



Revisión

The effectiveness of intervention programs in the prevention and control of obesity in infants: a systematic review

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Abstract

Objective: This study aims to conduct a literature review to evaluate the effectiveness of intervention programs in the prevention and control of obesity in children and to map the locations where the studies were carried out.

Methods: A systematic review using the PubMed / MEDLINE and LILACS databases to trace the published literature on intervention programs for prevention and control of obesity in the period of January 2004 to October 2013. The initial search was conducted using the terms “body mass index”, “Intervention” and “children” or “adolescent” and only articles published in English, Spanish or Portuguese were selected.

Results: We found that interventions based only on advice had modest results in identifying changes in the anthropometric indicators of children and adolescents over time, although they appear to be effective in promoting positive changes in the eating habits of this population. Among the studies identified, 77.8% were conducted in high-income countries, 22.2% in middle to high income countries and no intervention studies were found in middle to low income countries.

Conclusion: Intervention programs based only on counseling are effective in promoting changes in dietary patterns, but show poor results in the changes of anthropometric parameters of children and adolescents.

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Key words: Obesity. Children. Adolescents. Intervention.

EFFECTIVIDAD DE PROGRAMAS DE INTERVENCIÓN EN LA PREVENCIÓN Y EN EL CONTROL DEL EXCESO DE PESO INFANTIL: REVISIÓN SISTEMÁTICA

Resumen

Objetivo: Este trabajo pretende realizar una revisión de literatura para evaluar la efectividad de programas de intervención en la prevención y en el control del exceso de peso infantil y hacer el mapeamiento de los sitios donde los estudios fueron hechos.

Métodos: Estudio de revisión sistemática utilizando las bases de datos de PUBMED/MEDLINE y LILACS para rastrear la literatura publicada sobre programas de intervenciones para prevención y control de exceso de peso entre el período de enero de 2004 a octubre de 2013. La búsqueda inicial fue realizada utilizando los términos “body mass index” and “Intervention” and “children” or “adolescent” y fueron seleccionados apenas los artículos publicados en Inglés, español y portugués.

Resultados: se observó que intervenciones pautadas unicamente en el asesoramiento presentaron resultados modestos para identificar alteraciones en los indicadores antropométricos de niños y adolescentes a lo largo del tiempo, aunque parezcan ser efectivos para realizar cambios positivos en los hábitos alimentares de esa población. Entre los estudios identificados, 77.8% fueron realizados en países con renta alta, 22.2% en los países con renta media-alta y no hay estudios de intervención en países con renta media-baja y baja.

Conclusión: Los programas de intervenciones basados solamente en el asesoramiento son efectivos para promover cambios en la calidad alimentar, pero presentan insignificantes resultados en la alteración de los parámetros antropométricos de niños y adolescentes.

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Palabras clave: Obesidad. Niños. Adolescentes. Intervención.

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Abbreviations

WC: waist circumference.
BMI/A: Body Mass Index/age.
BMI: Body Mass Index.
W/H: Weight/height.
WHO: World Health Organization.
CNDs: Chronic Noncommunicable Diseases.
ml: milliliters.
RCT: Randomized Clinical Trial.
TV: Television.

Introduction

Obesity is a disease characterized by the excessive accumulation of body fat and has become very common in children and adolescents¹. Diagnosis in the pediatric population is performed, most of the time, through anthropometric indicators such as the Body Mass Index/age (BMI/A), weight/height (W/H), Waist Circumference (WC) and skin folds, taking into account the sex and the age of the individual^{1,2}. The BMI/A is the most used indicator in individuals over 5 years of age^{3,4}, and excess weight is when the BMI/A \geq 85th percentile and $<$ 97th percentile and obesity is when this indicator is \geq 97th percentile⁴.

