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Prevalence of overweight and obesity in Brazilian children and adolescents: a systematic review

Prevalência de sobrepeso e obesidade em crianças e adolescentes brasileiros: uma revisão sistemática

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Abstract – It is important to know about overweight and obesity situation of Brazilian children and adolescents. The present study aims to update scientific production, through a systematic review, on the prevalence and factors associated with overweight and obesity in Brazilian children and adolescents. Nine databases were verified, and 1,316 references were examined from 2018 to 2019. The electronic search was conducted by three independent researchers. All review steps followed a strategy based on PRISMA. 40 studies were included in this systematic review. Most studies use the World Health Organization classification criteria. The prevalence of overweight in Brazilian children and adolescents varies from 8.8% to 22.2% (boys: 6.2% to 21%; girls: 6.9% to 27.6%). The prevalence of obesity varied from 3.8% to 24% (boys: 2.4% to 28.9%; girls: 1.6% to 19.4%). It was observed that the socioeconomic factors (sex, skin color, economic level, region, mother's educational level, living in a rented house and without access to the internet), hereditary/genetic (family history of dyslipidemia and overweight and rs9939609 genotype) and behavioral (physical activity, screen time, eating habits, perceived body weight, health vulnerability, presence of a result close to home, alcoholic beverages, cigarette consumption) were associated with the outcome. It is concluded that the prevalence of overweight and obesity among Brazilian children and adolescents are worrisome and most of the factors associated with the outcomes are subject to change from the adoption of a healthy lifestyle.

Key words: Overweight; Obesity; Risk factors; Childhood; Adolescence; Brazil.

Resumo – *É importante conhecer a situação de sobrepeso e obesidade de crianças e adolescentes brasileiros. O presente estudo teve como objetivo atualizar a produção científica, por meio de uma revisão sistemática, sobre av prevalência e os fatores associados ao sobrepeso e à obesidade em crianças e adolescentes brasileiros. Nove bases de dados foram verificadas e 1.316 referências foram examinadas de 2018 a 2019. A busca eletrônica foi realizada por três pesquisadores independentes. Todas as etapas de revisão seguiram uma estratégia baseada no PRISMA. 40 estudos foram incluídos nesta revisão sistemática. A maioria dos estudos usou os critérios de classificação da Organização Mundial da Saúde. A prevalência de excesso de peso em crianças e adolescentes brasileiros variou de 8,8% a 22,2% (meninos: 6,2% a 21%; meninas: 6,9% a 27,6%). A prevalência de obesidade variou de 3,8% a 24% (meninos: 2,4% a 28,9%; meninas: 1,6% a 19,4%). Observou-se que os fatores socioeconômicos (sexo, cor da pele, nível econômico, região, escolaridade da mãe, morar em casa alugada e sem acesso à internet), hereditários/genéticos (histórico familiar de dislipidemia e excesso de peso e genótipo rs9939609) e comportamentais (atividade física, tempo de tela, hábitos alimentares, peso corporal percebido, vulnerabilidade à saúde, presença de resultado próximo a casa, bebida alcoólica, consumo de cigarro) estiveram associados ao desfecho. Conclui-se que as prevalências de sobrepeso e obesidade entre crianças e adolescentes brasileiros são preocupantes e a maioria dos fatores associados aos desfechos está sujeita a mudanças a partir da adoção de um estilo de vida saudável.*

Palavras-chave: *Sobrepeso; Obesidade; Fatores de risco; Infância; Adolescência; Brasil.*

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INTRODUCTION

Overweight and obesity have been presented as one of the biggest problem public health face worldwide, mainly due to the increase in their prevalence observed in recent years in different age groups[1]. In children and adolescents (5 to 19 years old), from 1975 to 2016, an increase of more than four times (from 4% to 18%) was observed in the prevalence of obesity[1].

