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REVIEW ARTICLE

Effect of intervention programs in schools to reduce screen time: a meta-analysis☆

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KEYWORDS
Child;
Adolescent;
School health;
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Abstract
Objective: to evaluate the effects of intervention program strategies on the time spent on activities such as watching television, playing videogames, and using the computer among schoolchildren.
Sources: a search for randomized controlled trials available in the literature was performed in the following electronic databases: PubMed, Lilacs, Embase, Scopus, Web of Science, and Cochrane Library using the following Keywords randomized controlled trial, intervention studies, sedentary lifestyle, screen time, and school. A summary measure based on the standardized mean difference was used with a 95% confidence interval.
Data synthesis: a total of 1,552 studies were identified, of which 16 were included in the meta-analysis. The interventions in the randomized controlled trials (n = 8,785) showed a significant effect in reducing screen time, with a standardized mean difference (random effect) of: −0.25 (−0.37, −0.13), $p < 0.01$.
Conclusion: interventions have demonstrated the positive effects of the decrease of screen time among schoolchildren.

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PALAVRAS-CHAVE
Criança;
Adolescente;
Saúde escolar;
Estilo de vida sedentário

Efeito dos programas de intervenção no âmbito escolar para reduzir o tempo gasto em frente a telas: uma meta-análise

Resumo

Objetivo: avaliar os efeitos das estratégias dos programas de intervenção sobre o tempo dedicado a atividades como assistir à televisão, jogar videogame e usar computador em escolares.
Fonte dos dados: foi realizada busca de estudos controlados randomizados, disponíveis nas bases de dados eletrônicas PubMed, Lilacs, Embase, Scopus, *Web of Science* e *Cochrane Library*, com os descritores: *randomized controlled trial, intervention studies, sedentary lifestyle, screen time* e *school*. Medida de sumário baseada na diferença das médias padronizadas foi usada com intervalo de confiança de 95%.
Síntese dos dados: foram identificados 1.552 estudos, dos quais 16 foram incluídos na meta-análise. As intervenções nos estudos controlados randomizados (n = 8.785) apresentaram efeito significativo na redução do tempo em frente à tela, com diferença das médias padronizadas (efeito randômico): −0,25 (−0,37; −0,13), p < 0,01.
Conclusão: as intervenções mostraram efeitos positivos na redução do tempo em frente à tela em escolares.

Introduction

Although the World Health Organization recommends that children and adolescents should not spend more than two hours a day in front of the television, computers, or video games, a population-based study performed in Brazil, the National Survey of Schoolchild's Health (Pesquisa Nacional de Saúde do Escolar - PeNSE) demonstrated that 78% of eight-graders watched television for two or more hours daily. This indicator ranged from 71% to 82.3% in the Brazilian capitals.[1,2]

The longer periods of time during which children and adolescents engage in activities such as watching television, playing video games, and using the computer are associated with several health problems, including arterial hypertension,[3] metabolic syndrome,[4] and overweight, as reported in several international[5–9] and Brazilian studies.[10–15] They are also associated with negative behavioral changes, such as changes in sleep,[16–18] in interpersonal relationships and attention,[19] and increased aggression.[20,21]

Excessive time in front of the screen is also associated with food, especially with low intake of fruits and vegetables,[22] and with excessive intake of high-calorie foods and those with high content of fats, sugars, and sodium. Additionally, it influences the choice of foods, as the children are exposed to unhealthy food advertisements.[23,24] Some studies have also indicated an association with eating disorders.[25–27]

Therefore, several strategies have focused on changing the sedentary lifestyle with a decrease in daily screen time through intervention programs, especially in the prevention of obesity.[28–30]

Children and adolescents constitute the primary target of these strategies, which represent the possibility of health promotion and protection against obesity and future chronic diseases.[31,32] Therefore, the school is an important scenario to promote educational practices and to motivate individuals to adopt healthy lifestyle habits and maintain them throughout adulthood.[33]

This study presents the main results of a meta-analysis aimed to evaluate the effects of interventions, conducted in the school environment, on the time dedicated to activities such as watching television, playing video games, and using a computer.

Methods

This was a meta-analysis based on search performed in Lilacs, PubMed, Web of Science, Scopus, Embase, and Cochrane Library electronic databases, between 1998 and August of 2012, using the following Keywords

Randomized Controlled Trial, Intervention Study, Sedentary Lifestyle, Media, Screen Time, Television, Computer, Video Games, Children, Adolescents, Overweight, Obesity, Food and Nutrition Education, Physical Education, Physical Activity, Schools.