Excess weight has been an important public health problem in the world noted by its increasing occurrence in different regions. In recent reports, the World Health Organization (WHO) estimates that about 170 million children and adolescents worldwide are overweight, however the prevalence of excess weight and obesity varies widely between countries, and sometimes within the same country, with the highest prevalence having been observed in middle to high income countries, and the highest and fastest growth has occurred in middle to low income countries^{5,6}.

In the United States, the prevalence of excess weight in children and adolescents increased from 13.9% in 1999/2000 to 31.8% in 2009/10^{7,8}. This trend was also observed in Canada⁹, England, Scotland¹⁰ and other countries^{11,12}.

In Brazil, the prevalence of excess weight and obesity in children was 33.5% and 14.3%, and 20.5% and 4.9% in adolescents, respectively, with it being more prevalent in the southern and southeastern regions, and among male individuals¹³. Over the past three decades, the prevalence of excess weight has tripled and obesity has increased more than fivefold among children, while among adolescents it has also increased steadily¹³.

Obesity is a multifactorial disease, but it is believed that the weight gain in the pediatric population and the increasing tendency of the event have been associated with several changes over time, especially with food transition - characterized by the increased consumption of foods with a high-energy density, low-fiber, high amount of sugars and total and saturated fats;

lower consumption of fruits, vegetables and whole grains - and a lower level of physical activity^{14,15}.

The need to control the progression of this disease, especially in children and adolescents, is urgent because, as well as the risk that excess weight and obesity poses to this population itself, other illnesses can develop at an early age than expected, such as dyslipidemia, hypertension¹⁶, metabolic syndrome^{17,18}, type II diabetes, cardiovascular diseases¹⁶, orthopedic complications, sleep disorders, hepatic steatosis^{1,15} and some forms of cancer¹⁹. This anthropometric standard during childhood is a risk factor to the perpetuation of obesity and the development of other chronic, non-communicable diseases (NCDs) in adulthood²⁰.

In an attempt to reverse this global panorama, the WHO has developed strategies to control the progression of obesity and other NCDs. In 2004, the WHO launched the Global Strategy on Diet, Physical Activity and Health²¹; in 2008 it developed a task force to evaluate and monitor the implementation of the Global Strategy on Diet, Physical Activity and Health; later, in 2011, it adopted a policy statement for the prevention and control of NCDs, including obesity as an urgent need for the global action plan. These proposals have a multi-sectoral approach involving health, education, culture, agriculture, industry, urban and economic planning, and they should be adapted to the reality of each location⁵.

Since then, there has been an increase in the number of intervention programs conducted for the control of obesity, especially in developed countries. The approaches used in intervention programs are diverse, and can be punctual and specific or multifactorial, involving environmental changes, in school curriculums, the implementation of nutritional education, inclusion of regular exercise inside or outside the school with teacher or family participation, so as to favor healthy food choices and lifestyles. Some of these interventions have been effective, but the results seem to be timely, and are still limited in terms of controlling excess weight in children. Thus, the primary objective of this review is to evaluate the effectiveness of intervention studies based on counseling in the control of excess weight in children. This work also aims to map the locations where the studies were conducted.

Materials and methods

To carry out this study, a systematic review was carried out using the PubMed / MEDLINE and LILACS databases to identify the published literature on intervention programs for the prevention and control of excess weight in children and adolescents for the period of January 2004 to October 2013. The choice of 2004 as the starting point for the search of scientific production in the area is due to the fact that it was the launch year of the Global Strategy on Diet, Physical Activity and Health by the WHO, which stimulated the

global development of specific and appropriate strategies to local realities for the prevention and control of childhood obesity. The initial search was conducted using the terms “body mass index”, “Intervention” and “children” or “adolescent”, and only articles published in English, Spanish or Portuguese were chosen.

To guide the search, some inclusion and exclusion criteria were adopted. This revision included: Original articles (experimental intervention study), whose intervention has objectified the prevention and control of obesity and has been based solely on nutritional advice, encouraging physical activity and/or guidance for the adoption of a healthy lifestyle; interventions that have been developed in the school, family or community environment, lasting at least 6 months, aimed at children and adolescents aged 6-18 years. To be included, studies should also submit at least one anthropometric index (body mass index, waist circumference, or skin fold thickness) as the dependent variable.

