

Review Article

Cardiovascular health promotion in childhood and adolescence: a literature review

Promoção de saúde cardiovascular na infância e na adolescência: uma revisão da literatura

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Mainardes VT, Canizella GP, Ramos MG, Yamamoto RM. Cardiovascular health promotion in childhood and adolescence: a literature review / *Promoção de saúde cardiovascular na infância e na adolescência: uma revisão da literatura*. Rev Med (São Paulo). 2022 Nov-Dec;101(6):e-199841.

ABSTRACT: Atherosclerosis is now recognized as a disease that starts early, in childhood. Among the main modifiable risk factors for cardiovascular diseases in adulthood, there are two disorders of nutrition and metabolism that can also affect children and adolescents, dyslipidemia and obesity. The objective was to determine if there is a positive association between the adoption of healthy lifestyle habits and the improvement of cardiovascular health in childhood and adolescence, expressed by the reduction of body fat and dyslipidemia. This study is a systematic review of the literature in the age group from 2 to 19 years old, evaluating publications from 2011 to 2021, in English, Spanish or Portuguese. The intervention was the promotion of healthy lifestyle habits, including regular physical activity and the adoption of adequate feed practices. Following the PICO anagram, the guiding question chosen was: does the promotion of healthy lifestyle habits result in improved cardiovascular health in childhood and adolescence, indicated by the reduction of body fat and the control of dyslipidemia? Of the 362 articles initially identified in the research portals, 350 were excluded and 12 were selected for the final analysis. The adoption of healthy lifestyle habits led to an improvement in cardiovascular health, expressed by a reduction in the body fat. In the case of dyslipidemia, there was disagreement among the authors, and it was not possible to conclude whether the promotion of healthy lifestyle habits protects children and adolescents against these metabolic disorders. The participation of the family and schools were strategies developed in the studies that achieved the improvement of cardiovascular health among children and adolescents. The authors noted the need for intervention conducted over longer periods of time to implement future cardiovascular health improvement measures that are maintained into adulthood, starting from the pediatric age group.

Keywords: Childhood; Adolescence; Health; Obesity; Dyslipidemia; Health promotion; Atherosclerosis.

RESUMO: A aterosclerose é hoje reconhecida como doença que se inicia precocemente, na infância. Entre os principais fatores de risco modificáveis para as doenças cardiovasculares (DCV) na idade adulta, encontram-se dois distúrbios da nutrição e do metabolismo que também podem incidir na infância e na adolescência, a dislipidemia e a obesidade. O objetivo foi determinar se existe uma associação positiva entre a adoção de hábitos saudáveis de vida e a melhoria da saúde cardiovascular na infância e na adolescência, expressa pela redução da gordura corpórea e das dislipidemias. Este estudo é uma revisão sistemática da literatura na faixa etária dos 2 aos 19 anos de idade, avaliando publicações do período de 2011 a 2021, em língua inglesa, espanhola ou portuguesa. A intervenção analisada foi a promoção de hábitos saudáveis de vida, incluindo a atividade física regular e a adoção de práticas alimentares adequadas. Seguindo o anagrama PICO, a pergunta orientadora escolhida foi: a promoção de hábitos saudáveis de vida resulta em melhoria da saúde cardiovascular na infância e na adolescência, indicada pela redução de gordura corpórea e pelo controle das dislipidemias? Dos 362 artigos inicialmente identificados nos portais de pesquisa, 350 foram excluídos e 12 foram selecionados para a análise final. A adoção de hábitos saudáveis de vida conduziu à melhoria da saúde cardiovascular, expressa pela redução da gordura corpórea. No caso das dislipidemias, houve discordância entre os autores e não foi possível concluir se a promoção de hábitos saudáveis de vida protege as crianças e os adolescentes contra esses distúrbios metabólicos. A participação da família e das escolas foram estratégias desenvolvidas nos estudos que alcançaram a melhoria da saúde cardiovascular entre as crianças e os adolescentes. Os autores observaram a necessidade de estudos de intervenção realizados durante períodos mais longos para implementar futuras medidas de melhoria da saúde cardiovascular que se mantenham até a idade adulta, a partir da faixa etária pediátrica.

Palavras-chave: Infância; Adolescência; Saúde; Obesidade; Dislipidemia; Promoção da saúde; Aterosclerose.

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INTRODUCTION

Cardiovascular diseases (CVD) are, in developed and developing countries, such as in Brazil, the main cause of death in adulthood¹. At the origin of CVD, there is a chronic inflammatory process of the arteries known as atherosclerosis, which may progress to coronary disease and acute myocardial infarction or to impaired cerebral circulation and stroke². Previously considered an inflammatory process that would occur only in adulthood, atherosclerosis is now recognized as a disease that starts early in childhood^{3,4}.

Among the main modifiable risk factors for CVD in adulthood are two nutrition and metabolism disorders that can also affect childhood and adolescence, dyslipidemia and obesity^{5,6}.

Dyslipidemia is characterized by a disorder of lipoprotein metabolism, in which there are increased levels of total cholesterol (TC), low density lipoprotein (LDL-c) and triglycerides (TG) and reduction of high-density lipoprotein (HDL-c)⁷, being one of the main risk factors for the development of atherosclerosis. It can be classified as primary, due to a hereditary defect of lipid metabolism, or secondary, when related to an underlying disease, caused by inadequate lifestyle habits or use of medications that modify the lipid profile^{8,9}.