A search was also performed using the references of relevant studies and systematic reviews that addressed the topic of interest. The following inclusion criteria were used for study selection: randomized controlled trials; publications since 1998 (including that year); schoolchildren aged 4 to 19 years; pre- and post-measurement of time spent watching television, playing video games, or using the computer; and interventions and programs that focused on changes in sedentary behavior aiming to reduce screen time, with a minimum duration of three months, conducted in the school environment. Since the present review included studies with pre- and post- measurement of screen time, the following were also used as eligibility criteria: interventions that focused on obesity prevention and changes in lifestyle through nutrition education and physical activity. In these studies, reduction of screen time was a secondary outcome.

The internal quality of the studies was assessed using the allocation concealment criteria proposed by the Cochrane Collaboration[34] and complemented by the Jadad et al.[35] scale. When assessing the allocation concealment criteria, the studies were classified into four categories: Category A or Adequate, meaning that the process of allocation was

adequately reported; Category B or Undetermined, meaning that the allocation process was not described, but was mentioned in the text of the randomized trial; Category C or Inadequate, stating that the process of allocation was inadequately reported; Category D or Not Used, stating that the study was not randomized. Studies classified as A and B, through allocation concealment analysis, were included. Those classified as C and D were excluded from the review, as they were not considered as properly performed.[34]

The criteria described by Jadad et al. to evaluate internal quality used in this study were randomization, double-blind masking, losses, and exclusions. A maximum of five points could be obtained. A study was considered poor quality if its score was less than or equal to three points.[35]

After searching for studies in the electronic databases, study selection started with the analysis of titles and abstracts by two reviewers according to the inclusion criteria. When the abstract lacked information, the study was read in full. Subsequently, only studies classified as A and B, according to the allocation concealment criteria, were included in the review.

Information was independently extracted by two reviewers to collect data from the selected studies. The results were cross-checked to verify concordance, and discordant results were resolved by consensus. The assessment by the reviewers was not masked regarding the authors and the study results.

For the statistical analysis, randomized controlled trials were entered into the meta-analysis, and the time spent in low-intensity activities such as watching television, playing video games, and using the computer was assessed in hours/day.

A summary measure based on the standardized mean difference (SMD) was used for the outcome studied. In order to obtain that summary measure and their respective 95% confidence intervals (95% CI) a model of fixed or random effects was followed, depending on the heterogeneity between studies. The test of consistency (I^2) was used to assess heterogeneity between studies, and a random effects model was used for $I^2 > 50\%$.[36,37] The I^2 test describes total variability due to heterogeneity; values equal to zero do not represent heterogeneity between studies; values below 25% represent low variability; intermediate values between 25 and 50%, moderate; and values greater than 50%, represent high variability.[36] The effect of interventions was also analyzed using the magnitude scale for statistical effect proposed by Cohen in 1988,[38] through SMD analysis. Statistical analysis was performed using the Review Manager (RevMan) software. Version 5.2. (Copenhagen, DN). The results were presented using forest plot graphs.

Results

Fig. 1 summarizes the flow chart of the study selection process. Initially, 1,552 studies were identified; of these, 1,373 were found by searching electronic databases and 179 through the references of relevant studies and systematic reviews that addressed the topic of interest.

Subsequently, the studies identified were imported into Endnote® reference manager, release X6; then, 402 duplicate studies were removed. A total of 1,150 studies were identified, of which 931 were excluded after a thorough analysis of title and summary demonstrated that they did not fit the inclusion criteria. Due to lack of information in the summary, 219 studies were analyzed in full; of these, 190 were excluded because they did not fit the inclusion criteria. After analyzing the eligibility, 29 studies were selected for the quality check according to the allocation concealment criteria. Studies classified as C and D were excluded, totaling four. Thus, 24 studies were selected for data collection, as they were classified as A and B. Of these, nine were excluded, as they did not have sufficient data for inclusion in the meta-analysis. Thus, 16 studies were included in this systematic review.[28–30,39–51]

Regarding the characteristics of the selected studies, most intervention programs were performed in the United States, with duration $\geq$ six months, and included the participation of the families (Table 1).