Studies which were carried out only with overweight or obese subjects were excluded as were those whose counseling was conducted via the web or by phone, which used medicine and/or bariatric surgery as an intervention strategy, which focused solely on the medical treatment or supplementation of nutrients, and that which offered practical exercise classes. Studies which aimed to evaluate the effect of interventions on the prevention of childhood obesity in sick individuals (eg. with diabetes, hypertension, cancer patients, cystic fibrosis, asthma among others) were also excluded, as well as studies that showed interventions focused on lifestyle, diet and physical activity, but that aimed to assess the impact on other diseases (asthma, HIV, dyslipidemia, hypertension, and others).

Two independent evaluators analyzed the articles using the inclusion and exclusion criteria established and disagreements were resolved by consensus. The selection of studies was initially performed by reading the titles and abstracts of the articles. In the second phase, the evaluators read the methods, and in the third phase, the full text of the articles was read. Articles which were considered not relevant (taking into account the criteria for inclusion and exclusion) were discarded. One of the reviewers extracted study data and set up the tables and the second, verified the quality of this extraction. The differences identified in this stage were discussed and resolved by consensus. The extracted data included population, study design, duration of the intervention, year of study, the total sample size, the size of the control group sample at the end of the experiment, the size of the intervention group sample at the end of the experiment, the age of the participants, where the study took place, anthropometric measures used to assess the effect of interventions, and main findings of the studies.

The interventions were considered effective when a reduction in the prevalence of excess weight, and a reduction of the BMI, waist circumference or skin fold was observed among the intervention participants,

when compared to the control subjects. Interventions that succeeded in promoting changes in the dietary pattern or lifestyle of the participants were also considered effective. Only significant changes ($P < 0.05$) were considered. The location of the programs were categorized into countries with high income, upper-middle income, lower middle income and low income, considering the classification of the list of countries in the World Bank made available by the WHO in 2008⁶.

Results

After the search for studies in the literature, a total of 2451 articles were identified. After reading the titles and abstracts, 2358 studies were excluded for not meeting the inclusion criteria. Ninety-three articles were selected for the final evaluation of reading the full article and details of the methods. At this stage, 84 studies were excluded for not meeting the requirements of inclusion in article. In the end, 9 articles^{22-26,27-30} were selected to compose this systematic review (Fig. 1).

The intervention programs were developed in the school environment in all of the selected studies, where five of them^{23,24,28-30} still relied on the direct or indirect participation of the family and two^{23,30} also approached the community in which the children and adolescents lived in. Three studies^{26,27,29} were based solely on nutritional guidance as an intervention strategy, discouraging the consumption of sweets and sugary drinks as a central theme and using other themes less. The other studies^{22-25,28,30} adopted nutritional guidance associated with encouraging physical activity and adopting a healthy lifestyle as a resource to prevent and control childhood obesity. The duration of the interventions ranged from 6 to 24 months. However, it was noted that only two studies^{24,25} had a duration of more than one year (Table I).

Among the selected studies, 77.8% were developed in countries classified as high income and 22.2% in middle to high income. We did not observe the development of intervention studies in countries classified as middle to low or low income (Table I).

BMI was used in different ways to evaluate the effectiveness of interventions for the prevention and control of childhood obesity, and the mean BMI and BMI/A (classification of anthropometric status) were the most commonly used indicators, followed by the BMI (z score) (continuous measurement). The weight, total body fat percentage (% total fat), WC, WC (z score), the amount of fat mass and fat-free mass (kg) were also used as indicators, but sporadically (Table II). The assessment of changes in the level of physical activity, food intake, and in the habit of watching television has also been adopted as indicators of the effectiveness of the intervention in some studies.