According to an estimate by the World Health Organization in 2008, the prevalence of the disease is high worldwide. In Europe, about 53.7% of the population has dyslipidemia. In the Americas, this number is 47.7%, being lower in the Western Pacific (36.7%) and Southeast Asia (30.3%)¹⁰. In Brazil, a population study conducted with more than 38,000 adolescents aged 12 to 17 years indicated 46.8% of low HDL and 20.1% of hypercholesterolemia¹¹.

In general, dyslipidemia in childhood is associated with inadequate eating habits maintained by family members. Factors such as low maternal education, overweight and reduced consumption of foods considered protective, such as vegetables, fruits, cereals and derivatives, are also implicated in the occurrence of dyslipidemias¹²⁻¹⁴. Sedentary lifestyle is another habit of life that extends from family members to children and adolescents and is also directly associated with dyslipidemias and obesity.

The increased prevalence of obesity among children and adolescents is another phenomenon observed in the pediatric age group, particularly in the last 30 years, which is directly associated with the increased prevalence of dyslipidemias¹⁵.

The decrease in the prevalence of dyslipidemias and obesity in children and adolescents is a goal to be achieved in Brazil. The control of dyslipidemias allows the

intervention in still asymptomatic patients, preventing the progression to atherosclerosis and avoiding complications in adulthood. Prevention and early intervention in the case of obesity reduce the risk of the appearance of clinical alterations that make up the so-called metabolic syndrome, in childhood and adolescence¹⁶.

Education and health promotion programs are different strategies used in the management of modifiable factors related to the risk of developing dyslipidemia. The change in life habits, including the practice of regular physical activity and the adoption of healthier eating, are among the Brazilian recommendations to reduce, in childhood and adolescence, the modifiable risk factors for CVD, such as dyslipidemia and obesity^{17,18}. The main hypothesis of this study is the existence of a positive association between the adoption of healthy lifestyle habits and the improvement of cardiovascular health in childhood and adolescence.

OBJECTIVE

The objective of this work was to determine whether the promotion of healthy lifestyle habits, including the improvement of eating habits and the performance of regular physical activity, results in improved cardiovascular health in childhood and adolescence, expressed by the reduction of body fat and the control of dyslipidemias.

METHODS

The present study is a systematic review of the literature in the age group from two to 19 years of age. The articles were selected from the following databases: Latin American and Caribbean Literature on Health Sciences (LILACS), Cochrane Library Database and PubMed from September to October 2021. The keywords used were dyslipidemia or metabolic syndrome or obesity (outcome) and child or adolescent (age group) and health promotion or education for health and school and cardiovascular health and physical activity or healthy eating (intervention).

To assist in the identification of studies addressing the research theme, the main hypothesis and study variables, the guiding question chosen was: the promotion of healthy lifestyle habits results in improved cardiovascular health in childhood and adolescence, indicated by the reduction of body fat or by the control of dyslipidemias. Table 1 shows the components of the research question, following the PICO¹⁹ anagram.

Table 1- components of the research question, following the PICO anagram

Description	Abbreviation	Question Component
Population	P	Children and adolescents
Intervention	I	Promotion of healthy lifestyle habits
Comparison	C	With or without comparison
Dénouement	Or	Improving cardiovascular health

The independent variable analyzed, or intervention, was the promotion of healthy lifestyle habits. In the present study, healthy lifestyle habits were considered: the adoption of adequate eating habits and the practice of regular physical activity. The dependent variable analyzed was cardiovascular health in childhood and adolescence, expressed by the frequency of dyslipidemia, obesity, or the evolution of body mass index.

In this study, dyslipidemias were considered the following alterations for the population between 2 and 19 years: CT > 170 mg/dL; LDL-c > 110 mg/dL; HDL-c < 45 mg/dL; and TG > 75 mg/dL in children aged 0 to 9 years, and > 90 mg/dL in adolescents aged 10 to 19 years.

The anthropometric indicators used for the diagnosis of obesity and for the evolution of nutritional status were body mass index (BMI) and waist or abdominal circumference (AC). BMI was obtained from the division of weight into kilos by height in meters squared. The cutoff point used for anthropometric diagnosis of obesity was the 85th percentile (corresponding to the Z +1 score). The growth benchmarks considered were the *National Center for Health Statistics* (NCHS-2000)²⁰ and the *World Health Organization* (WHO-2006)²¹. Abdominal circumference was obtained from internationally recommended measures²².

