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Effect of interventions on the body mass index of school-age students

ABSTRACT

OBJECTIVE: To evaluate the effect of intervention programs using nutritional education, physical activity or both on the reduction of body mass index in school-age students.

METHODS: The systematic review with meta-analysis included randomized controlled studies available from the following electronic databases for the years 1998 to 2010: PubMed, Lilacs, Embase, Scopus, Web of Science and Cochrane Library. The descriptors were: randomized controlled trial, overweight, obesity, body mass index, child, adolescent, physical activity, nutrition education and Schools. A weighted average was based on the standardized means difference and used a 95% confidence interval. The inconsistency test was utilized to evaluate the heterogeneity of studies.

RESULTS: Initially, 995 studies were identified, of which 23 were included, and 3 meta-analyses were performed. Isolated physical activity interventions did not present a significant reduction in body mass index, with a standardized mean difference of -0.02 (95%CI: -0.08; 0.04). A similar result (n= 3,524) was observed in the isolated interventions of nutritional education, with a standardized mean difference of -0.03 (95%CI: -0.10; 0.04). When the interventions with physical activity and nutritional education were combined, the result of the meta-analysis (n= 9,997) presented a statistically significant effect in the reduction of body mass index in school-age students, with a standardized mean difference: -0.37 (95%CI: -0.63; -0.12).

CONCLUSIONS: The interventions that combined physical activity and nutritional education had more positive effects in the reduction of body mass index among school-age students than when they were applied individually.

DESCRIPTORS: Child. Adolescent. Obesity, prevention & control. Body Mass Index. Food and Nutrition Education. Physical Education and Training. Motor Activity. Weight Reduction Programs. Meta-Analysis.

INTRODUCTION

Obesity is a condition where the accumulation of body fat increases and results in harm to health.^a Despite being an ideal, this definition is difficult to apply due to the limited availability of easy to administer methods to evaluate body composition.⁸ Body mass index (BMI) is used to define obesity. The World Health Organization published the new child growth standards in 2006 and made

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^a World Health Organization. Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation on Obesity. Geneva; 2000.

information about BMI available in graphic and tables with percentile values and Z scores, simplifying their use at a population level.⁴⁷ The increasing prevalence of obesity threatens the health of an increasing portion of the population. It is a challenge to health services and necessitates practical methods of diagnosis and monitoring that are low cost.

The most current national level data on the nutritional status of Brazilian children age 5 years and less is the *Pesquisa de Orçamentos Familiares* (POF – Household Budget Survey) from 2008-2009 and the *Pesquisa Nacional sobre Demografia e Saúde* (PNDS – National Demographic and Health Survey) of 2006. The results of the POF show that the prevalence of overweight varied from 32% to 40% in children age five to nine years in the Southeast, South and Central-West regions and from 25% to 30% in the North and Northeast regions, which was the age group for which the increased prevalence of obesity was most dramatic.^b There was an increased prevalence of overweight in the population age 10 to 19 years, from 3.7% to 21.7% among boys and from 7.5% to 19.4% among girls between the periods of 1974-1975 and 2009-2009.^b The PNDS recorded a national prevalence of overweight of 6.6%, with the highest proportion in the South (8.8%) and the lowest in the North (5.2%).^c

Lifestyle changes (a diet composed of industrialized, sugar and fat rich foods and the reduced consumption of fruits and vegetables) combined with little physical activity (increased television and videogame time and reduced practice of physical activity) in addition to lifestyle factors, contribute to the continual increase in the prevalence of overweight and obesity among children and adolescents.⁴¹⁻⁴⁴

Although there is no consensus on which interventions are more adequate to decrease obesity, the approaches tend to center on changes in lifestyle, nutritional education and promotion of physical activity.¹⁰ Schools are a strategic place to promote through education the formation of daily habits in physical activity and proper nutrition.

The objective of this study was to evaluate the effects of interventions using physical activity, nutritional education or both on the reduction of BMI in school-age children.