Considering the internal quality of the included studies, through its analysis by allocation concealment,[34] the allocation process was considered adequate in 11 studies (category A), and in five of them, the process was not described, but mentioned in the text of the randomized trial (category B). Regarding the assessment according to the Jadad et al. scale, all 35 were considered as poor quality. The characteristics of the included studies are described in Table 1.

None of the studies applied the intervention programs aiming to reduce the screen time alone, but combined with other components, including nutrition education and physical activity. Moreover, in some of them, the interventions were conducted with extracurricular activities after school hours.[30,40,44] Furthermore, screen time in hours per day was the measurement method used in most studies. The characteristics of the intervention program strategies are detailed in Table 2.

To assess screen time, 16 studies were entered into the meta-analysis, and results with 8,785 participants showed a statistically significant effect of interventions on the decrease of screen time, with SMD (random effect): - 0.25 hours/day (95% CI = - 0.37, - 0.13), $p < 0.01$ between the intervention group and the control group, with a magnitude of effect considered to be small. There was heterogeneity between the studies with high variability ($I^2 = 85\%$) (Fig. 2).

Discussion

This systematic review with meta-analysis allows a preliminary insight into the impact of interventions implemented in schools, focusing on sedentary behavior by reducing screen time, considered important in the prevention of obesity in children and adolescents.

When analyzing the international literature, relevant results were also observed in the decrease of sedentary behavior in children with SMD: - 0.29 (95% CI = - 0.35, - 0.22) in the meta-analysis presented by Kamath et al., and in adolescents in the study by Biddle et al. with SMD: - 0.192 (95% CI: - 0.30, - 0.08).[52,53]

In schoolchildren, the result of the meta-analysis by Maniccia et al. was also positive regarding interventions to decrease time spent in front of the TV with SMD: - 0.15 (95% CI: - 0.23, - 0.06),[54] a similar result to that observed in the present study. According to a systematic review by Schmidt

Table 1 Characteristics of the randomized controlled trials included in the systematic review.

1st Author	Year	Place	n	Age	Gender	Family component	Time of intervention (months)	Evaluation of time in front of screens	Measurement of time in front of screens	Aloc Conc	Jadad
Robinson[28]	1999	United States	192	8.9	F/M	S	6	TV	H/W	B	PQ
Gortmaker[29]	1999	United States	1,220	11.7	F/M	NM	14	TV/VIDEO	H/D	A	PQ
Sahota[39]	2001	United Kingdom	599	8.39	F/M	S	9	TV/CPT	H/D	A	PQ
Robinson[30]	2003	United States	61	9.5	F	S	3	TV/VIDEO/GAMES	H/W	B	PQ
Story[40]	2003	United States	53	9.3	F	S	3	TV	H/D	B	PQ
Fitzgibbon[41]	2006	United States	324	4.2	F/M	S	3.5	TV	H/D	A	PQ
Foster[42]	2008	United States	705	11.2	F/M	S	24	TV	H/D	B	PQ
Jones[43]	2008	United States	606	12.4	F	NM	18	TV/VIDEO/CPT/GAMES	MIN/DAY	A	PQ
Weintraub[44]	2008	United States	21	9.50	F/M	S	6	TV/VIDEO/GAMES/CPT	H/W	A	PQ
Gentile[45]	2009	United States	1,318	9.6	F/M	S	24	TV/GAMES	H/W	B	PQ
Lubans[46]	2009	Australia	106	14.1	F/M	S	6	TV	H/D	A	PQ
Singh[47]	2009	Holland	903	12 – 14[a]	F/M	NM	8	TV/CPT	MIN/D	A	PQ
Sacher[48]	2010	United Kingdom	72	10.2	F/M	S	6	TV/CPT	H/W	A	PQ
Bjelland[49]	2011	Norway	1,309	11.2	F/M	S	8	TV/DVD/CPT/GAMES	H/D	A	PQ
Puder[50]	2011	Switzerland	625	5.1	F/M	S	12	TV/VIDEO/CPT/GAMES	MIN/DAY	A	PQ
Ezendam[51]	2012	The Netherlands	671	12.65	F/M	S	12	TV/CPT	MIN/D	A	PQ

Legend: Year, year of publication; Location, site of the intervention, n, sample size; Age, mean age, F, female, M, male, S, Yes, NM, not mentioned; Evaluation of screen time: TV, television, DVD, Digital Video Disc; CPT, computer; VIDEO, VCR; GAME, Videogame; H/D, hours a day; H/W, hours a week; M/W, minutes a week,; M/D, minutes a day; Alloc conc., level of allocation concealment according to the Cochrane Collaboration; A, adequate allocation concealment; B, allocation concealment is not described, but it is mentioned in the text of the randomized study; Jadad, Jadad scale of study quality; PQ, poor quality.