This study included systematic reviews and randomized clinical trials, published in Portuguese, English and Spanish journals, from 2011 to 2021. The reports of experiences, theses, dissertations, books, and book chapters were excluded. In the first stage, called pre-selection, the following exclusion criteria were used, from the insertion of keywords in the search portals: duplicity, when the same article was identified more than once; age group under 2 years or above 19 years; irrelevance, when the article did not refer to the theme and the research question; study design. In the last stage of the article selection phase, the titles and abstracts of the pre-selected scientific articles were reviewed by one author. The articles that met the inclusion criteria, population, dependent variables and study design were retrieved in full and submitted for analysis. The information extracted from the articles selected for analysis were age group, location and study

design, year of realization and publication, nutritional status, frequency of dyslipidemia, number of individuals, laboratory method used in the diagnosis of dyslipidemia. Regarding the intervention performed, the following information was collected: location (health units, schools), situation of life habits and eating habits before starting the intervention, type (physical activity, food education, awareness of life habits), form (educational lectures, brochures, seminars, workshops, individual activities, group activities), duration and periodicity of the proposed activities, monitoring of the intervention, professionals who carried out the intervention, criteria for evaluating the intervention. In each study, the possible measurement biases were analyzed. The authors analyzed information that allowed us to conclude whether the study populations were comparable. In the final analysis, the results were interpreted, discussed and the synthesis of knowledge obtained from the present study was elaborated.

FINDINGS

Of the 362 articles initially identified in the databases, 35 articles considered relevant were pre-selected, according to the research's main question, by title and abstract analysis. Of these 35 articles, 23 were excluded after evaluating the study design and its relevance. The remaining 12 articles were submitted to the analysis phase of this systematic review (Flowchart 1)²³⁻³⁴.

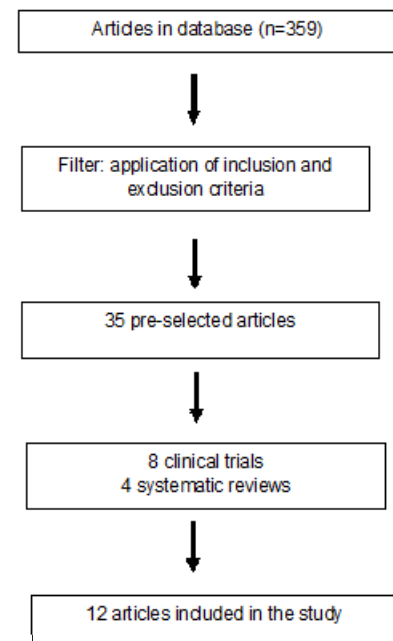
**Flowchart 1:** Selection and evaluation of articles, according to eligibility criteria.

Table 2: General characterization of selected scientific articles

Author/year	Type of study	Summary
Barkas et al. ²³ 2020	Systematic review	Seventeen studies that included children and adolescents belonging to families with family hypercholesterolemia and received guidance to change their diet for a minimum period of three weeks, with the aim of reducing dyslipidemias, were evaluated. Dietary changes led to a reduction in dyslipidemias.
Leis et al. ²⁴ 2019	Systematic review	Ten studies were analyzed, where school and extracurricular activities were carried out with implementation of diets, changes in school menus, extra classes of physical education and gardening and educational lectures, with the goal of reducing obesity and dyslipidemias. Studies indicate that the interventions reduced obesity and were inconclusive as to the possibility of reducing dyslipidemias.
Wadolowska et al. ²⁵ 2019	Clinical trial	In 48 schools, 319 Polish adolescents from 11 to 12 years of age were selected for 9 months for an education program addressing healthy eating and physical activity. The evolution of body fat in the intervention group was compared with 145 individuals in the control group, who were not submitted to this educational program. The adolescents included in the educational intervention group presented body fat reduction.
Mazloomi-Mahmoodabad et al. ²⁶ 2017	Clinical trial	86 overweight or obese adolescents aged 13 to 18 years were selected in a clinic for a nutritional education program, which encouraged positive attitudes and included the support of family, friends, and teachers in 5 one-hour sessions. There was monitoring for 6 weeks after the end of the intervention and evaluation of the evolution of nutritional status. The educational program modified behaviors and attitudes, leading to weight and body fat loss in the study population.
Gatto et al. ²⁷ 2017	Clinical trial	172 students, of Latin origin, 85% of them overweight, with an average age of 9 years, received, for 12 weeks, interactive classes on feeding, growing fruits and vegetables and preparing meals with these vegetables. The evolution of BMI and dyslipidemias was compared with 147 students in the control group. The authors conclude that dietary alterations promoted body fat reduction in the intervention group.
Keszytüs et al. ²⁸ 2017	Clinical trial	955 students in the intervention group and 778 in the control group, with an average age of 7 years, comprised the population of this study, which, during 1 year, developed three strategies: the promotion of physical activity, the reduction of the consumption of sugary drinks and the time in front of screens. The cardiovascular health promotion strategies adopted in this study led to the reduction of abdominal fat
Poitras et al. ²⁹ 2016	Systematic review	We analyzed 162 studies, classified as clinical trials, observational studies and cross-sectional studies, involving individuals aged 5 to 17 years. The exposure variable was physical activity in different degrees of intensity and the outcome was body fat percentage and cardiovascular health markers, including dyslipidemias. The promotion of cardiovascular health, due to increased physical activity, led to a reduction in body mass and reduced dyslipidemias in children and adolescents.
Macknin et al. ³⁰ 2015	Clinical trial	30 obese and hypercholesterolemia individuals were distributed with their parents in 2 intervention groups for 4 weeks: a vegetable diet without added oils and the diet proposed by the American Heart Association, which allows, in addition to vegetables, low consumption of vegetable oils, lean meat and fish. The authors conclude that dietary alterations led to improved cardiovascular health, with reduction of body mass and dyslipidemias.
Marild et al. ³¹ 2015	Clinical trial	The evolution of nutritional status and dyslipidemia of 16,228 children aged 2 to 9 years (8,482 in the intervention group and 7,746 in the control group) was analyzed, carried out in 8 European countries. Families, schools, and communities were involved in a unique and sustainable program of dietary changes, physical activities, respect for daily sleep time and time control in front of television. The educational activities carried out did not promote reduction of body fat or dyslipidemias.
Kong et al. ³² 2013	Clinical trial	60 students, with an average age of 15 years, overweight (31 students in the intervention group and 29 in the control group) were evaluated for the evolution of BMI, triglycerides and HDL. The intervention group attended 8 educational activities, with an interval of 2 to 3 weeks, addressing physical activity and adequate nutrition. The authors conclude that these educational activities promoted body fat reduction and did not reduce dyslipidemias.
Campos Pastor et al. ³³ 2012	Clinical trial	The evolution of nutritional status and dyslipidemias of 256 students aged 12 to 16 years in Spain belonging to a public and one private school was analyzed. The intervention included the provision of breakfast at school, guidance, and monthly monitoring of the diet and stimulation of physical activity. The promotion of cardiovascular health led, in this study, to the reduction of obesity and dyslipidemias.
Silveira et al. ³⁴ 2011	Systematic review	Twenty-four studies conducted in schools were evaluated, seeking changes in eating habits, including increased consumption of fruits and vegetables. The involvement of students, parents, teachers, and the change in food in schools were the strategies developed. The aim of this review was to evaluate the efficiency of these nutritional interventions in the prevention and control of overweight in children and adolescents. The studies analyzed proved the efficiency of dietary alterations to control overweight in childhood and adolescence.

