine if the variability in outcomes was greater than expected from sampling error and measurement artifacts. In addition to credibility intervals, homogeneity of effects was examined using the Q-statistic and the '75% rule'[7]. The Q-statistic (within-group goodness-of-fit) has an approximate chi-square distribution with $k - 1$ degrees of freedom (k = number of effect sizes). A significant Q-statistic indicates heterogeneity of effects. The 75% rule posits that 'in any data set in which known and correctable artifacts account for 75% of the variance in study correlations [outcomes], it is likely that the remaining 25% is due to uncontrolled artifacts' (p.68)[7]. Thus, the value represents the percent variance accounted for by corrected study artifacts. However, it should also be noted that because the number of studies in each subgroup was small, there exists the possibility of second-order sampling error--the extent to which outcomes of available studies vary randomly about the mean. Where assumptions of homogeneity were rejected, effects were computed separately by hypothesised moderators. These included effects by age and gender, types of measure used for independent and dependent variables, as well as study design factors.

Results

Page restrictions prevent a full presentation of individual sample characteristics and forest plots of effect sizes (four mixed meta-analyses were conducted, yielding 107 separate effects)[*].

TV viewing, video/computer game use and body fatness. A total of 39 studies[4 5 11-47] were located that presented empirical data on TV viewing, video/computer use and body fatness among children and youth. Of these, nine were not included in the review because they involved experimental manipulations of sedentary behavior and physical activity[40], involved interventions targeting additional sedentary behaviors[41-43], were single-subject case studies[44 45], measured only body mass[46], or presented data previously published [47]. From the remaining 30 studies, data were available on 52 independent samples. Effect sizes are reported separately by body fatness and TV viewing (k = 52) and body fatness and video/computer game use (k = 6). Of the 30 published studies only one (3%) was published prior to 1990, eight 27% were published between 1990 and 1995, and the remaining 21 (70%) were published after 1995.

Sample characteristics. A total of 44,707 young people were studied (median = 294; range = 22 to 7,299). Samples were from the USA (k = 25), Canada (k = 17), Belgium, Japan (both k = 2), Australia, China, France, Germany, Mexico and the United Kingdom (all k = 1). Forty-six percent of samples were 7-12 years of age, with the remainder being under 7 yr (8%),

[*] these results can be obtained from the lead author upon request

13-18 yr (23%), or a combination (23%). The majority of samples were single-sex (42% girl-only, 29% boy-only), with 29% including both boys and girls.

Table 1 presents the results of the meta-analysis between TV viewing and body fatness and video/computer game use and body fatness. Ninety-six percent of effect sizes were in the predicted direction (positive). Table 2 presents the results of the moderator analysis for TV viewing and body fatness. A moderator analysis of the relationship between video/computer game use and body fatness was not performed because second-order sampling error is likely to confound results when the initial number of effects is small[7].

[Insert Tables 1 & 2 about here]

TV viewing, video/computer game use and physical activity. Thirty-three studies[11-13 17 18 21 25 30-32 36 38 39 46 48-66] were located that presented a measure of association between physical activity and TV viewing, playing video games or computer use. Nine studies were excluded from analyses either because they had serious design limitations[46 50 51], presented insufficient data for meta-analytic synthesis[11 12 54], presented data on composite measures of sedentary behavior[49 52] or reported on special populations[36]. The remaining 24 studies presented data on 41 independent samples (the unit of analysis) and were included in the final analyses. Fifteen studies presented data on one sample, seven studies presented data on two samples and two studies presented data on six samples. Effect sizes are reported separately by physical activity and TV viewing (k = 39) and physical activity and video/computer game use (k = 10). Of the 24 published papers, none were published prior to 1990, 42% (k = 10) were published between 1990 and 1995 and 58% (k = 14) were published after 1995.