The global epidemic of obesity in childhood and adolescence remains one of the greatest global health challenges[1]. The obesity problem is not only related to excess body fat, but the relationship established between the highest levels of fat with metabolic and cardiovascular consequences (arterial hypertension, dyslipidemia, type 2 diabetes, atherosclerosis, metabolic syndrome)[2]. In addition to physical health, obesity also stands out, impacting psychological (low self-esteem, anxiety, depression, mood changes) and social (discrimination, prejudice, exclusion)[3].

The knowledge of the prevalence of overweight and obesity in children and adolescents, as well as the identification of the groups most exposed to this outcome are extremely relevant, because the earlier the interventions in these specific groups occur, the impact and the permanence of this condition in adulthood can be avoided or mitigated. Furthermore, it has been observed that the treatment of obesity in adulthood has been burdensome, and the problem becomes even more worrying since obese children are five times more likely to remain with this status in adulthood when compared to non-obese children[4].

In view of the above, updating information about the prevalence and the groups most exposed to overweight and obesity, in pediatric age, is necessary for planning prevention and treatment actions aimed at combating childhood and youth obesity. Therefore, the present study aimed to update scientific production, through a systematic review, on the prevalence and factors associated with overweight and obesity in Brazilian children and adolescents.

METHODS

This systematic review was prepared in accordance with the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA)[5] and was published in the OSF (DOI 10.17605/OSF.IO/SJGV9).

The searches were carried out on July 30, 2020, in the databases MEDLINE/Pubmed, Scopus, Web of Science, Virtual Health Library, SciELO, CINAHL/EBSCO, SPORTDiscus/EBSCO, PsycINFO/APA and Embase. All studies published in 2018 and 2019 were selected without language restriction. These databases were chosen because they include journals in the health field.

The terms used to elaborate the search key were consulted in the Medical Subject Headings (MeSH). The Boolean operators "OR" and "AND" were used to combine the terms, in English, (prevalence OR frequency) AND (obesity OR obese OR overweight) AND (children OR adolescent OR youth OR schoolchildren) AND (Brazil OR Brazilian). As an example of the searches, you can see the following key, used in the MEDLINE/Pubmed database: ((((prevalence) OR (frequency)) AND (((obesity) OR (obese)) OR (overweight))) AND ((((children) OR (adolescent)) OR (youth)) OR (schoolchildren))) AND ((Brazil) OR (Brazilian))).

The review included: a) articles published from April 1, 2018 to December 31, 2019, as the present study refers to an update of the findings of Simões et al.[6]; b) studies with a cross-sectional design; c) studies carried out with Brazilian children and adolescents (ages 7 to 19); d) published in Portuguese, English or Spanish; e) who used the body mass index as an anthropometric indicator to determine the status of body weight; f) studies in which the outcome was overweight and/or obesity; g) studies published in its full version. Studies were not included in which: a) overweight and obesity were treated as exposure factors; b) did not present the cutoff point used to classify overweight/obesity.

All stages of this review were conducted by three researchers, independently. Whenever they had any disagreement confronting the results of the reading steps, the opinion of a fourth expert researcher in the area was asked. After selecting the articles included in the review, the information on the author and year of publication were extracted, where the study was carried out, age range and sample size, cutoff point used to classify the status of body weight, prevalence of the outcome and associated factors. In the present study, we chose to present the prevalences and factors associated with overweight, obesity and overweight (defined as overweight + obesity), due to the different classifications used in the studies.

The National Institutes of Health's Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies[7] was used in order to assess the risk of bias in the studies included in the review. This tool is specific for cohort or cross-sectional studies and has 14 evaluation criteria, which were applied individually for each study. Each criterion can receive the answers "yes", "no", "not applicable" or "not reported". In order to classify the risk of bias, a sum of criteria was obtained that obtained a "yes" answer. Studies that scored 0 to 6 were classified as "high risk of bias", 7 to 8 "moderate" and 9 to 14 "low".