METHODS

A meta-analysis was performed with a criteria-based search strategy for studies published between 1998 and

August of 2010, in the following electronic databases: Lilacs, PubMed, Web Of Science, Scopus, EMBASE and Cochrane Library. The following key words were used: randomized controlled trial, overweight, obesity, BMI, child, adolescent, physical activity, nutrition education and schools. Campbell et al⁵ performed a systematic review in 2001 with studies published until 1998, which explains our decision to include studies beginning in that year. A search was performed from the bibliographic references of the relevant studies and of the systematic reviews concerning the topic of interest. The inclusion criteria were: randomized controlled studies with students age four to 19 years and with baseline and endline measurement of BMI, in addition to interventions using nutritional education, physical activity or both for a minimal duration of three months. The internal quality of the study was evaluated by criteria of blinded randomization proposed by Cochrane¹⁹ and complemented by the Jadad Scale.²² The studies were classified into four categories by the criteria of blinded randomization: Category A or Adequate (adequate randomization process); Category B or Undetermined (undescribed randomization process but the text mentions the study is randomized); Category C or Inadequate (randomization process inadequately described); Category D or Not Utilized (non-random study). Studies classified as A and B, by the analysis of blinded randomization, were included. Studies classified as C and D were excluded from review because they were considered inadequate experiments.

The criteria described by Jadad et al²² for evaluating internal quality were randomization, double-blinding and loss to follow-up and exclusions. The results were presented by scoring (maximum of five points). A study is considered of poor quality if it receives a score \leq three.

The information was independently extracted by two reviewers. The results were matched to verify concordance and the discordant results were resolved by consensus. The evaluation by the reviewers was not blinded from the authors and the study results.

A summary measure based on the standardized mean difference (SMD) was used. The calculation of this summary measure and its 95% confidence interval was according to the fixed effects model or the random effects model, depending on the heterogeneity between the studies. The test of inconsistency (I^2) was used to evaluate heterogeneity between the studies and random effects model was used for $I^2 > 50\%$.^{20,21} The effect size estimated from the scale of magnitudes for effect statistics was evaluated by the SMD.⁷

^b Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares 2008-2009: antropometria e estado nutricional de crianças, adolescentes e adultos no Brasil. Rio de Janeiro; 2010.

^c Ministério da Saúde (BR). Pesquisa nacional de Demografia e Saúde da Criança e da Mulher – PNDS 2006: dimensões do processo reprodutivo e da saúde da criança. Brasília (DF); 2009. (Série G. Estatística e Informação em Saúde).

The statistical analyses was performed using the software program Review Manager version 5.1, produced by Cochrane Collaboration, and results were presented through use of Forest Plot graphics.

RESULTS

There were 995 studies identified, including 231 duplicates; 642 were excluded after analysis of titles and abstracts because they did not meet the inclusion criteria. The full text was analyzed for 122 articles of which 37 were excluded because they did not meet the inclusion criteria. Eighty-five studies were analyzed and classified by the criteria of blinded randomization;¹⁹ and 40 studies were classified as A or B and

selected. Of these, 17 were excluded for not presenting sufficient data, for a final total of 23 included studies (Figure 1; Table).

Of the 23 studies, 16 evaluated the effect of physical activity and nutritional education as an intervention to reduce BMI, five evaluated physical activity and two evaluated nutritional education. The majority of prevention programs promoted physical activity^{4,9,11-12,14,16,24,26-29,38,40,46,50,51,53} and two programs recommended physical activity.^{15,55} All the studies included programs that encouraged healthy dietary habits through presentations and didactic materials. Of these studies, seven had interventions with school meals and cafeterias.^{4,14,26-28,52-53}