Eleven of the twelve studies included in the analysis developed educational activities aimed at changing eating habits to improve the cardiovascular health of study populations^{23-28,30-34}. Of these 11 studies, six also included the stimulus to regular physical activity^{24,25,28,31-33}. The study by Marild et al.³¹ included orientations regarding time in front of the television and respect for daily sleep time. Kesztyüs et al.²⁸ stimulated the decrease in time in front of screens.

The study conducted by Poitras et al.²⁹ exclusively analyzed the association between regular physical activity and cardiovascular health of children and adolescents.

The evolution of body fat was the first indicator of cardiovascular health in childhood and adolescence chosen, analyzed, in 11 of the 12 studies included in this literature review. From this analysis, the first hypothesis of this review was confirmed. The intervention strategies on the cardiovascular health of children and adolescents, represented in the articles selected for this review by changes in eating habits and routine physical activity, led to the reduction of body fat in ten of the eleven scientific articles that analyzed the evolution of body fat after nutritional intervention. In all seven studies analyzed in the systematic review conducted by Leis et al.²⁴, there were differences between the intervention groups and the control groups, with statistical significance in 5 of these studies, in the evolution of body fat, by the evolution of AC. Wadolowska et al.²⁵ observed a statistically significant reduction in CA in -0.13 standard deviation (SD), compared to the control group. Mazloomi-Mahmoodabad et al.²⁶, after the educational intervention performed, found an average reduction of -0.46 SD in BMI and -1.96 SD in CA. Gatto et al.²⁷ found statistically significant reductions in BMI Z score (-0.1 versus -0.04), and in CA (-1.2 cm versus 0.1 cm), comparing students from control and intervention groups. The study by Kesztyüs²⁸ et al. found statistically significant differences between the intervention group and the control group in the evolution of the BMI percentile. Poitras et al.²⁹ concluded that physical activity, particularly performed regularly and maintained for periods longer than 3 months, is directly related to body fat reduction. Macknin et al.³⁰ observed a statistically significant reduction of -0.14 BMI Z score in children and adolescents after the dietary intervention performed. Mårild et al.³¹ did not observe statistically significant differences in the evolution of body fat, after the health promotion activities implemented. In the study by Kong et al.³², there were statistically significant reductions in the BMI percentile (difference -0.3 versus 0.2), and in CA (0 cm versus 1.7 cm), between the control and intervention groups. Campos Pastor et al. found a statistically significant reduction in BMI, from 21.7 to 21.2 in males and from 21.6 to 21.1 in females. Silveira et al. concluded that longitudinal studies of nutritional education lasting between 1 and 3 years are capable of leading to a reduction in the prevalence of overweight and obesity

between 31 and 39%, in childhood and adolescence.

The second indicator of cardiovascular health in childhood and adolescence analyzed in the studies included in this literature review was the evolution of dyslipidemias in 8 of the 12 studies submitted to the analysis in this review. The laboratory methods identified in these studies for the definition of dyslipidemias were TG, HDL-c, LDL-c and CT.