RESULTS

Searches of selected databases resulted in a total of 1,316 records. After excluding duplicates (n = 579), reading titles (n = 659), abstracts (n = 31) and full texts (n = 23), a total of 40 studies were considered eligible to make up the present systematic review (Figure 1).

The main characteristics of the studies included in this review are shown in Table 1. The total sample, considering all studies, was greater than 266,529 children and adolescents aged 7 to 19 (two studies with nationally representative data did not specify the final sample).

According to the regions, most of the studies were carried out in the Southeast (32.5%), followed by the South (25%), studies with nationwide data (17.5%), Northeast (15%), Center- West (5%), a study in the North region (2.5%) and one with data from 10 cities in four states (2.5%). Most studies (80%) used the criteria of the World Health Organization (WHO) to determine overweight/obesity, 12.5% used the cutoff points of the International Obesity Task Force (IOTF), 5% used the criteria of Centers of Disease Control and Prevention (CDC), and a study used the national cutoffs of Conde and Monteiro.

The supplementary file 1 (https://osf.io/4k5r8/) shows the risk of bias in the studies included in the systematic review. It was observed that 32.5% (n = 13) of the studies received the classification "good", 45% (n = 18) received the classification "reasonable" and 22.5% (n = 9) were classified as "bad".

The average prevalence of overweight was 13.7% in boys, 15.7% in girls and 17.5% in the total sample. The average prevalence of obesity was 9.9% in boys, 8.5% in girls and 11.7% in the total sample. The range of overweight prevalences ranged from 2.9% to 40.3%, with the general average of overweight prevalences equaling 26.1%. The average overweight in boys and girls did not differ (22.5%) (Table 1).

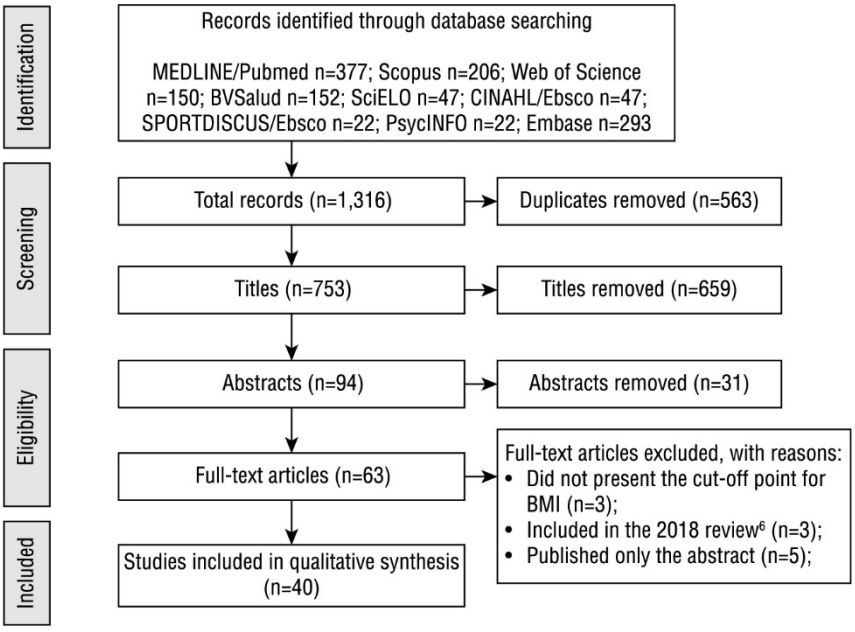

Figure 1. Flowchart diagram of studies selection.

Table 1. Characteristics of studies on the prevalence of overweight and obesity in Brazilian children and adolescents.