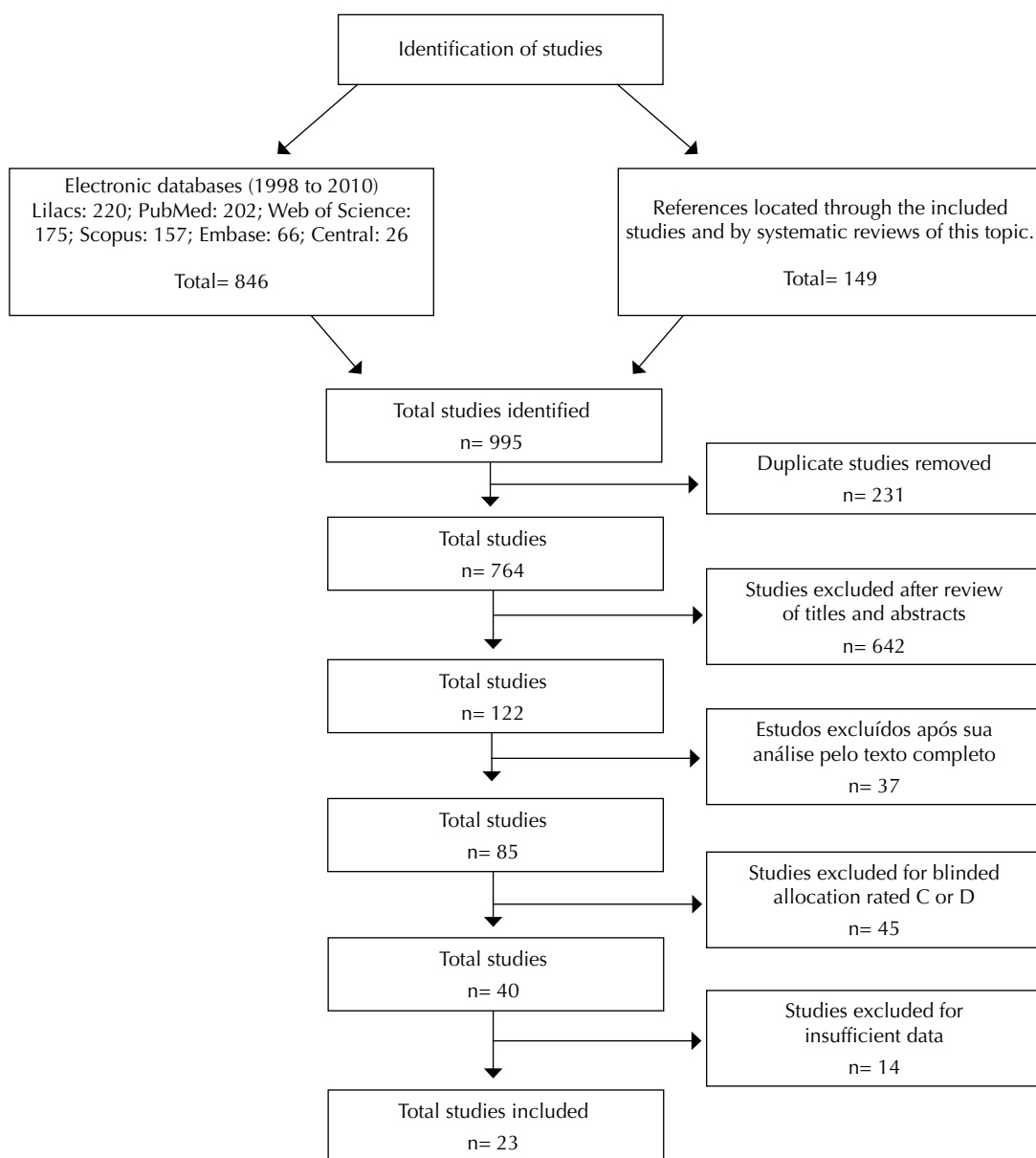


Figure 1. Study selection strategy.

Table. Characteristics of studies included in the systematic review.

1 st Author	Year	Location	Age (years)	n	Intervention	Intervention period (months)	Blinding Rating	Jadad
Robinson ⁵⁰	1999	USA	± 9 ^a	192	PA	6	B	2
Caballero ⁴	2003	USA	7 to 10	1.409	PAPA+NE	36	B	2
Neumark-Sztainer ⁴⁶	2003	USA	± 15 ^a	190	PA+NE	4	B	2
Story ⁵⁴	2003	USA	8 to 10	53	PA+NE	3	B	3
James ²³	2004	England	7 to 11	574	NE	12	A	2
Kafatos ²⁹	2005	Greece	± 7 ^a	541	PA+NE	72	B	2
Yin ⁵⁵	2005	Georgia	± 9 ^a	525	PA	8	B	2
Haerens ¹⁶	2006	Belgium	11 to 15	1.562	PA+NE	24	B	2
Eliakim ¹²	2007	Israel	5 to 6	101	PA+NE	4	B	2
Jiang ²⁴	2007	China	± 8 ^a	2.425	PA+NE	36	B	2
Johnston ²⁶	2007	USA	10 to 14	66	PA+NE	3	B	2
Johnston ²⁷	2007	USA	10 to 14	57	PA+NE	6	B	2
Singh ⁵²	2007	Netherlands	12 to 13	1.053	PA+NE	8	A	2
Foster ¹⁴	2008	USA	± 11 ^a	844	PA+NE	24	B	2
Vizcaino ³⁸	2008	Spain	9 to 10	1.044	PA	9	A	2
Donnelly ¹¹	2009	USA	7 to 8	1.490	PA	36	B	2
Gentile ¹⁵	2009	USA	± 10 ^a	1.201	PA+NE	6	B	2
Muckelbauer ⁴⁵	2009	Germany	± 8 ^a	2.950	NE	8	B	2
Peralta ⁴⁸	2009	Australia	12 to 13	32	PA+NE	6	A	5
Aguilar ⁵¹	2010	Spain	9 to 11	921	PA	18	B	2
Johnston ²⁸	2010	USA	10 to 14	54	PA+NE	12	A	2
Mihos ⁴⁰	2010	Greece	12 to 13	208	PA+NE	3	A	2
Singhal ⁵³	2010	India	15 to 17	201	PA+NE	6	A	2