[a] Age interval.

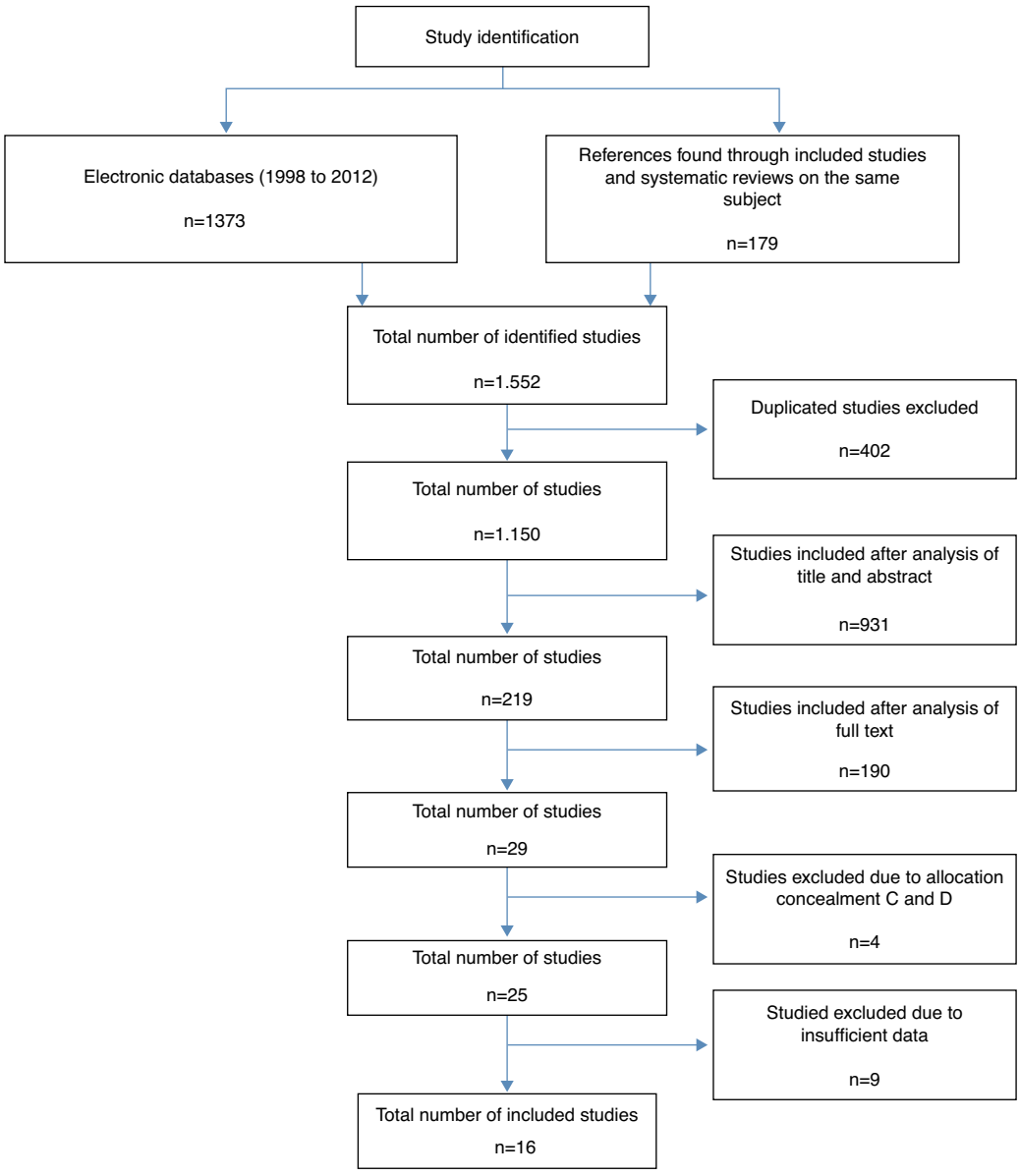


Figure 1 Flow chart of the study selection process.