It was observed that only four studies^{24,25,27,29} identified statistically significant changes in the anthropometric parameters used to evaluate the effectiveness of

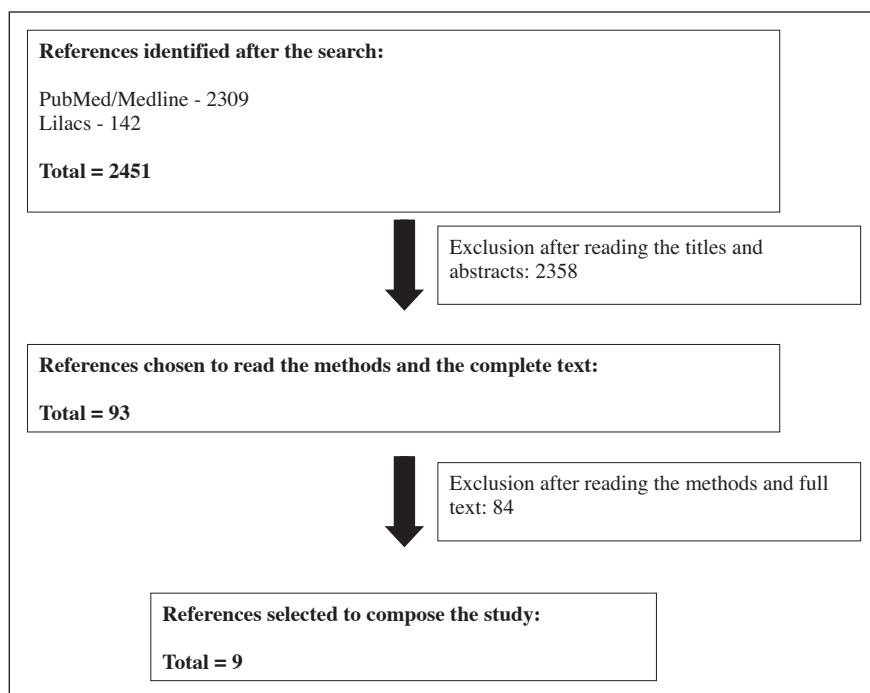


Fig. 1.—A Graph showing the selection of articles to compose the systematic review.

interventions in the prevention and control of excess weight just after the ending of the intervention. James et al (2004)²⁹ reported a slight reduction in the prevalence of excess weight in the group who participated in the intervention and increased prevalence of excess weight among participants in the control group. The difference in the prevalence of excess weight among groups (7.7%) was significant. Sichieri et al (2009)²⁷ found a slight reduction in the BMI (-0.01 $p = 0.009$) just for girls who were overweight at the start of the study, after adjusting for age. In addition, Johnston et al (2013)²⁴ observed no changes in the anthropometric indicators during the first year of the intervention, but after the second year they reported a reduction in the BMI z score (-0.08 $p = 0.01$) of the experimental group when compared to the control. In the study of Llagués et al (2012)²⁵, we observed an increase of the BMI in both groups, but the increase was lower in the experimental group (1.96) than in control group (2.84), with a significant difference between the groups ($p = 0.001$) (Table II).

Black et al (2010)²³ identified a reduction of 5% in the prevalence of excess weight among the intervention participants and an increase of 3% among the participants in the control group from the baseline to the end of the intervention, but there was not statistically significant difference between the groups ($p = 0.327$). However, it was observed that the reduction of 5% in excess weight among intervention participants was maintained 13 months after the end of the intervention, and that the control group had an increase of over 8%, making the total increase 11% from the baseline to the end of study. This ratio difference between the groups was statistically significant ($p = 0.006$).