^a Mean age

Legend: Year – Publication year; Location – Location of intervention; n – Sample size; Blinding rating – per Cochrane; Jadad – Jadad scale for study quality; PA – Physical activity; NE – nutritional education; PA + NE: Physical activity and nutritional education.

Seven studies were considered adequate in their randomization procedure, and it was not described in 16 studies, although the text mentioned that the study was randomized. Twenty-two studies were considered poor quality and one as good quality (Table).

Three meta-analyses were performed to evaluate the effect of interventions that isolated or combined physical activity and nutritional education about BMI among students:

Five studies were grouped to evaluate the effect of the interventions with physical activity among students. The results with 4,172 participants did not show a statistically significant effect of the interventions with physical activity in the reduction of BMI, with SMD (fixed effects): -0.02 (95%CI -0.08;0.04), $p = 0.46$, between the intervention group (IG) compared to the control group (CG), with a trivial effect magnitude. There was no heterogeneity between studies ($I^2 = 0\%$) (Figure 2).

Two studies involving interventions with nutritional education were included and the results grouped for a total 3,524 participants, and the analysis demonstrated no statistically significant effect in the reduction of BMI, with a SMD (fixed effects): -0.03 (95%CI -0.10;0.04), $p = 0.39$ between the IG compared to the CG, with an effect magnitude considered trivial. There was heterogeneity between studies, with low variability ($I^2 = 36\%$) (Figure 3).

To evaluate the effect of interventions with physical activity and nutritional education among students, 16 studies were grouped. The results with 9,997 participants presented a statistically significant effect of the interventions with physical activity and nutritional education together upon the BMI, with SMD (random effects): -0.37 (95%CI -0.63;-0.12), $p < 0.01$, between the IG compared to the CG with a small effect magnitude. There was heterogeneity between the studies, with high variability ($I^2 = 97\%$) (Figure 4).

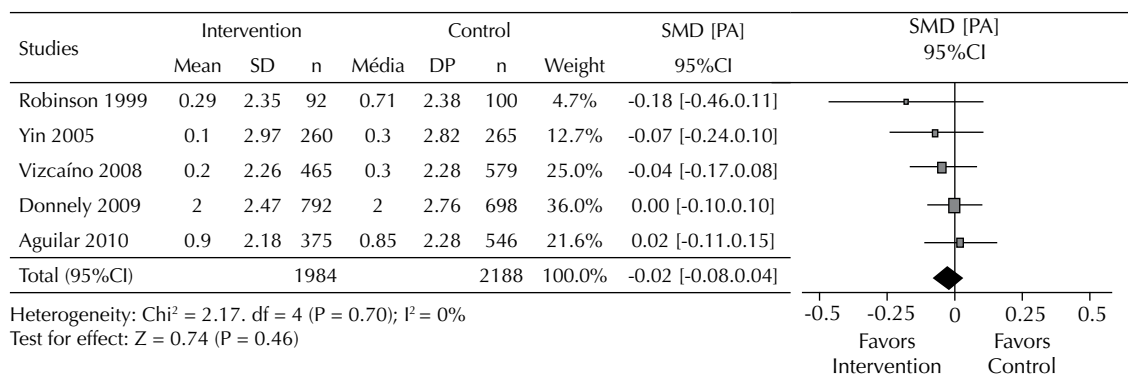


Figure 2. Forest Plot for the studies comparing the IG with the CG for interventions with physical activity and BMI among students.

