

Risk factors involved in adolescent obesity: an integrative review

Simone Carvalho Neves (<https://orcid.org/0000-0002-9685-761X>)¹

Luciana Miranda Rodrigues (<https://orcid.org/0000-0001-8664-9529>)²

Paulo Alexandre de Souza São Bento (<https://orcid.org/0000-0002-1598-3340>)³

Maria Cecília de Souza Minayo (<https://orcid.org/0000-0001-6187-9301>)⁴

Abstract *The scope of this study was to examine the risk factors for the development of obesity in adolescence. The objective was to identify risk factors for adolescent obesity by means of an Integrative Review of the Literature. The PICO strategy was used to formulate the following central line of inquiry: What are the risk factors for the development of obesity during adolescence? The VHL and EBSCOhost research databases were consulted, resulting in a selection of 25 articles for in-depth study. The phenomenon of obesity was understood as the result of biological, social, psychological, and nutritional factors. The research revealed a lack of consensus on the risks and benefits, which makes evidence-based recommendations difficult. The study identified proposals that can be implemented, such as a change in eating habits, weight control and the practice of physical exercise. Such behavioral changes can be recommended within the context of the family, schools, and health services. The review recommends prevention strategies and the recognition of school as the ideal medium for health promotion through education. From a political and social standpoint, it is necessary to challenge the prevalence of publicity of the food industry that entices adolescents to consume processed foods with high fat and sugar content.*

Key words *Adolescent, Chronic disease, Health in schools, Obesity*

¹ Enfermagem Souza Marques, Fundação Técnico-Educacional Souza Marques. Av. Ernani Cardoso 335/345, Cascadura. 21310.310 Rio de Janeiro RJ Brasil. srneves23@gmail.com

² Instituto Nacional de Traumatologia e Ortopedia Jamil Haddad (INTO). Rio de Janeiro RJ Brasil.

³ Instituto Nacional de Saúde da Mulher, da Criança e do Adolescente Fernandes Figueira (IFF), Fundação Oswaldo Cruz. Rio de Janeiro RJ Brasil.

⁴ Departamento de Estudos sobre Violência e Saúde Jorge Careli (Claves), Escola Nacional de Saúde Pública, Fundação Oswaldo Cruz. Rio de Janeiro RJ Brasil.

Introduction

Adolescence is the transition phase from childhood to adulthood and covers the period between 10 and 19 years of age¹. In Brazil, according to the 2010 Demographic Census, the adolescent population was approximately 18 million between 10 and 14 years of age and 17 million between 15 and 19 years of age².

Viero and Farias³ highlight the fact that this phase is marked by far-reaching changes, representing a potentially difficult period in terms of sundry challenges and vulnerabilities because of the transformations inherent to the process of attaining human maturity. One of these vulnerabilities is related to the emergence of obesity, which constitutes a public health problem. It is considered one of the chronic non-communicable diseases (CNCD) with a high incidence among young people nowadays, signifying that if there are no effective interventions to treat it, obesity will tend to worsen over the course of life.

Obesity is defined as a nutritional and metabolic disorder of multifactorial origin. It is a condition in which the percentage of body fat in the individual is high, due to an imbalance between the intake and expenditure of energy. Genetic, emotional and lifestyle factors are closely related to its origin or perpetuation⁴.

Obesity in adolescents can be the result of both genetics and the intake of large amounts of fat and calories. In addition, the lack of physical activities and a great deal of time spent on social media, playing interactive games, and watching television can contribute to the exacerbation of the problem⁵. Obese adolescents tend to become obese adults who suffer from clinical complications from being overweight and have a reduced life expectancy⁴.

The situation discussed here is not restricted to Brazil. The prevalence of obesity and overweight in adolescents is observed in several countries such as the United States of America and Latin American countries⁴. Data from the Pan American Health Organization (PAHO)⁶ reveal that obesity rates in children and adolescents worldwide were 1% in 1975 (equivalent to 5 million girls and 6 million boys), and 6% in 2016 (corresponding to 50 million girls and almost 74 million boys). PAHO further points out that the number of the obese aged between 5 and 19 years has increased more than tenfold, from 11 million in 1975 to 124 million in 2016⁶. Although the factors associated with the phenomenon are multiple, the influence of marketing of the food

industries and the policies that support it cannot be overlooked. Nor is the fact that, in most countries, the most nutritious and healthy foods are still expensive and inaccessible to families and communities with low purchasing power⁷.

Based on the epidemiological evidence of the increase in obesity, PAHO/WHO has been recommending member countries to implement and maintain surveillance systems for risk factors. In Brazil, the Adolescent Health Program (PROSAD)^{4,8} was created in 1989 with multiple objectives, one of which was the prevention of chronic diseases, which includes obesity. This program led to some beneficial developments, such as the recent National School Health Survey (PeNSE)⁹, a strategic partnership between the Ministry of Health and the Brazilian Institute of Geography and Statistics (IBGE) with the support of the Ministry of Education and Culture (MEC). One of its objectives was to identify priorities for the development of public policies for the promotion of health among adolescents⁹. Its focus was on risk surveillance and protection against chronic diseases in Brazil. This study brought to light several unhealthy lifestyles that were common among young people, including the consumption of tobacco, alcohol and illicit drugs, inadequate nutrition, and a sedentary lifestyle.

Given the empirical importance of obesity during adolescence, this article sought to identify the risk factors for obesity among adolescents by means of an integrative review of the literature.

Methods

This study involved an integrative review of the literature (IRL), utilizing the concepts and methods proposed by Soares *et al.*¹⁰ as a theoretical benchmark. In the health field, the IRL concentrates on summarizing scientific findings in order to identify and understand problems, situations and vulnerabilities related to the population¹⁰. It calls for the authors to put forward hypotheses and draw conclusions on the issue in question, which is a complex task that is based on the proposal for collaboration and integration of various lines of action with the aim of identifying evidence-based practices¹¹.

The PICO strategy^{12,13} was used to formulate the central line of inquiry of this study, since it facilitates an accurate search for the scientific evidence related to the topic. PICO is an acronym where the letter P indicates the population, the

letter I is related to the intervention, the letter C refers to the comparison and the letter O represents the expected outcomes. The comparative study by Methley¹³ on various types of reviews suggests that the PICO strategy remains the model with the greatest sensitivity for searches in different databases.