Changes in the food intake after intervention programs were reported by five studies^{23,26,27,29,30}. James et al (2004)²⁹ observed a reduction in the consumption of sugary beverages among participants in the intervention group and an increase in the control group, and the difference of the total consumption of sugary beverages was significant between the groups ($p = 0.80:02$). Sichieri et al (2009)²⁷ also reported lower consumption of sugary drinks in both the intervention and control group, however the reduction in the first group was four times larger than the second group and the difference in consumption between the two groups after the intervention was significant ($p = 0:03$). Another positive change was the increase in consumption of fruit and vegetables (2.69 $p < 0.05$) in the experimental group when compared to the control, after 8 months of the intervention, reported by Gentile et al (2009)³⁰. The decrease in the consumption of unhealthy snacks and desserts was higher for the group who participated in the intervention (-2.21 $p = 0.001$) when compared to the control group in the study by Black et al (2010)²³, but a slight reduction in the consumption of fruits (-0.41 $p = 0.021$) was also noted. Cunha et al (2013)²⁶ observed a reduction in the consumption of sweet biscuits (-1.35 $p < 0.001$), soft drinks (-0.2 $p = 0.02$) and increased fruit consumption in the intervention (0.17 $p = 0.04$) group when compared to the control.

Changes in the level of physical activity and the time spent watching television per day³⁰ after the intervention were observed timely. Black et al (2010)²³ reported an increase in the level of physical activity (29.22 $p = 0.009$) and Gentile et al (2009)³⁰ observed a reduction in the time spent watching TV (-2.15

Tabla I
Characteristics of the included articles

<i>Autor (year)</i>	<i>Study design</i>	<i>n initial</i>	<i>n final</i>	<i>Age (years)</i>	<i>Location</i>	<i>Description of the intervention</i>	<i>Duration of the intervention</i>
James <i>et al</i> , 2004	RCT*	644	574	7-11	England	Nutritional education to reduce the consumption of sugary drinks and prevent excess weight. (School + home activities)	12 months
Sichieri <i>et al</i> , 2008	RCT	1166	1134	10-11	Brazil	Nutritional education to reduce the consumption of sugary drinks and prevent excess weight (educational sessions + motivational games + class + inserting content into the school curriculum + educational posters + activities of 20 to 30 minutes). (School)	7 months
Gentile <i>et al</i> , 2009	RCT	1323	1110	6-12	USA	Educational sessions aimed at changing dietary habits, encouraging physical activity and a healthy lifestyle. (School + family + community)	8 months
Black <i>et al</i> , 2010	RCT	235	184	11-16	USA	Educational sessions aimed at changing eating habits and unhealthy lifestyles. (School + family + community)	11 months
Llargués <i>et al</i> , 2012	RCT	704	509	10-11	Spain	Nutritional education to promote healthy eating habits and encouraging exercise. (School)	24 months
Lloyd <i>et al</i> , 2012	RCT	222	193	9-10	England	Educational sessions to discourage the consumption of sweets, sugary drinks, unhealthy snacks and encourage the appropriate energy balance and a healthy lifestyle. (School)	12 months
Rosário <i>et al</i> , 2012	RCT	574	294	6-12	Portugal	Educational sessions to promote healthy consumption and lifestyles. (School + home activities)	6 months
Cunha <i>et al</i> , 2013	RCT	574	559	10-11	Brazil	Educational sessions based on discouraging sugary drinks, cookies and processed foods; and to encourage the consumption of fruits, water and regional foods. (School)	9 months
Johnston <i>et al</i> , 2013	RCT	835	629	7-9	USA	Educational sessions aimed at encouraging a healthy diet and lifestyle (inserting content into the school curriculum and using messages encouraging healthy eating). (School + family + individual)	24 months

*Randomized controlled trial.

$p < 0.05$), between those who participated in the intervention, when compared to the control groups.

Discussion

The programs of interventions based solely on nutritional counseling, the encouragement of physical activity and the incitement of the adoption of a healthy lifestyle have shown little effectiveness in the prevention and control of obesity in children and adolescents. In this review, we found that these interventions had

modest results to verify changes in the anthropometric indicators of children and adolescents over time, although they appear to be effective in promoting positive changes in the eating habits of this population.