DISCUSSION

The results of the meta-analysis for the isolated interventions with physical activity or nutritional education did not show a statistically significant effect on the reduction of BMI among students. A similar result was presented in a meta-analysis by Harris et al¹⁸ that evaluated the effect of interventions with physical activity on BMI of children in school setting, with a SMD: -0.05 (95%CI -0.19;0.10).

Isolated interventions did not result in changes of BMI, which can be partially explained by recognition that changes to body mass do not occur in a short period. The studies included in these analysis implemented interventions with a duration longer than three months and the meta-analysis were limited by the reduced number of studies included.

There was a reduction in BMI for the meta-analysis of interventions that combined interventions with physical activity and nutritional education. A similar result was also observed by Katz³² for combined interventions and decreased body mass with SMD: -0.29 (95%CI -0.45;-0.14) among students. This suggests that strategies to reduce and prevent obesity should focus on dietary consumption patterns and caloric expenditure through

physical activity, aspects that should be prioritized in the planning of public policies for health.

Studies about the effect of interventions upon BMI should be interpreted with caution, since the evaluation of nutritional status using this index among adolescents should consider the stage of sexual maturation. Changes in body mass can be characteristic of certain developmental phases and not the result of inadequate dietary consumption, inadequate physical activity or both.

Although it does not measure physical composition, the widespread use of BMI in epidemiologic studies as an indicator for nutritional status is justified by its ease of measurement, large availability of data on body mass, in addition to its relationship with morbidity and mortality.²

When analyzed individually, the studies included in this review demonstrated positive results from lifestyle changes that reduced television, videogame and computer screentime,^{14-15,50} that increased the consumption of fruits and vegetables¹⁴⁻¹⁵ and that reduced the consumption of foods rich in fat.^{4,14} These findings reinforce the importance of developing actions and programs to change lifestyles among this age group, since their lifestyles are in formation.

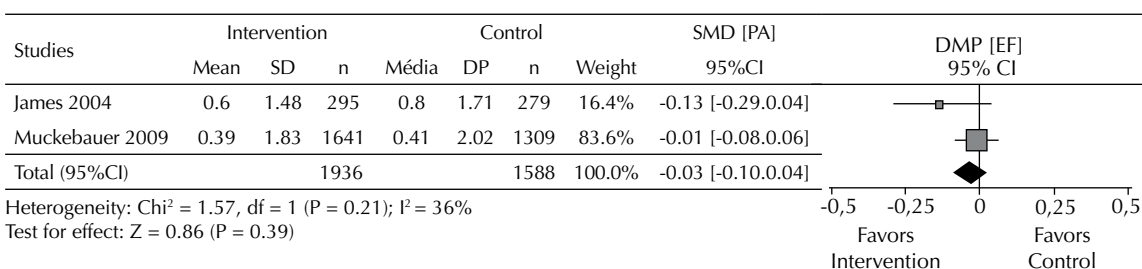
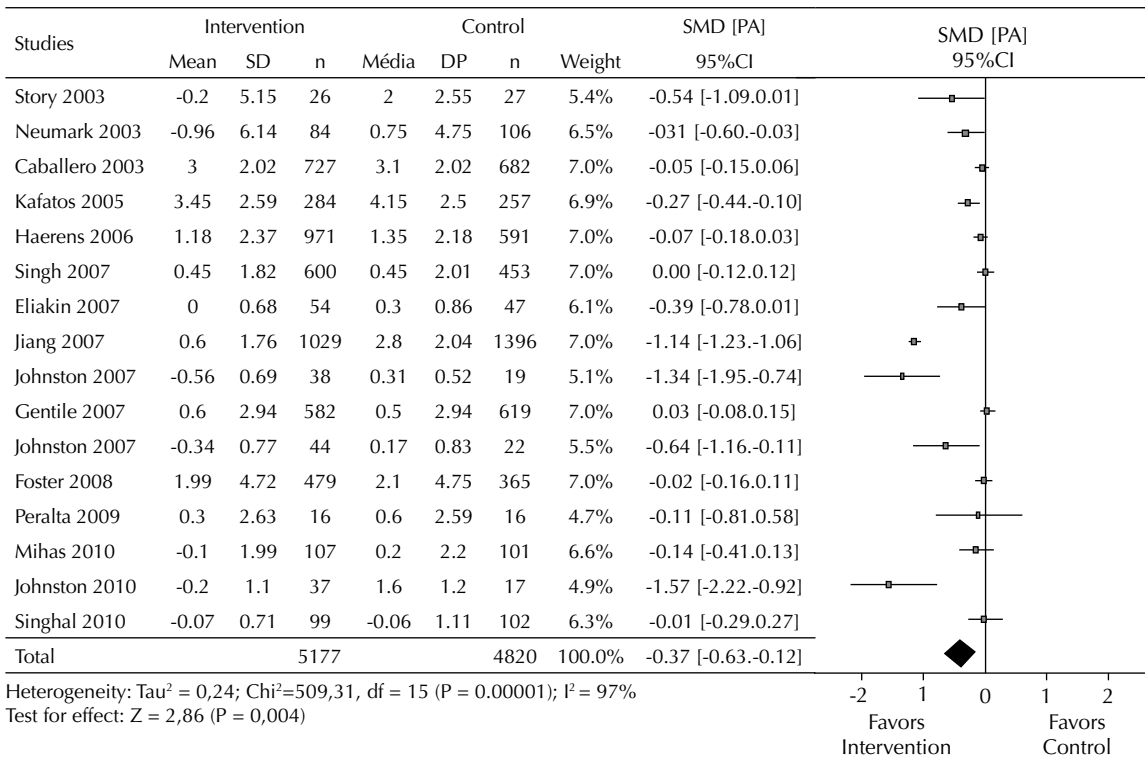