In this respect, the acronym determined for this study was: P – adolescent; I – obesity; C – not applicable; O – to identify the risk factors for obesity. Thus, the central line of inquiry for this article was: *What are the risk factors for the development of obesity during adolescence?*

The following databases were consulted for the search for articles: Virtual Health Library (VHL) and EBSCOhost in the following databases: National Library of Medicine (MEDLINE via PubMed), Latin American and Caribbean Center on Health Sciences (LILACS) and Academic Search Premier – ASP. The following official key words (Decs, 2017) were used: adolescent; chronic disease; school health; obesity.

The cross-checking was performed using the advanced search tool and the Boolean *and*. The search was conducted with the following key words: adolescent *and* chronic illness *and* school health *and* obesity in Portuguese with the respective equivalents in English. Articles in Portuguese, English and Spanish published between January 2007 and December 2017 were used as filters.

The following exclusion criteria relating to the texts located included: articles with research participants younger than ten years of age and older than eighteen years of age; articles on adolescents with communicable diseases; hospitalization situations and drug or laboratory studies.

The articles listed for this IRL were organized in a synoptic table that contained: periodical/journal; title; authors; type of approach; participants; research scenario; year of publication; level of evidence; study location; and main results. The flowchart in Figure 1 represents the structure of the corpus of this review.

The analysis of the articles was based on the GRADE (Grading of Recommendations Assessment, Development and Evaluation) scale. GRADE is a system that was developed by a group of researchers that aims to gauge the quality of the evidence and the strength of the recommendations. The level of evidence represents the confidence in the information used to support a given recommendation and the assessment of the

quality of the evidence, being classified into four levels: high, medium, low and very low¹⁴.

It should be pointed that this type of study does not require the approval of the Ethics and Research Committee. Only public domain articles were used and all ethical criteria regarding the preservation of authorship and citation of sources were respected.

Results and discussion

The selection of articles was conducted by means of a search in the Medline (n = 106), LILACS (n = 3) and ASP (n = 49) databases, arriving at a partial total of 158 articles. At the outset, 63 articles that did not meet the inclusion criteria were excluded (study filters – Figure 1). Following the initial analysis of the search for evidence, 52 articles were excluded after reading the titles and abstracts as they did not adequately address the PICO question. Fourteen articles were withdrawn due to the following situations: duplicate, being ineligible, the fact they were qualitative studies, review studies or because they were not available for reading. Therefore, 25 studies were included for in-depth perusal.

The 25 articles included in the integrative review were all located in the Medline database (Table 1). Of this total, 14 were published in the last six years (2013-2017) and 11 between 2007 and 2011. The articles selected were published in journals in the United States of America (20%), Oceanian Countries (20%), Europe (16%), India (12%), Australia (8%), Central America (8%), China (8%), Canada (4%) and Iran (4%). Most of the authors conducted cross-sectional research (76%) and the remainder used a longitudinal approach (12%), stratified multistage sampling (8%) and a Knockout study carried out in 4 moments (4%).

A thorough and critical reading of each article was carried out. The works presented a multiplicity of results associated with the risk factors of obesity during adolescence. The discussion of this study was divided into three categories that included the biological factors¹⁵⁻¹⁹, the social factors²⁰⁻³⁷ and the nutritional factors^{38,39}. The stated intention was to conduct a non-dichotomous discussion of the phenomenon and, effectively, the findings of this review revealed that analyzing obesity requires a viewpoint that considers the multiple aspects of this condition.

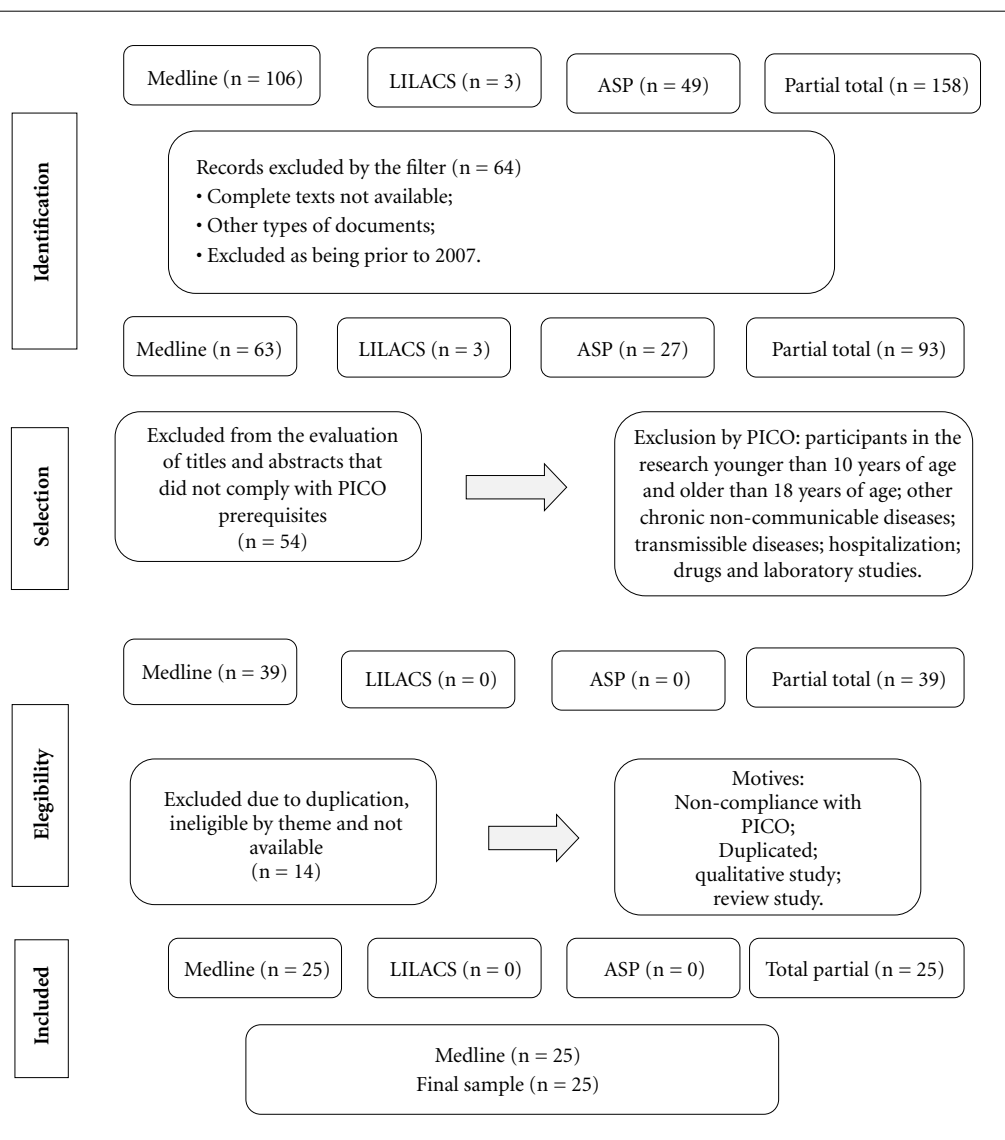


Figure 1. Flowchart of the stages conducted in the selection of articles.