It is known that eating habits and a healthy lifestyle are learnt and based on social relations that are established in different living experiences throughout life, particularly during childhood and adolescence. Therefore, it is believed that the school and family environment are conducive to the development of intervention programs aimed at health promotion and NCD prevention^{21,31}. The school was chosen for all se-

Table II
Results of the selected studies

Autor (year)	Indicators used	Results
James <i>et al.</i> , 2004	BMI* (mean) BMI/A continuous (z score) (mean) Anthropometric status (BMI/A [∞] categorical) Consumption of sugary drinks	There was no significant difference in the BMI mean [BMI = 0.13 Kg/m ² (-0.1 - 0.3)] and in the BMI z score mean [BMI z score = 0.04 (-0.04 - 0.12)] between the groups at the end of the intervention. Increased prevalence of excess weight in the control group (7.5%) and reduction in the intervention group (0.2%) was observed. The difference in the proportion of 7.7% (2.2 - 13.1) was statistically significant. There was a reduction in the total consumption of sugary beverages (-0.6 glasses/day) in the intervention group and an increase in the control (0.2 glasses/day). The difference of the total consumption of sugary drinks was statistically significant between the groups ($p = 0.02$).
Sichieri <i>et al.</i> , 2008	Weight BMI (mean) Anthropometric status (BMI/A [∞] categorical) Consumption of sugary drinks	The weight and the mean BMI increased in both groups (no statistical significance). For girls overweight at the start of the study, there was a slight reduction in the mean BMI [BMI = -0.01 Kg/m ² ($p = 0.009$)] after adjustment for age. The prevalence of excess weight increased for both groups (no statistical significance). The mean consumption of sugary drinks for the intervention group reduced (-69 ml/day) group just like the control group (-13 ml/day), however the reduction was 4 times greater in the intervention group than in the control group. The difference in consumption of sugary drinks was statistically significant between groups ($p = 0.03$).
Gentile <i>et al.</i> , 2009	BMI (mean) Time spent watching TV** Level of physical activity Consumption of fruit and vegetables	No statistically significant change in mean BMI and physical activity level was observed. A significant increase in the consumption of fruits and vegetables [2.69 servings/week ($p < 0.05$)], and a reduced time spent watching TV [-2.15 hours/week ($p < 0.05$)] was noted, according to parents' reports, when comparing the experimental group with the control.
Black <i>et al.</i> , 2010	BMI (mean) BMI/A continuous (z score) (mean) Anthropometric status (BMI/A [∞] categorical) % body fat percentage Fat mass (kg) Fat free mass (kg) Physical activity Diet	Excess weight declined (5%) among the intervention participants and increased (3%) among participants in the control group by the end of the intervention, however there was no statistically significant difference between the groups ($p = 0.327$). No difference was observed statistically for other anthropometric measures at the end of the intervention. It was further observed that there was an increased level of physical activity [29.22 minutes/day ($p = 0.009$)], greater reduction in snacking and desserts [-2.21 servings/day ($p = 0.001$)] and a reduced consumption of fruit [0.41 servings/day ($p = 0.021$)] among those who participated in the intervention group compared to the control group.
Llargués <i>et al.</i> , 2012	BMI (mean) Anthropometric status (BMI/A [∞] categorical)	<p>Results after 24 months after baseline (13 months after the end of intervention):</p> It was observed that the reduction of 5% in excess weight among intervention participants between the baseline and the end of the intervention was maintained and that the control group had an increase of over 8%, making the total increase 11% among the control group members from the baseline to end of study. The ratio difference between the groups was statistically significant ($p = 0.006$). Among the overweight students who participated in the intervention, there was a reduction in the percentage of the total body fat [-1.54% ($p = 0.003$)] and increased lean body mass [1.41 Kg ($p = 0.021$)]. We also observed a greater reduction in the consumption of snacks and desserts in the intervention group compared with controls [-0.69 servings/day ($p = 0.026$)]. There was an increase in the BMI of participants in the control group (2.84 Kg/m ²) greater than the increase observed in the intervention group (1.96 Kg/m ²) and the difference between the groups was significant ($p = 0.001$). An increase in overweight (6.95%) and obese (3.2%) in the control group and the increased prevalence of overweight (3.8%) and a reduction in obesity (-1.7%) in the intervention group was noted. The increase of overweight was higher in the control than in the intervention group (3.1%).