Barka et al.²³ in their systematic review, conclude that the addition of plant sterols or sterols have a reduction effect of TC (M: -0.62 mmol/L) and LDL-c (M: -0.58 mmol/L) in individuals with family hypercholesterolemia compared to cholesterol-reducing diets, and that supplementation with omega-3 fatty acids reduces the serum value of triglycerides (M: -0.27 mmol/L) compared to placebo. All values obtained were statistically significant. Macknin et al.³⁰ introduced dietary changes and achieved a statistically significant reduction in total cholesterol (M: -22.5 mg/dL) and LDL-c (M: -13.14 mg/dL). Poitras et al.²⁹ observed results that confirm the hypothesis of the present review, concluding that there is a direct relationship between the practice of regular physical activity in childhood and adolescence, particularly physical activity classified, according to intensity, as moderate or vigorous and clinical control of dyslipidemias, translated by reduction of triglycerides and LDL-c and by the elevation of HDL-c. Campos Pastor et al.³³ observed positive outcomes when comparing the evolution of dyslipidemias before and after the intervention. There was a decrease in the percentage of individuals with GIT>150 mg/dl (4.7% vs 0.8%) or hdl-c<40mg/dl (7.0% vs 2.8%), after changing the life habits of the adolescents included in this study.

On the other hand, Leis et al.²⁴ state, in their systematic review, that three of the four randomized clinical trials that evaluated plasma lipids did not find significant differences between the evolution observed for the control and intervention groups. Marild et al.³¹, in their multi-center study conducted in eight European countries, they did not observe benefits from the change in eating habits and the increase in physical activities on dyslipidemias. Kong et al.³² observed differences in body mass evolution when comparing the intervention group with the control group but did not find differences in triglyceride or HDL rates.

DISCUSSION

This study analyzed systematic reviews and randomized clinical trials and showed a positive association between the promotion of healthy lifestyle habits, through physical activities and change in eating habits, and the improvement of cardiovascular health in the pediatric population, expressed by the reduction of obesity, proving one of the hypotheses elaborated for this literature review. Educating children and adolescents preferably with the involvement of parents and schools, in order to achieve

healthy eating and to develop regular physical activities, were implemented actions that, according to this study, modified the life and health of children and adolescents, leading to the reduction of body fat in the intervention groups.

The reduction of screen time, including television, was associated with reduced body fat and improved nutritional status in the study by Kesztyüs et al.²⁸, who simultaneously used physical activities and food education. In the study by Marild et al.³¹, the proposed educational activities, including dietary changes, stimulation of physical activity and the reduction of time watching television did not lead to the improvement of body fat. This disagreement points to the need to conduct studies that conclude on the effectiveness of time control in front of screens in reducing body fat.

Obesity in childhood and adolescence is a nutritional disease of increasing prevalence in the world, including developed countries, countries in transition and economic, as is the case in Brazil, and underdeveloped countries. Its clinical and epidemiological importance stems from the high risk observed for obese children and adolescents, when compared to those who were not obese in the pediatric age group, of presenting diseases until adulthood, including diabetes mellitus type 2, hypertension, hypercholesterolemia, hypertriglyceridemia and coronary and carotid atherosclerosis³⁵⁻³⁶. Consequently, the control of obesity in childhood and adolescence, by promoting cardiovascular health, can contribute to decrease morbidity and mortality in adulthood. Despite the difficulty of modifying habits adopted by families, the results presented by authors in different countries show the importance of promoting qualified health actions in an integrated way between basic health units, families and educational institutions located in their area of coverage. Finding adequate spaces for physical activity, professionals who work as volunteers in the coordination of physical activities, encouraging the creation of community gardens and raising local resources for the acquisition of foods such as fruits, vegetables and vegetables, at a lower cost for families, are alternatives to change the life and health of the population using basic health units³⁷⁻³⁸.

When analyzing the possible association between the promotion of healthy lifestyle habits and dyslipidemias, this systematic review found inconclusive results. Some studies found, after the proposed interventions, the decrease in dyslipidemia and other studies did not observe significant changes in the frequencies observed before these interventions. The studies that found a positive relationship were those that allied educational measures with practical activities, characterized by nutritional interventions and the implementation of regular physical activity, that is, real changes in the life habits of children and adolescents^{23,29,30,33}.

On the other hand, studies that have not shown that promoting healthy lifestyle habits lead to a decrease in

dyslipidemias in the pediatric age group, alert to a possible difficulty in the therapeutic approach of dyslipidemias. Dyslipidemias, in order to be fully controlled, both hypercholesterolemia and hypertriglyceridemia, may require changes in life habits more intense and prolonged than family members and patients can achieve, even if included in regular health education programs²⁴. When performing partial, incomplete or irregular changes in eating habits and physical activity routine, there is a lower effectiveness of these therapeutic measures indicated by the guidelines of medical societies, considered effective to control dyslipidemias in children, adolescents, and adulthood³⁹⁻⁴¹.

An important point, observed from the literature review conducted in this study, is the presence of few Brazilian studies, particularly population-based studies, that indicate the prevalence of dyslipidemias in children and adolescents^{8,11,42-45} and the lack of studies addressing the promotion of cardiovascular health in the pediatric age group.

The studies included in this systematic review used different methodologies in the approach to cardiovascular health in childhood and adolescence, with variations in total intervention time, weekly workload, intensity and content, more often focused on eating habits, being associated or not with the incentive to regular physical activities. This heterogeneity leads to difficulties to elaborate precise recommendations regarding the most effective measures to improve cardiovascular health, expressed by overweight for height or dyslipidemias. More controlled studies, conducted in longer time frames, preferably longer than one year, using a higher frequency of monitoring of lipid profile and evaluation parameters for obesity would be useful to obtain even more conclusive results on the beneficial effects of changing life habits.