Figure 3. Forest Plot for the studies comparing the IG with CG for interventions with nutritional education and BMI among students.



SD: Standard deviation; n: Sample size; SMD [PA]: standardized mean difference for fixed effects; CI: Confidence interval; I²: Inconsistency test.

Figure 4. Forest Plot for studies comparing IG and CG for interventions with physical activity and nutritional education on BMI among students.

The literature documents the benefits of physical activity and of healthy nutrition upon skeletal health (mineral content and bone density)^{34-36,55} increased flexibility and aerobic capacity^{6,30,55} and in the inverse relationship with cardiovascular risk factors.^{6,17,33,39,49} The practice of regular physical activity, when begun in childhood or adolescence, protects adults against physical inactivity.^{1,3,37}

The most challenging aspect for health promotion strategies is adherence outside of schools, since health is negatively impacted by the food industry through advertisements and commercials for calorie-dense foods. Technological advances such as videogames and computers attract children to a lifestyle of little physical activity and increased calorie consumption. Researchers foresee growth in high-speed internet and videos on screens (cable TV, VCR, DVD, videogames, computer games), according to a conference by the National Institutes of Health in the United States, and these changes will continue to incentivize lifestyle changes among children and adolescents.²⁵ Strategies to prevent obesity should focus on factors that prevent its development.

Interventions with families, especially parental involvement in the promotion of healthy habits, should

be contemplated and stimulated by interventional programs. Children are influenced by their parents' habits; therefore, recommendations introduced in schools should be followed at home through the positive example of parents for their children, through healthy nutrition and the regular practice of physical exercise. Interventions have better results when the strategy includes a family component.^{13,31}

The 23 studies included in the meta-analysis have limitations, since the majority were performed with a small sample and were considered of low quality by the Jadad scale because they did not describe the allocation randomization procedure, blinding, losses and exclusions. This implies a need for more well-designed randomized controlled clinical studies. No Brazilian study was included in this review since they did not meet the inclusion criteria.

This systematic review is subject to publication bias, since it is easier to publish studies that report beneficial effects for a given intervention, in detriment to studies that do not describe beneficial effects.

This study suggests a need for randomized controlled studies with well-designed methodologic criteria in order to evaluate the effect of interventions, especially

among Brazilian population. The results can help in calculating sample sizes during the planning of future studies to evaluate the effect of structured interventions among an intervention and control group. Interventions

that combine physical activity and nutritional education present better effects on the reduction of BMI among students, as a strategy to prevent and control obesity, than if applied in an isolated manner.

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