et al., strategies to decrease screen time showed positive results; in most studies, the interventions were conducted in the school environment.[55] A controversial meta-analysis by Wahi et al. observed no changes in screen time between the intervention group and the control group, with SMD (mean difference): - 0.90 (95% CI: - 3.47, 1.66).[56]

The meta-analysis of randomized controlled trials also demonstrated that interventions aimed at decreasing sedentary time presented a statistically significant effect in reducing body mass index with SMD: - 0.89 (95% CI: - 1.67, - 0.11) in the intervention group compared to the control group. In this same review, the qualitative analysis of randomized controlled trials and longitudinal and cohort studies concluded that watching television for two or more hours a day is associated with increased body composition, low self-esteem, and lower school performance in children and adolescents of school age (5 to 17 years).[57]

In many studies included in the present review, interventions that focused on sedentary behavior aimed to reduce the time dedicated to activities such as watching television, playing video games, and using the computer. Moreover, the measurement of physical inactivity was assessed through screen time.

Of the studies included in this review, no intervention programs aimed solely to reduce screen time; they were combined with other components, including nutrition education and physical activity. This suggests that strategies aimed at changing sedentary behavior and reducing screen time should focus on both physical activity and nutrition education, aspects that should be considered in public policy planning in the healthcare are. Although some studies have observed no association between screen time and physical activity,[58,59] a reduction in screen time and promotion of physical activity are crucial aspects of intervention programs.

Table 2 Characteristics of the intervention programs.

1st Author	Year	Characteristics of the intervention programs
Robinson[28]	1999	**Description:** The intervention program aimed to reduce the time dedicated to electronics and replace it with more physical activities. The classes were followed by a challenge to the students, asking them to leave their electronic devices turned off for ten days. Letters were sent to parents so that they could also help in the challenge, which would encourage their children to have a more active life.
Gortmaker[29]	1999	**Name of the program:** Planet Health **Description:** The program was introduced in the school curriculum and focused on four behavioral changes: reducing the time in front of television, increasing the level of physical activity to moderate-vigorous; decreasing the consumption of high-fat foods, and increasing the consumption of fruits and vegetables.
Sahota[39]	2001	**Name of the program:** Active programme promoting lifestyle in schools (APPLES) **Description:** This interdisciplinary program involved modifications in school meals, as well as development and implementation of school action plans aimed to promote healthy eating and physical activity, in addition to parental involvement in the activities.
Robinson[30]	2003	**Name of the program:** Stanford GEMS **Description:** The program consisted of dance classes offered after school hours. It also included an intervention to reduce the time using television, VCR, and video games.
Story[40]	2003	**Name of the program:** Keys to Eating, Exercising, Playing, and Sharing (KEEPS) **Description:** The program was developed at meetings held after school hours. The physical activity intervention aimed to increase the intensity of physical activity to moderate-vigorous and decrease physical inactivity, with the reduction of screen time. Changes in dietary habits aimed to reduce the consumption of fatty foods and increase the consumption of fruits, vegetables, and water. The intervention program included the participation of parents, as they received weekly brochures on the importance of physical activity and nutrition for health promotion. They attended a cooking practice and games related to physical activity, such as a dance contest.
Fitzgibbon[41]	2006	**Description:** The intervention program aimed to increase the consumption of fruits and vegetables, decrease the intake of high-fat foods, decrease sedentary lifestyle, and increase physical activity.
Foster[42]	2008	**Name of the program:** School Nutrition Policy Initiative (SNPI) **Description:** The students participated in the 2-1-5 challenge, which aimed to reduce sedentary lifestyles and encourage healthy eating: [2]: two hours a day of television and video games, [1]: one hour a day of physical activity, and [5]: consume five servings of fruits and vegetables a day. There were changes in all meals served at the schools. Meetings, brochures, and workshops were held with the families, encouraging the reduction of physical inactivity, increase in physical activity, and consumption of more fruits and vegetables.
Jones[43]	2008	**Name of the program:** The Incorporating More Physical Activity and Calcium in Teens (IMPACT) **Description:** This interdisciplinary program aimed to promote bone health in girls, increasing the level of physical activity and consumption of calcium-rich foods.
Weintraub[44]	2008	**Name of the program:** Stanford Sports **Description:** This intervention was based on soccer classes offered after school hours. The soccer classes were structured to promote positive experiences through sports practice, with emphasis on self-respect and the importance of teamwork. Shin guards, uniforms, and water bottles were provided for each player. Soccer games that involved the children, their parents, and coaches were also carried out.
Gentile[45]	2009	**Name of the program:** Switch **Description:** The interventions in schools were directed to children and their families, aiming to increase physical activity, reduce television time, and increase the consumption of fruits and vegetables. Families and teachers received monthly information that included brochures describing the project, tips to increase physical activity and consumption of fruits and vegetables in a creative and attractive way, in addition to planning meals and making the list for grocery shopping. The community also received information on the prevention of childhood obesity. Some community activities were performed: launching of the project at a community event, distributing posters, supplying printed materials in public and private health services, creating a web page, and printing a monthly information bulletin in the local newspapers.