Sample characteristics. A total of 143,235 young people were studied (median = 527; range = 36 to 20,766), although one study[62] (six samples) was a pan-European collaborative survey of 118,173 youth. Excluding this study, the median sample size was 448 (n range = 36 to 5650). Samples were from the USA (k = 19), Canada (k = 7), pan-Europe (k = 6), Belgium, Hong Kong (both k = 2), Germany, Iceland, Norway, South Africa and Spain (all k = 1). Thirty-nine percent of samples (k = 16) were 13-18 years of age, with the remainder being 7-12 yr (22%), under 7 yr (7%), or a combination (32%). The majority of samples were single-sex (41% girl-only, 32% boy-only), with 27% including both boys and girls.

Table 3 presents the results of the meta-analysis between TV viewing and physical activity and video/computer game use and physical activity. Table 4 presents the results of the moderator analysis for TV viewing and physical activity. Again, a moderator analysis of the relationship between video/computer game use and physical activity was not performed because of the likelihood of second-order sampling error.

[Insert Tables 3 & 4 about here]

Discussion – TV viewing, video/computer game use and body fatness

The sample-weighted effect size (Pearson *r*) between TV viewing and body fatness was 0.066 (95% CI = 0.056 to 0.078). The sample-weighted fully corrected effect size was 0.084. While this relationship is statistically significant ($p<.05$), the fact that 99% of the variance in body fatness may be explained by factors other than TV viewing calls into question the clinical relevance of the TV viewing and body fatness relationship. This conclusion is in contrast to many statements in the literature. For example, Bar-Or and colleagues[6] make it clear that current data support a strong and clinically significant relationship between TV viewing and body fatness yet draw their conclusion from only two[4 5] of the samples included in our review, one of which yields an effect size that is a statistical outlier (r = 0.324)[5] to the extant literature. A more balanced appraisal than Bar-Or et al's is made by Caspersen, Nixon and DuRant[67]. They cite four studies showing mixed results. While there is biologic plausibility for a causal relationship[4] and the available evidence is consistent (96% of the effect sizes are positive), relationships are small, dose-response data are lacking, important confounders (e.g., diet) are rarely accounted for and temporal precedence has not been established. This is largely due to the high proportion (83%) of samples that rely on a cross-sectional design. The one randomized controlled trial[12] revealed that an intervention to reduce TV viewing and video game use among 8-9 yr old children attenuated the maturation-related increase in body fatness across a 6-month period. The experimental trials of Gortmaker at al[68] and Epstein and colleagues[42] are also noteworthy because similar decreases in pediatric obesity have been reported when TV viewing was reduced. However, because these studies also targeted other sedentary behaviors[42] or increases in physical activity[68], it is difficult to isolate the effects of TV viewing on changes in body fatness. There is a definite need for more experimental research to evaluate the effects of TV viewing on body fatness during childhood.

Because the current analysis adjusted for four common artifacts known to bias the mean effect size, plausible explanations of findings are that additional artifacts (e.g., imperfect construct validity of measures) confound true relationships or that body fatness is largely independent of TV viewing.

Although few studies have examined relationships between TV viewing and fatness in very young children (0-6 yr), our meta-analytic evidence suggests that effects are greater in this age group than during adolescence (13-18 yr). The reason for this finding is uncertain but it may have implications for interventions designed to reduce or prevent pediatric overweight and obesity. The mean effect size also appears invariant with regard to gender.

The sample-weighted effect size between video/computer game use and body fatness was 0.070 (95% CI = -0.048 to 0.188). The sample-weighted fully corrected effect size was 0.128. The 95% CI for the sample-weighted effect size suggests that the relationship in the population is probably zero. However, this should be interpreted with caution because the mean effect size is based on only six primary effect sizes, suggesting the possibility of second-order sampling error[7].

Discussion – TV viewing, video/computer game use and physical activity

The sample-weighted effect size (Pearson *r*) between TV viewing and physical activity was -0.096 (95% CI = -0.080 to -0.112). The sample-weighted fully corrected effect size was -0.129. A statistically significant negative effect provides possible evidence for a displacement hypothesis. A recent review[69] of correlates of physical activity of children and adolescents concluded the relationship between TV/video games and physical activity to be indeterminate among 4-12 yr olds and zero among 13-18 year olds. The current review examined these studies more closely, located additional evidence and concluded that the relationship among 0-6 year olds is zero (CI's include zero) and 'small' among 7-18 year olds. There was no significant difference between the size of effect among 7-12 year olds and 13-18 year olds. Again, the mean effect size appeared invariant by gender.