It was not possible to find studies comparator the effect of dietary alterations with the performance of regular physical activity or with the reduction of time before screens on the evolution of body fat and the control of overweight and dyslipidemias in children and adolescents. On the other hand, research is needed to demonstrate whether the effects of cardiovascular health interventions in children and adolescents are long-lasting to protect their health until adulthood.

CONCLUSION

There is a positive association between the promotion of healthy habits, such as physical activities and changes in eating habits, and the reduction of body mass, one of the indicators of improvement of cardiovascular health in the pediatric age group, chosen for this systematic review. In the case of dyslipidemias, it was not possible to conclude whether the promotion of healthy lifestyle habits effectively protects children and adolescents against

these metabolic disorders. The participation of the family and schools were strategies developed in the studies that achieved the improvement of cardiovascular health among children and adolescents. The authors observed the need for intervention studies conducted during longer periods

and to increase the number of Brazilian studies that help determine the prevalence of dyslipidemias in children and adolescents to implement future measures to improve cardiovascular health that continue until adulthood, from the pediatric age group.

Authors' participation: *Mainardes VT, Canizella GP, Ramos MG* – were responsible for the idealization of the work, analysis, and interpretation of the data and writing of the first version of the manuscript. *Yamamoto RM* - was responsible for reviewing the original text and guiding the work.

REFERENCES

- Oliveira GMM, Brant CCL, Polanczyk CA, Biolo A, Nascimento BR, Malta DC, Souza MFM, et al. Estatística cardiovascular - Brasil 2020. *Arq Bras Cardiol.* 2020;115(3):308-439. <https://doi.org/10.36660/abc.20200812>
- Mangili L. Alta prevalência de dislipidemias em crianças e adolescentes: oportunidade para prevenção. *Arq Bras Cardiol.* 2020;114(1):57-58. <https://doi.org/10.36660/abc.20190761>
- Strong JP, Malcom GT, Newman WP 3rd, Oalman MC. Early lesions of atherosclerosis in childhood and youth: natural history and risk factors. *J Am Coll Nutr.* 1992;11(Suppl):51S-54S. doi: <https://doi.org/10.1080/07315724.1992.10737984>.
- McGill HC Jr, McMahan CA, Herderick EE, Malcom GT, Tracy RE, Strong JP. Origin of atherosclerosis in childhood and adolescence. *Am J Clin Nutr.* 2000;72(5 Suppl):1307S-1315S. doi: <https://doi.org/10.1093/ajcn/72.5.1307s>.
- Yusuf S, Joseph P, Rangarajan S, Islam S, Mente A, Hystad P, et al. Modifiable risk factors, cardiovascular disease, and mortality in 155 722 individuals from 21 high-income, middle-income, and low-income countries (PURE): a prospective cohort study. *Lancet.* 2020;395(10226):795-808. doi: [https://doi.org/10.1016/S0140-6736\(19\)32008-2](https://doi.org/10.1016/S0140-6736(19)32008-2).
- Koliaki C, Liatis S, Kokkinos A. Obesity and cardiovascular disease: revisiting an old relationship. *Metabolism.* 2019;92:98-107. doi: <https://doi.org/10.1016/j.metabol.2018.10.011>.
- Burlutskaya AV, Tril VE, Polischuk LV, Pokrovskii VM. Dyslipidemia in pediatrician's practice. *Rev Cardiovasc Med.* 2021;22(3):817-834. doi: <https://doi.org/10.31083/j.rcm2203088>.
- Maia JAF, Pinto FJM, Silva FR, Dantas DSG, Sampaio RMM, Chaves EMC, et al. Prevalência de dislipidemias em crianças de 2 a 9 anos. *Rev Bras Enferm.* 2020;73(4):1-7. doi: <http://dx.doi.org/10.1590/0034-7167-2019-0759>
- Sociedade Brasileira de Pediatria. Departamento Científico de Endocrinologia (2019-2021). Dislipidemia na criança e no adolescente - Orientações para o pediatra. Guia prático de atualização da Sociedade Brasileira de Pediatria; 2020;(8):1-13. Disponível em https://www.sbp.com.br/fileadmin/user_upload/22336c-GPA_-_Dislipidemia_Crianca_e_Adoles.pdf
- World Health Organization. Global Health Observatory data repository. Geneva; 2013. Available from: <https://apps.who.int/gho/data/view.main.2570?lang=en>
- Faria Neto JR, Bento VF, Baena CP, Olandoski M, Gonçalves LG, Abreu Gde A, et al. ERICA: prevalence of dyslipidemia in Brazilian adolescents. *Rev Saude Publica.* 2016;50(Suppl 1):10s. doi: <https://doi.org/10.1590/S01518-8787.2016050006723>.
- Mello ED, Luft VC, Meyer F. Atendimento ambulatorial individualizado versus programa de educação em grupo: qual oferece mais mudança de hábitos alimentares e de atividade física em crianças obesas? *J Pediatr (Rio J).* 2004;80(6):468-74. doi: <https://doi.org/10.2223/1260>.
- Araújo ES, Costa SNH. Estudos sobre dislipidemia em crianças no Brasil: revisão bibliográfica. In: *Cadernos de artigos da 7ª Mostra de Produção Científica da Pós-Graduação Lato Sensu da PUC Goiás*. Goiás, out. 2012.
- Gambetta JC, Araujo MB, Cheisa P. Dislipemias en la edad pediátrica. Importancia del diagnóstico y tratamiento precoces. *Rev Urug Cardiol.* 2019;34(3):208-238. <https://doi.org/10.29277/cardio.34.3.20>
- Lobstein T, Jackson-Leach R, Moodie ML, Hall KD, Gortmaker SL, Swinburn BA, et al. Child and adolescent obesity: part of a bigger picture. *Lancet.* 2015;385(9986):2510-20. doi: [https://doi.org/10.1016/S0140-6736\(14\)61746-3](https://doi.org/10.1016/S0140-6736(14)61746-3).
- DeBoer MD. Assessing and managing the metabolic syndrome in children and adolescents. *Nutrients.* 2019;11(8):1788. doi: <https://doi.org/10.3390/nut11081788>.
- World Health Organization. WHO guidelines on physical activity and sedentary behaviour: at a glance. Geneva: World Health Organization; 2020. Available from: <https://www.who.int/publications/i/item/9789240014886>
- Sociedade Brasileira de Pediatria. Departamento de Nutrologia. Obesidade na infância e adolescência – manual de orientação. 3a ed. São Paulo: SBP; 2019. Disponível em https://www.sbp.com.br/fileadmin/user_upload/Manual_de_Obesidade_-_3a_Ed_web_compressed.pdf
- Galvão TF, Pereira MG. Revisões sistemáticas da literatura: passos para sua elaboração. *Epidemiol Serv Saúde.* 2014;23(1):183-184. <http://dx.doi.org/10.5123/S1679-49742014000100018>
- Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM,