Source: Authors' elaboration.

Biomedical aspects of adolescent obesity

Coutinho⁴⁰ emphasizes that the “gene map of human obesity” continues to develop rapidly each year, as more genes and chromosomal regions are related to it. This gene map identified more than 430 genes, associated with phenotypes of human obesity⁴¹. However, Clement & Ferre⁴² report that numerous genetic markers have already been associated with obesity and its metabolic consequences, though the specific interactions between genotype and phenotype in

polygenic forms of obesity continue to be only scantily understood.

For its part, the field of epigenetics brings contributions to the understanding of the multifactoriality found in this review. The authors assert that there is evidence that exposure to various environmental conditions, in early stages of life, can induce persistent changes in the epigenome. However, the evidence also suggests that some epigenetic markers are modifiable according to lifestyle habits related to diet and physical activity. This evidence can contribute to the

Chart 1. Synopsis of the data collected in the articles of the integrative review of 2007 to 2017, organized by authors, year of publication, place of study, title, objectives and type of study.

Number of the Article	Author, year of publication and study location	Title	Objectives	Outline of the study
A1	Merlo et al. ³⁸ (2015) USA	School practices to increase the availability of fruits, vegetables and grains and reduce sodium in the school meal – United States of America (USA), 2000, 2006 and 2014.	To examine the prevalence of practices related to the implementation of nutritional standards in schools.	Cross-sectional study
A2	Song et al. ²⁰ (2013) USA	Secular trend of the prevalence of obesity in children in China between 1985 and 2010: gender disparity.	To identify whether the gender difference in obesity has increased or decreased over the past 25 years in Chinese schoolchildren, i.e. whether the rate of increase has been different for boys and girls.	Cross-sectional study
A3	Mbowe et al. ³⁰ (2014) Guatemala	Prevalence of metabolic syndrome and associated risk factors in schoolchildren in Guatemala.	To investigate the prevalence of metabolic syndrome and cardiovascular risk factors associated with metabolic syndrome among schoolchildren of a population of predominantly Mayan descent undergoing rapid urbanization.	Cross-sectional study
A4	Martinez, Ruelas, Granger ¹⁸ (2017) USA	Association between body mass index and salivary uric acid among children, youths and adults of Mexican origin: differences in development and gender.	To examine how uric acid levels in saliva differ among children of Mexican origin, at different stages of development.	Cross-sectional study
A5	Ichihō, Robles, Aitaoto ²³ (2013) North of Iceland	An assessment of non-communicable diseases, diabetes, and related risk factors, in the community: a systemic perspective.	To assess the capacity of administrative, clinical, support and data systems to address the problems of NCD, including diabetes and risk factors thereof.	Cross-sectional study
A6	Ichihō et al. ²⁸ (2013) Oceania	An assessment of non-communicable diseases, diabetes, and related risk factors, in the territory of American Samoa: a systemic perspective.	To describe the chronic NCD burden, assess capacity and activities related to service rendering, data collection, and reports identifying problems.	Cross-sectional study
A7	Ichihō et al. ²⁵ (2013) Marshall Islands	An assessment of non-communicable diseases, diabetes, and related risk factors, in the territory of the Republic of the Marshall Islands, Majuro Atoll: a systemic perspective.	To assess the capacity of administrative, clinical, support and data systems to address the problems of chronic NCD, including diabetes and risk factors thereof.	Cross-sectional study
A8	Ichihō et al. ²⁹ (2013) Palau	An assessment of non-communicable diseases, diabetes, and related risk factors, in the territory of the Republic of Palau: a systemic perspective.	To assess the capacity of administrative, clinical, support and data systems to address the problems of chronic NCD, including diabetes and risk factors thereof.	Cross-sectional study

it continues

prevention of obesity in subjects or populations with an unfavorable epigenetic profile, in the sense that the phenomenon cannot be analyzed in a fragmented manner, but as a result of factors

interrelated between biology and cultural conditions⁴³.

In the same vein, it is also important to point out that the authors who focused their studies on

Chart 1. Synopsis of the data collected in the articles of the integrative review of 2007 to 2017, organized by authors, year of publication, place of study, title, objectives and type of study.

Number of the Article	Author, year of publication and study location	Title	Objectives	Outline of the study
A9	Ichiho et al. ²⁶ (2013) Micronesia	An assessment of non-communicable diseases, diabetes, and related risk factors, in the territory of the federated states of Micronesia, State of Pohnpei: a systemic perspective.	To assess the capacity of administrative, clinical, support and data systems to address the problems of chronic NCD.	Cross-sectional study
A10	Ichiho et al. ²⁷ (2013) Marshall Republic	An assessment of non-communicable diseases, diabetes, and related risk factors, in the territory of the Republic of the Kwajalein Atoll of Marshall Island, Ebeyeve Island: a systemic perspective.	To assess the capacity of administrative, clinical, support and data systems to address the problems of chronic NCD including diabetes and risk factors thereof.	Cross-sectional study
A11	Singh, Yu, Kogan ²² (2013) USA	Health, chronic conditions and behavioral risk disparities among immigrant children and adolescents in the U.S.	To examine the different prevalence in 23 countries of health, chronic conditions, and behavioral indicators, among 91,532 children of immigrants and American children.	Cross-sectional study
A12	Lin et al. ¹⁵ (2015) Stockholm, Athens, Heraklion, Rome, Zaragoza	Animal and plant protein intake and the association thereof with obesity and cardiometabolic indicators in European adolescents: HELENA a cross-sectional study.	To evaluate animal and vegetable protein intake among European adolescents stratified by gender and age, and investigating the associations with cardiometabolic indicators (anthropometry and biomarkers).	Cross-sectional study
A13	Patel et al. ³² (2017) India	Chronic disease compliance within Indian households: a cross-sectional study.	To estimate the association between living with someone with a chronic condition and the chronic condition state per se.	Cross-sectional study
A14	Passmore et al. ³⁷ (2017) Australia	The impact of a community-led program promoting weight loss and healthy living in Aboriginal communities: the 'Knockout' health challenge in New South Wales.	To identify effective healthy lifestyle programs to address risk factors for chronic diseases among Aboriginal people.	Health Challenge Knockout
A15	Ekta, Tulika ²¹ (2016) India	Distribution of risk factors for cardiovascular diseases among high school boys and girls in the urban area of Dibrugarh Assam.	To compare the distribution of risk factors among boys and girls in Assam.	Cross-sectional study
A16	Leatherdale ¹⁹ (2015) Canada	Examination for the occurrence of modifiable risk factors associated with chronic disease among young people in the COMPASS Study.	To examine the prevalence of risk factors for cancer and how demographic and social factors are associated with the occurrence of risk factors among young people in the COMPASS Study.	Longitudinal study