From the moderator analysis, it was evident that the effect size differed by physical activity intensity, with only vigorous activity being significantly and inversely associated with TV viewing. A possible explanation is that TV viewing displaces only vigorous physical activity. However, because vigorous physical activity appears more easily recalled than moderate physical activity[70], the observed effect size between TV viewing and MVPA may be biased. Indeed, even after correcting for known artifacts, there remained uncorrected variance in these estimates. This suggests that additional unmeasured variables may be confounding possible relationships. Interestingly, when a TV composite variable was used (e.g., TV viewing, watching videos and playing computer games) the effect disappeared, suggesting possible mechanisms are specific to TV viewing.

The sample-weighted effect size between video/computer game use and physical activity was -0.104 (95% CI = -0.080 to -0.128). The sample-weighted fully corrected effect size was 0.141. This suggests that the relationship is best described as 'small.' Again, this should be interpreted with caution because the mean effect size is based on only 10 primary effects and second-order sampling error may be present[7].

General issues - Research designs and measurement

In the review of TV viewing and body fatness, 83% of samples were studied using cross-sectional designs (k = 43), eight samples were longitudinal[4 15 18 19 24 32], and one was a randomized controlled trial (RCT)[12]. The difference between the mean effect size from longitudinal and cross-sectional samples was not statistically significant. In the review of TV viewing and physical activity, 90% of samples were studied using cross-sectional designs (k = 35) and only four were longitudinal[18 32 61 66]. It is important note that no data were available from controlled trials that manipulated only TV viewing. Cross-sectional studies provide "Category C" level evidence[71] (with 4 Categories, A, B, C, & D) of possible relationships. Evidence is considered Category C when data supporting the conclusion are from uncontrolled or non-randomized trials, cross-sectional or prospective observational studies. The overwhelming reliance on cross-sectional data severely restricts the conclusions that can be drawn from the current evidence.

Assessment of TV viewing, video game playing and computer use. Across all reviews (k = 107 effects), 79% involved self-reported measures of sedentary behavior. Eleven effects (10.3%) were derived from parental reports of child behavior. Six effects[4 5 14 24] were derived from child and parent reports of child behavior, although correlations between child and parent estimates were generally poor (Spearman rho ~ 0.3). Levels of agreement improved when estimating only the number of days per week each behavior occurred[21]. In only two studies was TV viewing observed directly[18 19]. There was considerable variability in the criteria used for the assessment of TV viewing and video/computer game use. One third of all measures used a single self-report item, with the majority having categorical response formats (e.g., 0-2 hr, 2-3 hrs, etc.). The units of estimation also varied greatly with samples self-reporting in hours (59%), minutes (28%), programs (5%), days in which viewing occurred (4%), or separate bouts of viewing (4%). The sampling frame of TV viewing and video/computer game use also varied, with studies relying on recalls of one week (39%), two to six days (21%), one day (34%) or part-day (e.g., after school) (6%) to estimate habitual behavior. Reliability or validity data were presented in only 23% of samples reviewed. Twenty-six effects (29%) were derived using behavioral composites of TV viewing (e.g., TV viewing plus watching videos and playing computer games), making it difficult to isolate the strength of association between single behaviors and body fatness or physical activity.

Assessment of body fatness. It is important to note that all primary studies have utilised proxy measures of body fatness such as subcutaneous fat thickness (i.e., skinfolds) or height-to-weight ratios (i.e., BMI) to estimate fat mass. While these measures have been validated previously (e.g., Goran et al.[72]) this is an important limitation to conclusions drawn from this review. Body fatness was usually assessed using skinfold thickness (60%) or BMI (37%) derived from direct observation of height and weight. Four samples[15 20 38] relied on self-reported height and weight to compute BMI. Only one sample used dual-energy x-ray absorptiometry (DXA)[35] which is considered a 'gold standard' technique for assessing fat mass in children[72]. Although the mean effect size between TV viewing and fatness measured by skinfold thickness and fatness measured by BMI were not statistically different, all of the artifactual variance in the effect size was accounted for when using skinfolds. This suggests that the mean effect size is likely to be similar to the population effect size. When BMI is used as a proxy for body fatness, over 80% of the artifactual variance remains unaccounted for. This suggests either than these samples comprise a heterogeneous population or that uncorrected artifacts are contributing to the variance of the mean effect size.