- Flegal KM, Mei Z, Wei R, et al. 2000 CDC growth charts for the United States: methods and development. *Vital Health Stat.* 2002;11(246):1-203. Available from: https://www.cdc.gov/nchs/data/series/sr_11/sr11_246.pdf
21. Onis M, Garza C, Victora CG, Onyango AW, Frongillo EA, Martinez J. The WHO Multicentre Growth Reference Study: planning, study design, and methodology. *Food Nutr Bull.* 2004;25(1):S13-S14. doi: <http://dx.doi.org/10.1177/15648265040251S103>.
22. Centers for Disease Control (CDC). National Health and Nutrition Examination Survey (NHANES). Anthropometry procedures manual. Washington, DC: NIH, CDC; 2017. Available from: https://www.cdc.gov/nchs/data/nhanes/2017-2018/manuals/2017_Anthropometry_Procedures_Manual.pdf
23. Barkas F, Nomikos T, Liberopoulos E, Panagiotakos D. Diet and cardiovascular disease risk among individuals with familial hypercholesterolemia: systematic review and meta-analysis. *Nutrients.* 2020;12(8):2436. doi: <http://dx.doi.org/10.3390/nu12082436>.
24. Leis R, de Lamas C, de Castro MJ, Picáns R, Gil-Campos M, Couce ML. Effects of nutritional education interventions on metabolic risk in children and adolescents: a systematic review of controlled trials. *Nutrients.* 2019;12(1):31. doi: <http://dx.doi.org/10.3390/nu12010031>
25. Wadolowska L, Hamulka J, Kowalkowska J, Ulewicz N, Hoffmann M, Gornicka M, et al. Changes in sedentary and active lifestyle, diet quality and body composition nine months after an Education Program in Polish Students Aged 11-12 Years: report from the ABC of Healthy Eating Study. *Nutrients.* 2019;11(2):331. doi: <http://dx.doi.org/10.3390/nu12010031>.
26. Mazloomi-Mahmoodabad SS, Navabi ZS, Ahmadi A, Askarishahi M. The effect of educational intervention on weight loss in adolescents with overweight and obesity: application of the theory of planned behavior. *ARYA Atheroscler.* 2017;13(4):176-183. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5677321/>
27. Gatto NM, Martinez LC, Spruijt-Metz D, Davis JN. LA sprouts randomized controlled nutrition, cooking and gardening programme reduces obesity and metabolic risk in Hispanic/Latino youth. *Pediatr Obes.* 2017;12(1):28-37. doi: <http://dx.doi.org/10.1111/ijpo.12102>
28. Kesztyüs D, Lauer R, Kesztyüs T, Kilian R, Steinacker JM; "Join the Healthy Boat" Study Group. Costs and effects of a state-wide health promotion program in primary schools in Germany - the Baden-Württemberg Study: a cluster-randomized, controlled trial. *PLoS One.* 2017;12(2):e0172332. doi: <http://dx.doi.org/10.1371/journal.pone.0172332>.
29. Poitras VJ, Gray CE, Borghese MM, Carson V, Chaput JP, Janssen I, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Appl Physiol Nutr Metab.* 2016;41(6 Suppl 3):S197-239. doi: <http://dx.doi.org/10.1139/apnm-2015-0663>.
30. Macknin M, Kong T, Weier A, Worley S, Tang AS, Alkhouri N, et al. Plant-based, no-added-fat or American Heart Association diets: impact on cardiovascular risk in obese children with hypercholesterolemia and their parents. *J Pediatr.* 2015;166(4):953-9.e1-3. doi: <http://dx.doi.org/10.1016/j.jpeds.2014.12.058>.
31. Mårild S, Russo P, Veidebaum T, Tornaritis M, De Henauw S, De Bourdeaudhuij I, et al. IDEFICS consortium. Impact of a community based health-promotion programme in 2- to 9-year-old children in Europe on markers of the metabolic syndrome, the IDEFICS study. *Obes Rev.* 2015;16 Suppl 2:41-56. doi: <http://dx.doi.org/10.1111/obr.12368>.
32. Kong AS, Sussman AL, Yahne C, Skipper BJ, Burge MR, Davis SM. School-based health center intervention improves body mass index in overweight and obese adolescents. *J Obes.* 2013;2013:575016. doi: <http://dx.doi.org/10.1155/2013/575016>.
33. Campos Pastor MM, Serrano Pardo MD, Fernández Soto ML, Luna Del Castillo JD, Escobar-Jiménez F. Impact of a 'school-based' nutrition intervention on anthropometric parameters and the metabolic syndrome in Spanish adolescents. *Ann Nutr Metab.* 2012;61(4):281-8. doi: <http://dx.doi.org/10.1159/000341495>.
34. Silveira JA, Taddei JA, Guerra PH, Nobre MR. Effectiveness of school-based nutrition education interventions to prevent and reduce excessive weight gain in children and adolescents: a systematic review. *J Pediatr (Rio J).* 2011;87(5):382-92. doi: <http://dx.doi.org/10.2223/JPED.2123>
35. Sentalin PBR, Pinheiro AO, Oliveira RR, Zângaro RA, Campos LA, Baltatu OC. Obesity and metabolic syndrome in children in Brazil: The challenge of lifestyle change. *Medicine (Baltimore).* 2019;98(19):e15666. doi: <http://dx.doi.org/10.1097/MD.00000000000015666>.
36. Juonala M, Magnussen CG, Berenson GS, Venn A, Burns TL, Sabin MA, et al. Childhood adiposity, adult adiposity, and cardiovascular risk factors. *N Engl J Med.* 2011;365(20):1876-85. doi: <http://dx.doi.org/10.1056/NEJMoal010112>.
37. Van den Berg A, Warren JL, McIntosh A, Hoelscher D, Ory MG, Jovanovic C, Lopez M, Whittlesey L, Kirk A, Walton C, McKyer L, Ranjit N. Impact of a gardening and physical activity intervention in title 1 schools: the TGEG Study. *Child Obes.* 2020;16(S1):S44-S54. doi: <http://dx.doi.org/10.1089/chi.2019.0238>
38. Mello ED, Luft VC, Meyer F. Obesidade infantil: como podemos ser eficazes?. *J Pediatr (Rio J).* 2004;80(3):173-182.
39. Bamba V. Update on screening, etiology, and treatment of dyslipidemia in children. *J Clin Endocrinol Metab.* 2014;99(9):3093-102. <https://doi.org/10.1210/jc.2013-3860>
40. Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents; National Heart, Lung, and Blood Institute. Expert panel on integrated guidelines for cardiovascular health and risk