Tabla II (cont.)
Results of the selected studies

<i>Autor (year)</i>	<i>Indicators used</i>	<i>Results</i>
Lloyd <i>et al.</i> , 2012	BMI (mean), BMI/A continuous (z score) (mean) Anthropometric status (BMI/A [∞] categorical) WC*** WC z score % body fat percentage % body fat percentage z score Consumption of healthy snacks Consumption of snacks with a high Energy value Positive intake markers Negative intake markers Time spent watching TV Level of physical activity Time spent on sedentary activities	There were no statistically significant differences for anthropometric markers. There were no significant differences for measures of dietary intake, physical activity level, time spent in sedentary activities or watching TV.
Rosário <i>et al.</i> , 2012	BMI/A continuous (z score) (mean) Anthropometric status (BMI/A [∞] categorical) Consumption of kcal/day Level of physical activity	No significant differences between the groups alter the intervention were observed.
Cunha <i>et al.</i> , 2013	BMI (mean) Anthropometric status (BMI/A [∞] categorical) Consumption (biscuits, sweets, soft drinks, juices, grains e fruits)	There was no significant change in the mean BMI or the prevalence of excess weight among groups. There was a 3% increase in the prevalence of obesity in both groups (no statistical significance). There was a reduction of sweet biscuits [-1.35 g/day ($p < 0.001$)] and soft drinks [-0.2 glasses/day ($p = 0.02$)] in the group who participated in the intervention compared with the control. There was a further increase in the consumption of fruits (0.17 servings/day) in this group compared with the control group (-0.1 servings/day) $p = 0.04$.
Johnston <i>et al.</i> , 2013	BMI/A continuous (z score) (mean) BMI (mean) Anthropometric status (BMI/A [∞] categorical)	Alter 1 year of intervention no significant changes in the anthropometric variables were observed. Alter 2 years of intervention, there was a reduction in the BMI z score [-0.08 ($p < 0.01$)] in the intervention group when compared with the control group.

*BMI - Body Mass Index; **TV - television; ***WC - Waist circumference; ∞BMI/A - Body Mass Index/Age.

lected studies to undertake programs of intervention. However, some included the participation of the family^{23,24,28-30} and community^{23,30}, hoping that the formation of this network (school, family and community) could lead to the adoption of healthy dietary practices, healthy attitudes and actions; providing positive changes to habits that may be considered unsuitable, hence favoring the prevention and control of excess weight in children and adolescents. The school environment is often chosen by scholars for the implementation of intervention programs because it offers many opportunities to teach about the importance of nutrition and health practices, and because it exerts strong influence on children's health, especially in communities with less favorable socio-economic conditions³². It is emphasized that interventions aimed at the family should have a better result due to the involvement of everyone in the much-needed changes in eating habits and physical activity.

The fact that high income countries have a higher prevalence of excess weight in children and adolescents than those with medium to high income⁶ partly explains the greater interest of these countries to develop intervention programs to address the problem, joined by the fact that economic interests are also related to the cost of diseases linked to obesity. In this review, it was observed that the development of interventions aimed at preventing or controlling childhood obesity still happens reservedly in middle to high income countries, even though they already have a high prevalence of overweight and obese children and adolescents in the pediatric population⁶. This data may indicate that countries started to be involved in the control of childhood obesity only when the situation reached large proportions, effectively neglecting the early prevention activities.

According to the WHO (2011)⁶, countries with low and middle-incomes still have a lower prevalence of childhood obesity, but it is recognized that the increase in the number of cases of excess weight and obesity in children and adolescents has occurred in a more accelerated fashion in countries with middle to low incomes, than in countries with better socio-economic conditions. This epidemiological scenario reinforces the immediate need for the planning and development of effective interventions to prevent the spread of the problem in these countries⁶.