Author/year	Location	Sample	Age (years old)	Overweight (%)			Obesity (%)			Overweight (%)			Cutoff	Statistical analysis
				Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total		
Bezerra et al. (2018)[8]	Recife, PE	2400 (46.4% girls)	12 to 17	-	-	17.0	-	-	9.6	-	-	26.6	WHO	Poisson regression
Borges et al. (2018)[9]	Family Budget Research (POF- Brasil)	6784 (50.4% girls)	10 to 18	-	-	17.7	-	-	4.6	-	-	22.3	IOTF	Logistic regression
Chaput et al. (2018)[10]	São Paulo, SP	484 (51% girls)	09 to 11	-	-	-	-	-	21.7	-	-	-	WHO	-
Cnop et al. (2018)[11]	Rio de Janeiro, RJ	1749 (49.9% girls)	10 to 19	-	-	21.0	-	-	14.8	-	-	35.8	WHO	-
Conde et al. (2018)[12]	National School Health Survey (PeNSE-Brasil)									21.4	22.9	22.2	IOTF	-
Corrêa et al. (2018)[13]	Florianópolis, SC	2195 (47.8% girls)	07 to 14							37.6	29.0	33.5	WHO	Logistic regression
Cureau et al. (2018)[14]	Study of Cardiovascular Risks in Adolescents (ERICA-Brasil)	62063 (54.9% girls)	12 to 17									25.8	WHO	Poisson regression

WHO: World Health Organization; IOTF: International Obesity Task Force.

Table 1. Continued...

Author/year	Location	Sample	Age (years old)	Overweight (%)			Obesity (%)			Overweight (%)			Cutoff	Statistical analysis
				Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total		
Dumith et al. (2018)[15]	Caracol, PI	1075 (52.4% girls)	13 to 19	-	-	-	-	-	-	9.2	11.0	10.1	WHO	-
Fradkin et al. (2018)[16]	AM, CE, RS and SC	1738 (51% girls)		9.9	12.9	-	9.1	6.0	-	19.0	18.9	-	CDC	Logistic regression
Jardim et al. (2018)[17]	Goiânia, GO	1169 (53.1% girls)	12 to 17	-	-	-	-	-	-	29.0	18.2	23.3	WHO	-
Leal et al. (2018)[18]	Florianópolis, SC	1232 (49.3% girls)	07 to 10	-	-	-	-	-	-	-	-	34.4	WHO	Multilevel linear regression
Martini et al. (2020)[19]	Campinas, SP	822 (49.4% girls)	10 to 19	17.1	15.3	16.2	13.3	6.9	10.2	30.4	22.2	26.4	WHO	Chi-squared
Murphy et al. (2018)[20]	Brasil (ISAAC)	Nationally representative data	13 to 14	11.7	11.3	-	2.4	1.6	-	14.1	12.9	-	IOTF	-
Pereira et al. (2018)[21]	São Paulo, SP	822 (53% girls)	12 to 19	-	-	19.5	-	-	9.3	-	-	28.8	WHO	-
Pereira et al. (2018)[22]	São Paulo, SP	377	12 to 19	-	-	-	-	-	-	-	-	29.4	WHO	-
Previato and Behrens (2018)[23]	Minas Gerais	132 (51% girls)	15 to 19	7.7	13.4	10.6	9.3	6.0	7.6	17.0	19.4	18.2	WHO	-
Reuter et al. (2018)[24]	Santa Cruz do Sul, RS	381 (50.4% girls)	07 to 17	-	-	-	-	-	-	-	-	35.7	WHO	Poisson regression
Rossi et al. (2018)[25]	Florianópolis, SC	2484	07 to 14	-	-	-	-	-	-	21.5	12.7	34.2	WHO	Multivariate linear regression
Silva and Hasselmann (2018)[26]	Rio de Janeiro, RJ	1594 (56.2 girls)	13 to 19	-	-	-	-	-	-	16.5	18.6	17.7	WHO	Logistic regression
Silva Filho and Ybargollin (2019)[27]	Paraguaçu Paulista, SP	263 (44.1% girls)	10 to 15	19.7	27.6	-	9.5	15.5	-	29.2	43.1	-	Conde and Monteiro	-
Andrade et al. (2019)[28]	Salvador, BA	1496 (57.1% girls)	11 to 17	9.2	8.6	8.8	7.0	5.1	5.9	16.2	13.7	14.7	WHO	Chi-squared
Assis et al. (2019)[29]	Juiz de Fora, MG	661 (51.7% girls)	07 to 14	-	-	-	14.7	13.2	13.9	-	-	-	WHO	Logistic regression
Barbosa et al. (2019)[30]	Montes Claros, MG	635 (60.9% girls)	10 to 16	-	-	-	-	-	-	27.8	35.0	32.8	WHO	Poisson regression
Barbosa et al. (2019)[31]	Recife, PE	225 (56.4% girls)	10 to 19	15.3	24.4	20.4	13.3	18.1	16.0	28.6	42.5	36.4	WHO	Logistic regression
Dalmaso et al. (2019)[32]	Vitória, ES	572 (54.2% girls)	07 to 14	20.6	21.0	20.8	6.5	7.7	7.2	27.1	28.7	28.0	IOTF	-
Fávaro et al. (2019)[33]	Pesqueira, PE	139	07 to 09	-	-	-	-	-	-	-	-	2.9	WHO	-
Francesquet. (2019)[34]	Santa Cruz do Sul, RS	1243 (54.7% girls)	07 to 17	-	-	-	-	-	-	-	-	29.1	CDC	Logistic regression
Gonçalves et al. (2019)[35]	Brazil (ERICA)	73399 (49.8% girls)	12 to 17	-	-	-	9.1	7.6	8.4	-	-	-	WHO	Logistic regression
Guimarães et al. (2019)[36]	Curitiba, PR	997 (57% girls)	12 to 17	21.0	17.5	19.0	8.2	8.5	8.4	29.2	26.0	27.4	WHO	-
Lamarão et al. (2019)[37]	Macapá, AM	306 (48.7% girls)	10 to 19	6.2	6.9	-	2.6	3.6	-	8.8	10.5	-	WHO	Logistic regression
Leal et al. (2019)[38]	Brasil (PeNSE)	10926	13 to 17	-	-	-	-	-	-	23.7	23.8	23.7	WHO	Logistic regression
Li et al. (2019)[39]	São Paulo, SP	435 (51.5% girls)	09 to 11	-	-	-	-	-	21.8	-	-	-	WHO	Logistic regression
Neves et al. (2019)[40]	Juiz de Fora, MG	480 (57.5% girls)	14 to 19	-	-	18.6	-	-	9.5	-	-	28.1	WHO	-