Few studies reported whether they controlled body fatness measures for sexual maturity or age, variables which are known to confound interpretation[73]. Classifications of 'overweight' and 'obese' also differed across studies. For example, Bernard and colleagues[16] classified children as 'overweight' if they were above the 90th percentile whereas Dietz and Gortmaker[4] used the 85th percentile for 'obesity' and the 95th for 'superobesity'. A recent report[74] of international standards proposed for child overweight and obesity recommended using age- and sex-dependent centile curves defined to pass through cut-off points for BMI of 25 kg/m^2 and 30 kg/m^2 at age 18 yr. To date, no studies have adopted these definitions when studying the relationship between TV viewing and body fatness.

<u>Assessment of physical activity</u>. Forty-two effect sizes (86%) were derived from studies using self-reported measures of physical activity of which 91% were child reports and 8% were parent

reports of child behavior. No study-specific validity or reliability data was reported for the physical activity measure in one-third of samples. Only three of the self-reported measures utilised cognitive recall techniques administered via interview. Of the seven effect sizes derived using 'objective' measures of physical activity, four were based on accelerometry from a single study[60], two were derived from direct observation[18 59], and one from indirect calorimetry[39]. The mean effect size between objectively measured physical activity and TV viewing was not statistically different from self-reported physical activity and TV viewing.

Conclusions

It is concluded that a statistically small relationship exists between TV viewing and body fatness among children and youth although the magnitude of the relationship suggests we should be cautious about the clinical relevance of this finding. The strength of this relationship remains virtually unchanged even after correcting for common sources of bias[7] known to impact study outcomes. This finding is in contrast to many reports[6 75 76] which claim the relationship to be strong and conclusive. Possible mechanisms lack supporting evidence and claims that TV viewing, playing video games or using computers displace physical activity receive very limited empirical support. Possible relationships may be confounded by other factors such as the consumption of energy-dense snacks that may accompany these behaviors. Additional sources of error may also confound true relationships because most studies used cross-sectional designs which have detached and statistically aggregated time-use patterns across a day or week (e.g., hours of TV viewing per day). Because the temporal and environmental context of each behavior is lost, trends of association within sampling periods may be masked or cancelled out. It should be noted that the one randomized controlled trial[12] does provide evidence that reductions in TV viewing can attenuate the age-related increases in body fatness. More experimental research is needed to replicate these findings and explore possible mechanisms. However, based on the entire spectrum of current evidence, it is uncertain whether reductions in TV viewing or video/computer game use will elicit clinically relevant decreases in subcutaneous fat thickness or body mass index. While the total amount of time per day engaged in sedentary behavior is inevitably prohibitive of physical activity and the cumulative effect of multiple sedentary behaviors reduces total daily energy expenditure, relationships between sedentary behavior and health are unlikely to be explained using single markers of inactivity such as TV viewing or video/computer game use.

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Table 1. Results of the meta-analysis between TV viewing and body fatness and video/computer game use and body fatness.

	k	n	$\overline{r}_o$	$\overline{r}_c$	sd	Var.	75%	Q	95% Cr Int.	95% CI
TV viewing and Body Fatness	52	44707	0.066	0.084	0.084	0.007	33%	165.3**	0.060 to 0.108	0.056 to 0.078
Video/computer game use and Body Fatness	6	1722	0.070	0.128	0.181	0.033	31%	19.6**	-0.017 to 0.273	-0.048 to 0.188

Notes:

k = number of independent samples; n = total sample size; $\overline{r}_o$ = uncorrected sample-weighted mean effect size; $\overline{r}_c$ = fully corrected sample-weighted mean effect size; sd = standard deviation of fully corrected mean effect size; Var. = variance of fully corrected mean effect size; 75% = 75% rule; Q = within-group goodness of fit (approximates chi-square distribution with k-1 degrees of freedom); 95% Cr Int. = 95% credibility interval; 95% CI = 95% confidence interval.