Table 2 (*Continued*)

1st Author	Year	Characteristics of the intervention programs
Lubans[46]	2009	**Name of the program:** Program X **Description:** The interventions aimed to promote physical activity, reducing the time spent watching television, using the computer, and playing electronic games; to help children become more active with friends and family; to increase the consumption of fruits and vegetables, and water, and to reduce or replace sugary drinks for drinks with low sugar content. Informative manuals on the importance of physical activity and healthy nutrition were supplied to parents.
Singh[47]	2009	**Name of the program:** Dutch Obesity Intervention in Teenager (DOiT) **Description:** The program aimed to educate students about the importance of healthy eating and physical activity for health promotion. Interventions in school cafeterias were also performed.
Sacher[48]	2010	**Name of the program:** Mind, Exercise, Nutrition, Do it (MEND) **Description:** The interventions aimed to promote physical activity and healthy eating habits in obese children. Families also participated in a guided tour to the supermarket and received materials including healthy recipes.
Bjelland[49]	2011	**Name of the program:** HEalth In Adolescents (HEIA) **Description:** The interventions in schools aimed to educate children and their families to increase the level of physical activity, reduce time in front of the screen, and reduce consumption of sugary drinks.
Puder[50]	2011	**Name of the program:** Ballabeina **Description:** The interventions were developed for students, teachers, and families, and promoted physical activity and healthy eating, as well as discussing issues such as limitations in the use of television and the importance of sleep.
Ezendam[51]	2012	**Name of the program:** The FATaintPHAT **Description:** The interventions were performed through the internet during class time and aimed to reduce the consumption of drinks with high sugar content and high-calorie snacks; increase the consumption of fruits, vegetables, and whole wheat bread; reduce sedentary behaviors by reducing the time in front of the screen; and increase physical activity (commuting to school, sports, and leisure activities).

This practice can be conducted at school and during leisure time, as their health benefits, amply documented in the literature, are associated with skeletal health (bone mineral content and density),[60–62] increase in flexibility and aerobic capacity,[63,64] and an inverse association with cardiovascular risk factors.[63,65–68] Furthermore, regular physical activity, when started in childhood and/or adolescence, protects against physical inactivity in adulthood,[69–71] even though many studies showed no association between screen time and level of physical activity.

Regarding the interventions described in the studies, the family is emphasized as an important component, especially the involvement of parents in promoting healthy habits; this fact should be considered and encouraged by intervention programs, as children are influenced by the parents' habits. Therefore, the recommendations provided at school should be followed at home, through parents' positive examples to their children. Current scientific evidence suggests that intervention programs have better results when the strategies include the family component.[72,73]