WHO: World Health Organization; IOTF: International Obesity Task Force.

Table 1. Continued...

Author/year	Location	Sample	Age (years old)	Overweight (%)			Obesity (%)			Overweight (%)			Cutoff	Statistical analysis
				Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total		
Oliveira et al. (2019)[41]	Study of Cardiovascular Risks in Adolescents (ERICA-Brasil)	73624 (55.4% girls)	12 to 17	-	-	-	-	-	-	25.7	25.3	25.5	WHO	-
Pereira et al. (2019)[42]	Pelotas, RS	596 (48.2% girls)	07 to 08	-	-	-	28.9	19.4	24.0	-	-	-	WHO	Multiple linear regression
Rossi et al. (2019)[43]	Criciúma, Florianópolis, Joinville, Blumenau, Jaraguá do Sul, Lages, Chapecó and Joaçaba, SC	3930 (52% girls)	07 to 10	-	-	-	-	-	-	-	-	20.9	IOTF	Logistic regression
Rossi et al. (2019)[44]	Florianópolis, SC	2484 (56.5% girls)	07 to 14	-	-	21.5	-	-	12.7	-	-	34.2	WHO	Multivariate linear regression
Santos et al. (2019)[45]	Santa Catarina	6366	15 to 19	19.0	13.3	15.7	4.7	3.1	3.8	23.7	16.4	19.5	WHO	-
Santos et al. (2019)[46]	Hinterland and Agreste (dry region) of PE	179 (67% girls)	10 to 19	6.8	16.7	13.4	10.2	5.0	6.7	17.0	21.7	20.1	WHO	Poisson regression
Soria et al. (2019)[47]	Acreúna, GO	72	10 to 15	-	-	22.2	-	-	18.1	-	-	40.3	WHO	-

WHO: World Health Organization; IOTF: International Obesity Task Force.