it continues

biological issues also mentioned other risk factors for obesity during adolescence. Thus, Lin et al.¹⁵ mention the excessive consumption of animal and vegetable protein by obese youngsters.

Most of the adolescents studied by them were in Tanner stage 3 or 4, when the presence of the protein is essential for bone and muscle growth. However, the excess of additional protein intake

Chart 1. Synopsis of the data collected in the articles of the integrative review of 2007 to 2017, organized by authors, year of publication, place of study, title, objectives and type of study.

Number of the Article	Author, year of publication and study location	Title	Objectives	Outline of the study
A17	Guavamzadeh, Khalkhali, Alizadeh ³¹ (2013) Iran	TV viewing, irrespective of physical activity and obesogenic foods increase overweight and obesity among adolescents.	To estimate the prevalence of overweight and obesity and associated risk factors in a representative sample of students aged 11 to 20 years.	Cross-sectional study
A18	Crinall et al. ³⁵ (2017) Australia	Risk of cardiovascular disease among young Indigenous Australians: a current snapshot of preventive healthcare.	To examine preventive healthcare and registration of type 2 diabetes and risk factors for cardiovascular disease, and management thereof, in young Aboriginal and Torres Strait Islanders (Indigenous Australians) in primary healthcare centers (PHCs).	Cohort study
A19	Verstraeten et al. ³³ (2016) Equador	Individual and environmental factors influencing the eating behavior of low- and middle-income adolescents.	To test the validity of a conceptual structure.	Cross-sectional study
A20	Ricci-Cabello et al. ³⁶ (2015) England	Impact of the prevalence of concordant and discordant conditions on the quality of care for diabetes in family practices in England.	To examine the association between the prevalence of diabetes-concordant and diabetes-discordant conditions and the quality of treatment of this problem at the level of family practice in England.	Cross-sectional study
A21	Dong et al. ¹⁶ (2015) China	Associations between adiposity indicators and high blood pressure among Chinese children and adolescents.	To evaluate the prevalence of the increase of blood pressure using sex/age and the risk attributable to overweight and obesity in Chinese children between 7 and 17 years of age.	Stratified multistage sampling study
A22	Ortega et al. ²⁴ (2013) Italy, Switzerland, Estonia and Spain	Objectively measured physical activity and sedentary time during childhood, adolescence and youth: a cohort study.	To study changes in objective measures (accelerometry), moderate to vigorous physical activity and sedentary time from childhood to adolescence and from adolescence to young adulthood.	Longitudinal cohort study
A23	Gulati et al. ³⁴ (2013) India	Dietary intake and related family issues of overweight/ obesity: a study of four cities in India.	To evaluate knowledge, attitude and practice of nutrition, physical activity, and other lifestyles, in a nationally representative sample of urban mothers and children in India.	Cross-sectional study
A24	Nianogo et al. ³⁹ (2016) USA	Associations between self-perception of weight, food choice intentions and consumer response to calorie information: a retrospective investigation of public health center customers in Los Angeles County prior to the implementation of labeling regulations on menus.	To examine self-perceived associations of weight (measured by body weight) with food choice intentions and consumer response to calorie information among low-income adults during the era of menu-labelling regulation.	Cross-sectional study
A25	Dong et al. ¹⁷ (2015) China	Risk of high blood pressure in overweight and obese Chinese children.	To estimate the contribution of overweight and obesity associated with high blood pressure in Chinese children.	Stratified multistage sampling study

Source: Authors' elaboration.

represents a risk factor for the development of chronic diseases, one of which being obesity.

One of the consequences of increased body weight is a change in blood pressure. This mechanism occurs because the adipocyte is a cell that has currently been associated with the production of several mediators that can participate as pathophysiological mechanisms of systemic arterial hypertension (SAH) associated with obesity⁴⁴.

The studies by Dong et al.¹⁶ and Dong et al.¹⁷ associated obesity as a risk factor in the prevalence of SAH. The body mass index (BMI) was considered the best parameter to calculate overweight/obesity in the assessment of altered blood pressure among children and adolescents. BMI was also used in the study by Martinez, Ruelas and Granger¹⁸ showing that obese young people with increased BMI have altered uric acid rates and this is an indication of CNCD. In Brazil, the monitoring of children and adolescents is based on the graph of height versus age and BMI versus age, both present in the Adolescent Record (*Caderneta do Adolescente*)⁴⁵.

Leatherdale¹⁹ analyzed the prevalence of modifiable risk factors that are associated with cancer. He stressed in his study that of the total of adolescents analyzed, 6.2% were obese, 13.8% were overweight, 53.1% were classified as physically inactive, 96.7% were highly sedentary and 95.1% were not eating in a healthy manner. The author associated these habits with the risk of cancer in the future. Weight control, healthy habits and attitudes are important for the prevention of obesity and, consequently, other CNCDs.

Children and adolescents with obesity have a higher risk of developing chronic diseases such as heart disease, stroke, SAH, dyslipidemia, diabetes mellitus (DM), atherosclerosis, among others⁴⁶. These diseases are diagnosed in adults, but nowadays they have been increasingly diagnosed in children and adolescents.

With respect to the data presented in this first category, the WHO alert⁴⁷ is pertinent as, without disregarding the data, it recommends caution in the anthropometric analysis of adolescents, in the light of the major bodily and hormonal changes they experience, making it difficult to establish a definitive diagnosis of obesity at this stage of life.

Social factors involved in adolescent obesity

This category includes health problems related to the conditions in which a person lives and works. In other words, it involves social, econom-

ic, cultural, ethnic/racial, gender and psychological factors⁴⁸.