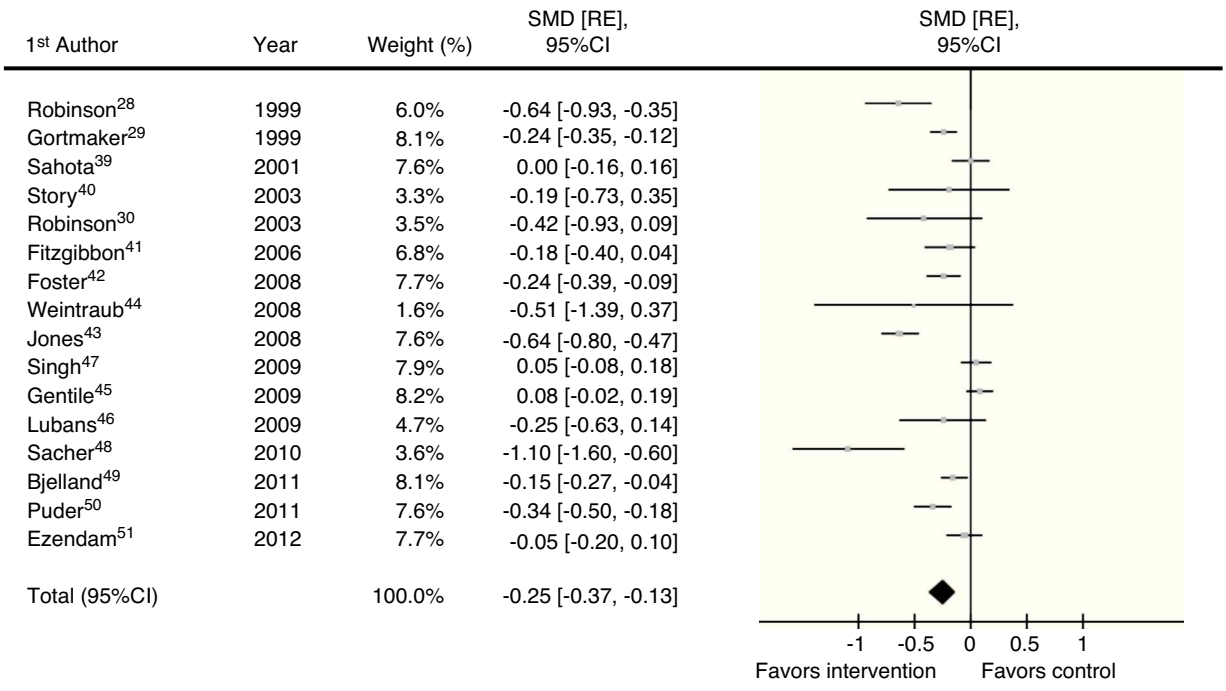
The limitations of this meta-analysis include a small number of trials, with some exclusions due to lack of suitable data for effect size calculation. Moreover, most of the included trials were performed with a small sample, and all were considered as poor quality according to the Jadad et al. scale, as they did not describe the allocation concealment in detail, the randomization procedure, blinding, losses, and exclusions. Furthermore, no Brazilian study was included in this review, as they did not meet the inclusion criteria.

This systematic review may be subject to publication bias, as trials that reported beneficial effects of certain interventions are more often published, at the expense of those that did not describe positive effects.

Another limitation of the included trials is related to the intervention programs, as most of them did not have the reduction of screen time as specific objective, but aimed to promote and encourage physical activity and healthy eating habits. For this reason, intervention studies with pre- and post-measurements of screen time in which this variable was considered a secondary outcome were included in the review, after comprehensive discussions among the project team members.

It should be emphasized that, although the time spent using television, computers, and video games is representative of frequently sedentary activities, the assessment should also consider analyses of time spent in the car, sitting and resting, situations involving traffic, work, and leisure activities.[74]

Moreover, the self-reported sedentary behavior evaluated by questionnaires was considered the methodological choice of most trials to assess sedentary behavior among schoolchildren. However, this method does not allow for accurate measures as those obtained with motion sensors, such as accelerometers. For many authors, sedentary



Heterogeneity: Chi^2=101.45, df=15 (P<0.00001); I^2=85%

Test for effect: Z=3.95 (P<0.0001)

n, sample size; SMD [RE], standardized mean difference with random effects;

CI, confidence interval; Chi^2, chi-square; I^2, inconsistence test; df, degree of freedom.

Figure 2 Forest plot for the studies comparing the intervention with the control group for interventions aimed at reducing the time in front of the screen (hours/day) in schoolchildren.

behavior is generally defined as time spent $\leq$ 1.5 METs.[75,76] Therefore, the combination of these two methods could be used to measure sedentary behavior.

The present review suggests the need for well-designed, randomized controlled trials with good methodological criteria to assess the effect of interventions, especially in Brazilian populations, as well as interventions whose main strategy is to reduce screen time.

The present results should be interpreted with caution, and may also help to plan future research. The evidence in this systematic review with meta-analysis suggests that changes in sedentary behavior, by reducing the time spent in activities such as watching television, playing video games, and using computers, are possible through intervention programs in schools, although the effects are small.

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Conflicts of interest

The authors declare no conflicts of interest.

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