* = p<.05; ** = p<.01.

Table 2. Meta-analysis results for the moderator analysis between TV viewing and body fatness.

Moderator variable	k	n	$\overline{r}_o$	$\overline{r}_c$	sd	Var.	75%	Q	95% Cr Int.	95% CI
Body Fatness measure										
BMI	19	29382	0.068	0.087	0.094	0.009	19%	98.8^{**}	0.048 to 0.132	0.040 to 0.096
Skinfold	31	14073	0.050	0.066	0.000	0.000	100%	24.3	0.066 to 0.066	0.033 to 0.067
Other[a]	2	1252	0.175	0.253	0.101	0.010	95%	2.1	0.113 to 0.393	0.086 to 0.264
TV measure										
Self report	36	29431	0.043	0.054	0.000	0.000	100%	24.8	0.054 to 0.054	0.041 to 0.045
Parent report	6	10151	0.114	0.219	0.084	0.007	42%	14.4^{*}	0.152 to 0.286	0.054 to 0.174
Direct observation	2	215	0.094	0.167	0.000	0.000	100%	1.2	0.167 to 0.167	0.094 to 0.094
TV only	33	21701	0.088	0.125	0.113	0.013	31%	106.3^{**}	0.086 to 0.164	0.056 to 0.120
TV composite	19	23006	0.043	0.054	0.017	0.000	97%	16.6	0.046 to 0.062	0.051 to 0.066
Study Design										
Cross-sectional	43	28718	0.081	0.111	0.101	0.012	35%	118.5^{**}	0.095 to 0.127	0.043 to 0.063
Longitudinal	8	15797	0.041	0.053	0.030	0.001	61%	13.1	0.042 to 0.064	0.030 to 0.052
RCT[b]	1	192	0.262	0.263	n/a	n/a	n/a	n/a	n/a	n/a
Gender										
Boys	15	14949	0.047	0.062	0.000	0.000	100%	7.3	0.062 to 0.062	0.047 to 0.047
Girls	22	21662	0.063	0.075	0.081	0.007	31%	65.0^{**}	0.040 to 0.110	0.034 to 0.092
Mixed	15	8096	0.112	0.173	0.132	0.017	29%	48.0^{**}	0.104 to 0.242	0.055 to 0.169
Age (yr)										
0-6	4	2047	0.146	0.190	0.046	0.002	100%	2.5	0.145 to 0.235	0.089 to 0.203
7-12	24	18788	0.076	0.127	0.081	0.007	93%	22.7	0.093 to 0.161	0.049 to 0.103
13-18	12	3196	0.057	0.069	0.000	0.000	100%	2.9	0.069 to 0.069	0.037 to 0.077

Table 2 Contd.

Notes:

k = number of independent samples; n = total sample size; $\overline{r_o}$ = uncorrected sample-weighted mean effect size; $\overline{r_c}$ = fully corrected sample-weighted mean effect size; sd = standard deviation of fully corrected mean effect size; Var. = variance of fully corrected mean effect size; 75% = 75% rule; Q = within-group goodness of fit (approximates chi-square distribution with k-1 degrees of freedom); 95% Cr Int. = 95% credibility interval; 95% CI = 95% confidence interval.

[a] fat mass (g) from dual-energy x-ray absorptiometry (k = 1), >2 SD (z) from Sempe's weight/height/sex reference charts (k = 1).

[b] RCT = randomized controlled trial

* = p<.05; ** = p<.01.

Table 3. Results of the meta-analysis between TV viewing and physical activity and video/computer game use and physical activity.

	k	n	$\overline{r}_o$	$\overline{r}_c$	sd	Var.	75%	Q	95% Cr Int.	95% CI
TV viewing and Physical Activity	39	141505	-0.096	-0.129	0.062	0.004	27%	140.8**	-0.110 to -0.148	-0.080 to -0.112
Video/computer game use and Physical Activity	10	119942	-0.104	-0.141	0.045	0.002	39%	28.3**	-0.173 to -0.119	-0.080 to -0.128

Notes:

k = number of independent samples; n = total sample size; $\overline{r}_o$ = uncorrected sample-weighted mean effect size; $\overline{r}_c$ = fully corrected sample-weighted mean effect size; sd = standard deviation of fully corrected mean effect size; Var. = variance of fully corrected mean effect size; 75% = 75% rule; Q = within-group goodness of fit (approximates chi-square distribution with k-1 degrees of freedom); 95% Cr Int. = 95% credibility interval; 95% CI = 95% confidence interval.