The authors Song et al.²⁰ and Ekta et al.²¹ established that the prevalence of obesity is higher among male adolescents. The disparity between the sexes is associated with the attitude regarding the body image of men – of Oriental men in the case mentioned by the author – for whom obesity is not considered to be prejudicial to health. However, it is a well-known fact that, in general, the difference in the prevalence of obesity in male and female adolescents can be influenced by ethnicity and can be explained by the sex chromosome or by the specific effects of the gonadal hormones⁴⁹.

The study by Singh, Yu and Kogan²² highlighted the fact that the risk behaviors of immigrant adolescents in the USA vary according to their ethnicity, culture and length of time of immigrant status. Individuals with higher sedentary lifestyle levels are more susceptible than those born in the area. The authors note, however, that with each generation there is a decrease in the rate of physical inactivity among adolescent immigrants.

Ichihō, Robles and Aitaoto²³ reported that the main causes of mortality from heart disease, stroke and cancer are associated with high rates of overweight and obesity. In the 15-year-old age group, overweight and obesity increased dramatically. There was an increase in hours spent by adolescents watching TV and, consequently, a decrease in attendance at physical education classes.

The study by Ortega et al.²⁴ corroborates with that of Ichihō, Robles and Aitaoto²³ by revealing that moderate to vigorous physical activity decreases between childhood and adolescence. A sedentary lifestyle tends to increase in this transition, as does the risk of developing obesity and other chronic diseases. Therefore, the encouragement of the school and family members is important for adolescents to become interested in the practice of physical exercise, making it pleasurable and beneficial to their health.

The studies by Ichihō et al.²⁵⁻²⁹ conducted in the Oceanian countries (American Samoa, Marshall Islands, Palau and Micronesia) show that, there as here, the risk factors associated with overweight and obesity include unhealthy eating habits, physical inactivity and the presence of illness and deaths from CNCD.

The studies by Mbowe et al.³⁰ and Ghavamzadeh, Khalkhali, Alizade³¹ include the school-age community. The authors stress that the mothers' educational level, the type of school and the

time spent watching TV are associated with the increase in overweight and obesity, as well as the intake of obesogenic foods and the lack of physical activities. An outcome that caused consternation in this analysis is the fact that obesity rates decreased by up to 32%, when there was an additional child in the household in a study conducted in Guatemala, where the human development index (HDI) was 0.616 in 2013 and where there is evidence of food insecurity within the family environment⁵⁰. This outcome is undoubtedly related to the socioeconomic conditions of the youths and their families.

Patel et al.³², Verstraeten et al.³³ and Gulati et al.³⁴ assert that the obesity situation of parents is reflected in the obesity of their children. The eating behavior of adolescents is part of a complex interaction with their cultural environment, and eating habits represent a long-term routine. Environmental factors are related to parental permissiveness in the choice and preference for food on the part of adolescents.

One of the problems addressed by Crinall et al.³⁵ is obesity and the clinical situation of young indigenous people in Australia regarding type 2 DM. The authors listed risk factors for CNCs, including obesity, and draw attention to interventions in culture that provoke diseases and underscore the importance of preventive actions aimed at social life and health.

The care provided by health services must be based on the receptivity of the user with a view to resolving problems. On the same lines as those pointed out by Crinall et al.³⁵, Ricci-Cabello et al.³⁶ call for attention to be given to the care of adolescents with CNC, including obesity. Individuals with comorbidity usually seek out the health services more frequently and are more likely to have their needs attended to. These services must be prepared to offer a welcoming and effective service.

The study by Passmore et al.³⁷ was carried out with aborigines (indigenous Australians) using a methodology called 'Challenge.' They developed a method that leads to weight loss and encourages physical activity and good nutrition. The set of actions helped adolescents to improve their health conditions and thus reduce obesity and the risk of other CNCs.

In Brazil, there is also a National Program of Healthcare for the Indigenous Population⁵⁰. However, there is little information about the relationship between health and nutrition in this group, especially in the case of adolescents. This lack of information makes it difficult to assess

cases of obesity in this population segment. Castro et al.⁵¹, for example, compared the results of their studies with non-indigenous Brazilian adolescents with surveys carried out with indigenous people. They concluded that the anthropometric measurements associated with overweight and obesity in the latter group are similar or higher, revealing the importance of monitoring young indigenous people. And Sá⁵² calls attention to several ailments that are occurring in this group, particularly endocrine, nutritional and metabolic illnesses, frequently resulting from obesity.

Nutritional aspects of adolescent obesity

In this category, two articles were analyzed. The first article addressed questions about both the consumption of foods high in calories and sodium and low in nutrients, as well as ultra-processed foods. This study was carried out in schools included in the National School Meals Program, through a periodic survey by the Center for Disease Control (CDC – USA). The second article studied the self-perception of adolescents related to weight and the labels of foods that are consumed. This study was conducted by the Los Angeles Department of Public Health (USA) with low-income adolescents and adults.

Merlo et al.³⁸ conducted a survey to examine schools with respect to practices stipulated by nutritional standards. The data collected through a national survey conducted in 2000, 2006 and 2014 by the CDC in the U.S. were analyzed regarding the quality of the food offered to adolescents, such as: fruits, vegetables, whole grains and sodium. The results showed that over time the supply of foods with low sodium content, substitution of salt for other seasoning, increased consumption of vegetables, whole grains and fruit supply increased over the course of 10 years. However, most teenagers in the U.S. do not abide by national recommendations for a healthy diet, with the risk of weight gain, obesity, diabetes and other illnesses. Approximately 90% of U.S. children and adolescents consume more sodium than recommended.

This study draws attention to the Brazilian Government initiative, which regulated the National School Meals Program (PNAE) in 2009 by means of Law No. 11,947⁵³. This Law was created to ensure that public school canteens offer healthy meals that meet the nutritional needs of the students, educating them to adopt healthy habits⁵³. In other words, the Brazilian initiative regarding the consumption of healthy foods,

when examined from the study by Merlo *et al.*³⁸, is ahead of its time, since it was published six years before the article. It was a government proposal to invest in the promotion of health in the school environment.

School are venues with the potential for working on issues of collective interest within the educational perspective. For this reason, the National Curriculum Parameters of Brazil propose that cross-sectional themes, such as health, be contemplated with the same relevance as conventional areas of teaching⁵⁴. Until the present time, the approach evaluated has considered the consumption of healthy foods from the institutional perspective. The following study broadened the outlook of the population.