reduction in children and adolescents: summary report. *Pediatrics*. 2011;128(Suppl 55):S213-56. doi: <http://dx.doi.org/10.1542/peds.2009-2107C>

41. Sociedade Brasileira de Cardiologia. Atualização da Diretriz de Prevenção Cardiovascular da Sociedade Brasileira de Cardiologia – 2019. *Arq Bras Cardiol*. 2019;113(4):787-891. Disponível em <http://publicacoes.cardiol.br/portal/abc/portugues/2019/v11304/pdf/11304022.pdf>
42. Calliari SS, Grando LG, Bertol CD, Siqueira LO. Dislipidemia em crianças e adolescentes do município de Marau-RS. *Cad Saude Coletiva*. 2019;27(4):368-373. <https://doi.org/10.1590/1414-462X201900040004>
43. Tomeleri CM, Ronque ER, Silva DR, Cardoso Júnior CG, Fernandes RA, Teixeira DC et al. Prevalence of dyslipidemia in adolescents: comparison between definitions. *Rev Port Cardiol*. 2015;34(2):103-9. doi: <http://dx.doi.org/10.1016/j.repc.2014.08.020>
44. Pereira PB, Arruda IK, Cavalcanti AM, Diniz AA. Lipid profile of schoolchildren from Recife, PE. *Arq Bras Cardiol*. 2010;95(5):606-13. doi: <http://dx.doi.org/10.1590/s0066-782x2010005000136>
45. Franca E, Alves JGB. Dislipidemia entre crianças e adolescentes de Pernambuco. *Arq Bras Cardiol* [online]. 2006;87(6):722-727. <https://doi.org/10.1590/S0066-782X2006001900007>

Received: July 05, 2022

Accepted: August 30, 2022