* = p<.05; ** = p<.01.

Table 4. Meta-analysis results for the moderator analysis between TV viewing and physical activity.

Moderator variable	k	n	$\overline{r}_o$	$\overline{r}_c$	sd	Var.	75%	Q	95% Cr Int.	95% CI
PA measure										
Self report	34	140887	-0.096	-0.132	0.062	0.004	28%	119.6**	-0.111 to -0.153	-0.079 to -0.113
Objective[a]	5	618	-0.118	-0.155	0.094	0.009	47%	10.7*	-0.073 to -0.237	-0.052 to -0.184
PA intensity										
Combined	12	9229	-0.066	-0.089	0.039	0.002	63%	17.4	-0.066 to -0.112	-0.046 to -0.085
MVPA[b]	11	1847	0.062	0.084	0.216	0.047	19%	56.7**	-0.044 to 0.211	-0.033 to 0.157
Vigorous	13	126046	-0.104	-0.140	0.040	0.002	44%	29.5**	-0.119 to -0.162	-0.083 to -0.125
Sports	3	9122	-0.066	-0.089	0.075	0.006	23%	13.1**	-0.004 to -0.174	0.000 to -0.131
TV measure										
Self report	33	139349	-0.097	-0.132	0.058	0.003	29%	112.2**	-0.112 to -0.151	-0.081 to -0.114
Parent report	5	2043	0.042	0.057	0.186	0.035	10%	39.3**	-0.126 to 0.239	-0.094 to 0.178
TV only	31	138005	-0.098	-0.132	0.050	0.003	35%	88.5**	-0.115 to -0.150	-0.083 to -0.113
TV composite	7	3393	-0.002	-0.002	0.232	0.054	7%	107.1**	-0.174 to 0.170	-0.129 to 0.126
Study Design										
Cross-sectional	35	139047	-0.097	-0.131	0.059	0.004	28%	119.6**	-0.112 to -0.151	-0.081 to -0.114
Longitudinal	4	2458	-0.007	-0.009	0.140	0.020	13%	30.3**	-0.146 to 0.128	-0.108 to 0.095
Gender										
Boys	12	63085	-0.085	-0.115	0.029	0.001	56%	21.3*	-0.099 to -0.131	-0.069 to -0.102
Girls	16	67136	-0.115	-0.156	0.072	0.005	26%	62.7**	-0.120 to -0.191	-0.086 to -0.144
Mixed	11	11284	-0.038	-0.051	0.109	0.012	13%	76.9**	-0.119 to 0.016	-0.088 to 0.012

Table 4 Contd.

Age (yr)											
	0-6	3	631	-0.046	-0.063	0.127	0.016	36%	8.4**	-0.206 to 0.081	-0.153 to 0.060
	7-12	9	84347	-0.090	-0.122	0.000	0.000	100%	5.0**	-0.122 to -0.122	-0.082 to -0.098
	13-18	16	14630	-0.113	-0.152	0.053	0.003	37%	43.4**	-0.127 to -0.178	-0.090 to -0.136

Notes:

k = number of independent samples; n = total sample size; $\overline{r_o}$ = uncorrected sample-weighted mean effect size; $\overline{r_c}$ = fully corrected sample-weighted mean effect size; sd = standard deviation of fully corrected mean effect size; Var. = variance of fully corrected mean effect size; 75% = 75% rule; Q = within-group goodness of fit (approximates chi-square distribution with k-1 degrees of freedom); 95% Cr Int. = 95% credibility interval; 95% CI = 95% confidence interval.

[a] accelerometry (k = 2); direct observation (k = 2); indirect calorimetry (k = 1).

[b] moderate-to-vigorous physical activity

* = p<.05; ** = p<.01.