Nianogo *et al.*³⁹ carried out a study with the objective of analyzing associations of self-perceived body weight with food choice intentions and consumer response to caloric information. The results showed that the self-perception of weight does not seem to be associated with the habit of reading food labels in order to obtain information regarding calories. For adolescents, knowledge about the nutritional composition of food is important such that this group can make safe choices for their own health.

In both studies, the authors were concerned with macro- and micro-situations with respect to food and obesity, be it in the quality of food, in government strategies and in the choice of individuals regarding food consumption. Therefore, in order to think about preventive actions, access, quality of care, lifestyle, choice, among others, it is necessary to reflect upon the conditions that lead individuals to obesity. The geo-economic issue is a limiting factor in access to food from a global standpoint. Due to living in poverty, the most socially vulnerable people choose to buy and consume products that are cheap and, therefore, have high levels of fat, sugar and salt⁵⁵, which results in an increase in obesity with worldwide undernourishment or malnutrition.

In the surveys reviewed here, it is clear that the dietary patterns of adolescents are influenced by the food manufacturers, with advertisements encouraging the consumption of processed foods high in fat and sugar, which have a special appeal among poor families and communities.

The analysis of the studies elicits a reflection on the context of the changes that most impact the lives of adolescents who are experiencing physical, psychological and social transformations, marked in particular, by the progressive emancipation from family and school.

The study made it possible to answer the research question on the risk factors that impact the development of obesity in adolescence: the geo-economic question of food processing companies; change in blood pressure; higher prevalence in males in cultures where men's body mass is perceived as the image of health; increased sedentary lifestyle among immigrants; increase in hours spent by adolescents in front of TV screens, computers and on social media to the detriment of the possibilities for physical activities; decreased attendance at physical education classes; the educational level of the mothers; the impact of obese parents on their children's obesity; excessive consumption of calorie- and sodium-rich foods, low in nutrients, and ultra-processed foods, and self-perception of own weight. These risk factors also increase the chances of the development of other CNCs.

The analysis of the articles was based on the GRADE (Grading of Recommendations Assessment, Development and Evaluation) to gauge the quality of the evidence and the strength of the recommendations. It is observed that given the variability of the results of the studies analyzed and the locations where the empirical research was conducted, the study does not provide precise evidence¹⁴. However, some generalization of knowledge about risk factors is possible and enables the formulation of some proposals for action such as: helping young people to cultivate balanced eating habits at school by teaching them to avoid ultra-processed foods; encouraging the practice of physical exercise; warning about the risk of excessive use of computers, TV and social media. The situation of obesity is complex and multifactorial, and it is necessary to monitor families and adolescents by strengthening the relationship between school and the Basic Health Unit in order to develop health actions by meeting the repressed demand with multiprofessionals, home visits and food re-education programs.

Conclusion

Adolescent obesity is a public health problem that affects not only physical growth and development, but also has an impact on social and emotional issues and experiences in stigmatizing situations. The study showed that obesity in adolescence is associated with pre-existing factors that promote the surge in weight gain, which are predominantly biological, social, and nutritional. In general, each of them has a different impact

depending on the circumstances, but they act in an interrelated and complex way, hence the difficulty of isolating one single associated factor.

One of the limitations of this review is the impossibility of defining the predominant factors given the variability of geography, culture and focus of the themes analyzed. This makes it difficult to make possible recommendations for the problem raised. However, based on the risk

factors that were examined in the studies, it is possible to say that young people can be protagonists in the transformation of their situation and, often, of their family, to the extent that they become aware of the issues involved in obesity and become multipliers of that knowledge. In this respect, the school and the Basic Health Units have a fundamental and incomparable role.

Collaborators

SC Neves, LM Rodrigues and PAS São Bento participated in the concept and design of the study. SC Neves, LM Rodrigues, PAS São Bento and MCS Minayo participated in the analysis and interpretation of the data. SC Neves, LM Rodrigues, PAS São Bento and MCS Minayo participated in the drafting and critical review of the article. MCS Minayo participated in the final version and approval of the manuscript.