BMI has been used in different ways to assess the impact of interventions on the prevention of childhood obesity, the mean BMI and BMI/A (classification of anthropometric status) forms being the most widely adopted by the studies. This result was similar to that observed in the literature review conducted by Flodmark et al (2006)³³, which also includes the skin folds as notable anthropometric measures. However, the use of the mean BMI has some limitations in practical application to children and adolescents, for not taking into account the at what stage of development they are. Considering this limitation, the use and interpretation

of this indicator should be performed with caution to avoid erroneous inferences³⁴. In the pediatric population, the use of BMI/A is more suitable, since the indicator takes into account sex, age and stage of development of the individuals in childhood and adolescence, and demonstrates good applicability in clinical practice through the ease of obtaining measurements, its low cost and reproducibility³ and for presenting good correlations with the increase of body fat^{3,34-36}.

Although few studies have been successful in obtaining changes in anthropometric parameters^{24,25,27,29}, many were able to make positive changes on unhealthy eating practices^{23,26,27,29,30} and others on lifestyle^{23,30}, which are the main determinants of obesity in childhood and adolescence. The dietary and lifestyle changes can prevent the development of other chronic NCDs^{21,37} and promote the improvement of long-term anthropometric indicators, as observed by Black et al (2010)²³, where at the end of the intervention they only identified an improvement in eating habits and increased physical activity, but 13 months after the intervention observed a reduction of excess weight among intervention participants and an increase in the control group, with a significant difference in proportion. Also there was a reduction of total body fat percentage and an increase in lean body mass among the experimental group when compared to the control. According to Sichiari and Souza (2008)³¹ and King et al (2011)³⁸, longer interventions may achieve better results, but can be costly and difficult to implement³¹. There is the need to implement systematic programs of health education involving these issues, and not just programs conducted in a timely manner.

In one meta-analysis, Kamath et al (2008)³⁹ also observed that the programs of interventions designed to prevent excess weight were more effective in promoting changes of eating habits and unhealthy lifestyles. Improvements in eating habits, increased physical activity and reduced time spent in sedentary activities are important determinants for the prevention of childhood obesity, without causing damage in the growth and development of children and adolescents^{39,40}.

In certain investigations, the intervention time is short to observe effects on anthropometric indicators, but it is possible to observe positive changes in eating behavior and physical activity that may impact on the prevention of excess weight in the long term. Most of the selected studies were developed in a period not exceeding 12 months, possibly limiting the results found by the authors³⁸. Other studies found that the decline in adiposity is generally observed in longer studies^{20,41} and involves a large number of participants⁴¹.

This review may be subject to publication bias, due to the increased interest in publishing studies demonstrating the beneficial effects of interventions, at the expense of those studies which do not show positive results.

To achieve more effective and lasting results, the strategies used for the prevention of obesity should be

varied and complex, involving not only the individual, his school and his family^{5,31}, but contemplating far-reaching policies, with the participation of agricultural industries, food industries, urban planning, transportation, regulatory agencies, health education, recreation and culture⁵. The educational process must also be continuous and ongoing, and should be reviewed periodically by professionals specifically trained and qualified for this purpose.

Given these results, it can be concluded that the programs of interventions based solely on nutritional guidance, encouraging physical activity and adopting a healthy lifestyle, and aimed at the prevention and control of childhood obesity, have been effective in promoting positive changes in the eating habits of children and adolescents, but demonstrate limited results when it comes to promoting changes in the anthropometric parameters used for evaluating the effectiveness of the intervention results. Furthermore, it was noted that interventions aimed at the prevention and control of obesity are performed only in regions where the prevalence of obesity is high. Intervention strategies need to be refined, and should include the population as a whole, even in areas where the prevalence of overweight is still low.

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