References

1. Brasil. Ministério da Saúde (MS). *A saúde de adolescentes e jovens: uma metodologia de auto-aprendizagem para equipes de atenção básica de saúde*. Brasília: MS; 2012.
2. Brasil. Instituto Brasileiro de Geografia e Estatística (IBGE). *Sinopse do Censo Demográfico 2010*. Rio de Janeiro: IBGE; 2011. [acessado 2017 Maio 8]. Disponível em: http://www.ibge.gov.br/home/estatistica/populacao/censo2010/sinopse/default_sinopse.shtml
3. Viero VSF, Farias JM. Educational actions for awareness of a healthier lifestyle in adolescents. *J Phys Educ* 2017; 28:e2812.
4. Brasil. Ministério da Saúde (MS). Secretaria de Vigilância em Saúde. Departamento de Análise de Situação de Saúde. *Plano de ações estratégicas para a saúde do adolescente*. Brasília: MS; 2017.
5. FUNDAÇÃO ABRINQ. *Cenário da infância e adolescência no Brasil 2018*. [acessado 2019 Julho 2]. Disponível em: https://observatorio3setor.org.br/wp-content/uploads/2018/04/cenario_da_infancia_2018_internet.pdf
6. Organização Pan-Americana da Saúde Brasil (OPAS). *Obesidade entre crianças e adolescentes aumentou dez vezes em quatro décadas, revela novo estudo do Imperial College London e da OMS*; 2017. [acessado 2018 Abril 4]. Disponível em: http://www.paho.org/bra/index.php?option=com_content&view=article&id=5527:obesidade-entre-criancas-e-adolescentes-aumentou-dez-vezes-em-quatro-decadas-revela-novo-estudo-do-imperial-college-london-e-da-oms&Itemid=820
7. Organização Pan-Americana da Saúde (OPAS). *Cuidados inovadores para condições crônicas: organização e prestação de atenção de alta qualidade às doenças crônicas não transmissíveis nas Américas*. Washington, DC: OPAS; 2015. [acessado em 2018 Abril 4]. Disponível em: <https://www.paho.org/hq/dmdocuments/2015/ent-cuidados-inovadores-InnovateCCC-digital-PT.pdf>
8. Jager ME, Batista FA, Perrone CM, Santos SS, Dias ACG. O adolescente no contexto da saúde pública brasileira: reflexões sobre o PROSAD. *Psicol Estud* 2014; 19(2):211-221.
9. Oliveira MM, Campos MO, Andreazzi MAR, Malta DC. Características da Pesquisa Nacional de Saúde do Escolar – PeNSE. *Epidemiol Serv Saude* 2017; 26(3):605-616.
10. Soares CB, Hoga LAK, Peduzzi M, Sangaleti C, Yonekura T, Silva D. Revisão integrativa: conceitos e métodos utilizados na enfermagem. *Rev Esc Enferm USP* 2014; 48(2):335-345.
11. Oliveira WA, Silva JL, Sampaio JMC, Silva MAI. Saúde do escolar: uma revisão integrativa sobre família e bullying. *Cien Saude Colet* 2017; 22(5):1553-1564.
12. Santos CMC, Pimenta CAM, Nobre MRC. A estratégia PICO para a construção da pergunta de pesquisa e busca de evidências. *Rev Latino-am Enferm* 2007; 15(3):508-511.
13. Methley AM, Campbell S, Chew-Graham C, McNally R, Cheraghi-Sohi S. PICO, PICOS and SPIDER: a comparison study of specificity and sensitivity in three search tools for qualitative systematic reviews. *BMC Health Serv Res* 2014; 14:579.
14. Brasil. Ministério da Saúde (MS). Secretaria de Ciência, Tecnologia e Insumos Estratégicos. Departamento de Ciência e Tecnologia. *Diretrizes metodológicas: Sistema GRADE – Manual de graduação da qualidade da evidência e força de recomendação para tomada de decisão em saúde*. Brasília: MS; 2014.
15. LinY, Mouratidou T, Vereecken C, Kersting M, Bolca S, Moraes ACF, Cuenca-García M, Moreno LA, González-Gross M, Valtueña J, Labayen I, Grammatikaki E, Hallstrom L, Leclercq C, Ferrari M, Gottrand F, Beghin L, Manios Y, Ottevaere1 C, Van Oyen H, Molnar D, Kafatos A, Widhalm K, Gómez-Martinez S, Prieto LED, De Henauw S, Huybrechts I. *Nutrition Journal* 2015, 14(1):10-21.
16. Dong B, Wang Z, Wang HJ, Ma J. Population attributable risk of overweight and obesity for high blood pressure in Chinese children. *Blood Press* 2015; 24(1):230-36.
17. Dong B, Wang Z, Wang HJ, Ma J. Associations between adiposity indicators and elevated blood pressure among Chinese children and adolescents. *J Hum Hypertens* 2015; 29:236-240.
18. Martínez AD, Ruelas L, Granger DA. Association between body mass index and salivary uric acid among Mexican-origin infants, youth and adults: gender and developmental differences. *Dev Psychobiol* 2017; 59(2):225-234.
19. Leatherdale ST. An examination of the co-occurrence of modifiable risk factors associated with chronic disease among youth in the COMPASS study. *Cancer causes control* 2015; 26(4):519-528.
20. Song Y, Wang HJ, Ma J, Wang Z. Secular trends of obesity prevalence in urban Chinese children from 1985 to 2010: gender disparity. *PLoS One* 2013; 8(1):e53069.
21. Ekta G, Tulika MG. Risk factor distribution for cardiovascular diseases among high school boys and girls of urban Dibrugarh, Assam. *J Family Med Prim Care* 2016; 5(1):108-113.
22. Singh GK, Yu SM, Kogan, MD. Health, chronic conditions, and behavioral risk disparities among U.S. immigrant children and adolescents. *Public Health Rep* 2013; 128(1):463-479.
23. Ichiho HM, Robles B, Aitaoto N. An assessment of non-communicable diseases, diabetes, and related risk factors in the Commonwealth of the Northern Mariana Islands: a systems perspective. *Hawaii J Med Public Health* 2013; 72(5 Suppl. 1):19-29.
24. Ortega FB, Konstabel K, Pasquali E, Ruiz JR, Hurtig-Wennlo A, Maestu J, Lof M, Harro J, Bellocco R, Labayen I, Veidebaum T, Sjostrom M. Objectively measured physical activity and sedentary time during childhood, adolescence and young adulthood: a cohort study. *PLoS One* 2013; 8(4):e60871.
25. Ichiho HM, DeBrum I, Kedi S, Langidrik J, Aitaoto N. An assessment of non-communicable diseases, diabetes, and related risk factors in the Republic of the Marshall Islands, Majuro Atoll: a systems perspective. *Hawaii J Med Public Health* 2013; 72(5 Suppl. 1):87-97.

26. Ichihō HM, Anson R, Keller E, Lippwe K, Aitaoto N. An assessment of non-communicable diseases, diabetes, and related risk factors in the federated states of Micronesia, State of Pohnpei: a systems perspective. *Hawaii J Med Public Health* 2013; 72(5 Suppl. 1):49-56.
27. Ichihō HM, Seremai J, Trinidad R, Paul I, Langidrik J, Aitaoto N. An assessment of non-communicable diseases, diabetes and related risk factors in the Republic of the Marshall Islands, Kwajalein Atoll, Ebeye Island: a systems perspective. *Hawaii J Med Public Health* 2013; 72(5 Suppl. 1):77-86.
28. Ichihō HM, Roby FT, Ponausuia ES, Aitaoto N. An assessment of non-communicable diseases, diabetes, and related risk factors in the territory of American Samoa: a systems perspective. *Hawaii J Med Public Health* 2013; 72(5 Suppl. 1):10-18.
29. Ichihō HM, Demei Y, Kuartei S, Aitaoto N. An assessment of non-communicable diseases, diabetes, and related risk factors in the republic of Palau: a systems perspective. *Hawaii J Med Public Health* 2013; 72(5 Suppl. 1):98-105.
30. Mbowe O, Diaz A, Wallace J, Mazariegos M, Jolly P. Prevalence of metabolic syndrome and associated cardiovascular risk factors in Guatemalan school children. *Matern Child Health J* 2014; 18(7):1619-1627.
31. Ghavamzadeh S, Khalkhali HR, Alizadeh M. TV viewing, independent of physical activity and obesogenic foods, increases overweight and obesity in adolescents. *J Health Popul Nutr* 2013; 31(3):334-342.
32. Patel SA, Dhillion PK, Kondal D, Jeemon P, Kahol K, Manimunda SP, Purty AJ, Deshpande A, Negi PC, Ladhani S, Toteja GS, Patel V, Prabhakaran D. Chronic disease concordance within Indian households: a cross-sectional study. *PLoS Med* 2017; 14(9):e1002395.
33. Verstraeten R, Leroy JL, Pieniak Z, Ochoa-Avilès A, Holdsworth M, Verbeke W, Maes L, Kolsteren P. Individual and environmental factors influencing adolescents' dietary behavior in low- and middle-income settings. *PLoS One* 2016; 11(7):e0157744.
34. Gulati S, Misra A, Colles SL, Kondal D, Gupta N, Goel K, Bansal S, Mishra M, Madkaikar V, Bhardwaj S. Dietary intakes and familial correlates of overweight/obesity: a four-cities study in India. *Ann Nutr Metab* 2013; 62(4):279-290.
35. Crinall B, Boyle J, Gibson-Helm M, Esler D, Larkins S, Baillie R. Cardiovascular disease risk in young Indigenous Australians: a snapshot of current preventive health care. *Aust N Z J Public Health* 2017; 41(5):460-466.
36. Ricci-Cabello I, Stevens S, Kontopantelis E, Dalton ARH, Griffiths RI, Campbell JL, Doran T, Valderas JM. Impact of the prevalence of concordant and discordant conditions on the quality of diabetes care in family practices in England. *Ann Fam Med* 2015; 13(6):514-522.
37. Passmore E, Shepherd B, Milat A, Maher L, Hennessey K, Havrlant R, Maxwell M, Hodge W, Christian F, Richards J, Mitchel J. The impact of a community-led program promoting weight loss and healthy living in Aboriginal communities: the New South Wales Knockout Health Challenge. *BMC Public Health* 2017; 17(1):951-960.
38. Merlo C, Brenner N, Kann L, McManus T, Harris D, Mugavero K. School-level practices to increase availability of fruits, vegetables, and whole grains, and reduce sodium in school meals – United States, 2000, 2006, and 2014. *MMWR Morb Mortal Wkly Rep* 2015; 64(33):905-908.
39. Nianogo RA, Kuo T, Smith LV, Arah OA. Associations between self-perception of weight, food choice intentions, and consumer response to calorie information: a retrospective investigation of public health center clients in Los Angeles County before the implementation of menu labeling regulation. *BMC Public Health* 2016; 16:60-69.
40. Coutinho W. *Etiologia da obesidade* [informativo]. Ano VII – n. 30, maio de 2007.
41. Snyder EE, Walts B, Perusse L, Chagnon IC, Weisnagel SJ, Rankinen T, Bouchard C. The human obesity gene map: the 2003 update. *Obes Res* 2004; 12(3):369-439.
42. Clément K, Ferré P. Genetics and the pathophysiology of obesity. *Pediatr Res* 2003; 53(5):721-725.
43. Casanello P, Krause BJ, Castro-Rodríguez JA, Uauy R. Epigenética y obesidad. *Rev Chil Pediatr* 2016; 87(5):335-342.
44. Barroso SG, Abreu VG, Francischetti EA. A participação do tecido adiposo visceral na gênese da hipertensão e doença cardiovascular aterogênica. Um conceito emergente. *Arq Bras Cardiol* 2002; 78(6):618-630.
45. Brasil. Ministério da Saúde (MS). *Caderneta do adolescente*. 2ed. 1ª reimp. Brasília: MS, 2012. [acessado em 2019 Ago 23]. Disponível em: <http://www.saude.gov.br/saude-para-voce/saude-do-adolescente-e-do-jovem/caderneta-do-adolescente>
46. Turke KC, Saraiva DJB, Lantieri CJB, Ferreira JFM, Chagas ACP. Fatores de risco cardiovascular: o diagnóstico e prevenção devem iniciar nas crianças e adolescentes. *Rev Soc Cardiol Estado de São Paulo* 2019; 29(1):25-27.
47. World Health Organization (WHO). *Physical Status: the use and interpretation of antropometry* [report]; 1995. [acessado em 2019 Jan 14]. Disponível em: https://apps.who.int/iris/bitstream/handle/10665/37003/WHO_TRS_854.pdf;jsessionid=9DF7E67E5DC036C3AC65F98B89D8081E?sequence=1
48. World Health Organization (WHO). *World conference on social determinants of health* [report]; 2011. [acessado em 2019 Jan 14]. Disponível em: https://www.who.int/sdhconference/resources/Conference_Report.pdf
49. Wisniewski AB, Chernausk SD. Gender in childhood obesity: family environment, hormones, and genes. *Gen Med* 2009; 6(1):76-85.
50. Organização Pan-americana de Saúde (OPAS). *Desigualdade exacerba fome, desnutrição e obesidade na América Latina e no Caribe* [editorial]. [acessado em 2019 Apr 02]. Disponível em: https://www.paho.org/bra/index.php?option=com_content&view=article&id=5799:desigualdade-exacerba-fome-desnutricao-e-obesidade-na-america-latina-e-no-caribe&Itemid=839
51. Castro TG, Barufaldi LA, Schlüssel MM, Conde WL, Leite MS, Schuch I. Waist circumference and waist circumference to height ratios of Kaingáng indigenous adolescents from the State of Rio Grande do Sul, Brazil. *Cad Saude Publica* 2012; 28(11):2053-2062.

52. Sá RAR. *Avaliação do risco de doenças cardiovasculares em indígenas Krenak do estado de Minas Gerais* [dissertação]. Belo Horizonte: Universidade Federal de Minas Gerais; 2018.
53. Brasil. Lei nº 11.947, de 16 de junho de 2009. Dispõe sobre o atendimento da alimentação escolar e do Programa Dinheiro Direto na Escola aos alunos da educação básica. *Diário Oficial da União* 2009; 16 jun.
54. Copetti J, Folmer V. *Educação e saúde no contexto escolar*. Uruguaiana: Universidade Federal do Pampa; 2015.
55. Organização Pan-Americana de Saúde (OPAS). *Obesidade entre crianças e adolescentes aumentou dez vezes em quatro décadas, revela novo estudo do Imperial College London e da OMS* [editorial]. [acessado em 2019 Apr 20]. Disponível em: https://www.paho.org/bra/index.php?option=com_content&view=article&id=5527:obesidade-entre-criancas-e-adolescentes-aumentou-dez-vezes-em-quatro-decadas-revela-novo-estudo-do-imperial-college-london-e-da-oms&Itemid=820

Article submitted 19/10/2019

Approved 02/03/2020

Final version submitted 04/03/2020

Chief editors: Romeu Gomes, Antônio Augusto Moura da Silva