Factors associated with overweight and obesity in Brazilian children and adolescents

Among the total of 40 studies included in the narrative synthesis, 23 investigated the factors associated with overweight and obesity in Brazilian children and adolescents (Table 2). For a better presentation of the results, we chose to group on socioeconomic, hereditary/genetic and behavioral factors.

Socioeconomic factors

The groups most exposed to overweight and obesity were male[13,16,19], black or indigenous[12,16], of low and high economic status[16] and residing in the South[12,16,38], Southeast[38] and North[16].

In addition, having a mother with complete or incomplete higher education[38], having a rented or rented house[46] and without internet access[31], being black or indigenous[12,16] increase the chances of children and adolescents being overweight /obesity. Additionally, post-pubertal adolescents[28] are also more likely to have the outcome.

Regarding age, divergent results were observed. Reuter et al.[24] found that adolescents aged 11 to 17 were more likely to be overweight/obese. On the other hand, Martini et al.[19] and Santos et al.[46] found that adolescents aged 10 to 14 were more exposed to overweight and obesity. Leal et al.[38], observed that the groups most exposed to excess weight were adolescents aged 13 to 15. Regarding income, it was observed that adolescents in the lowest fifths are

more likely to be overweight[12]. On the other hand, Assis et al.[29] found that the chances of overweight/obesity increased in the higher income groups.

Another divergent variable refers to the number of people living with the child/adolescent. Lamarão et al.[37] found that living at home with more than six people increases the chances of being overweight/obese. Diverging from these findings, Barbosa et al.[31] identified that living with less than four family members increases the chances of being overweight, while Leal et al.[38] revealed that living with more than 3 people reduces the chance of EW.

As for the area of residence, while Fradkin et al.[16] and Assis et al.[29] identified that children and adolescents who live in urban areas were less likely to be obese, Borges et al.[9] found that living in the urban area increases the chances of being overweight.

Hereditary/genetic factors

Having a family history of dyslipidemia[30], having a father with hypertension and having a father, mother and maternal grandmother with obesity increase the chances of children and adolescents being overweight/obese[18,24,25,34]. In addition, it was observed that adolescents with the rs9939609 genotype are more likely to be overweight/obese[34].

Behavioral Factors

Regarding behavioral factors, the studies included in this systematic review, in general, point out that physical inactivity/low levels of physical activity[14,39], high screen time[14,31], low fiber consumption[14], eating fad diets[37], inadequate diet[9,14,38], having perceived weight with overweight/obesity[31,46], presenting higher health vulnerability[29], having restaurants in the vicinity of the residence[13], consuming vegetables four days or more a week[38], consuming alcohol and cigarettes[14,37,46] increase the chances of overweight and obesity. Silva and Hasselmann[26], observed that girls who suffer physical aggression are less likely to be overweight.

Table 2. Factors associated with overweight and obesity in Brazilian children and adolescents.

Author/year	Associated factors
Borges et al. (2018)[9]	The greater adherence to the Snacks food pattern and the fast-food pattern increases the chances of EW.
Conde et al. (2018)[12]	Adolescents who declared themselves to be black or indigenous, from the south, from the urban area and from the lower fifths of income are more likely to be overweight.
Corrêa et al. (2018)[13]	Being male, using public markets/greengrocers and the presence of restaurants in the vicinity of the residence increase the chances of OW/OB.
Cureau et al. (2018)[14]	A higher lifestyle risk score (physical inactivity, high screen time, low fiber consumption, alcohol and tobacco consumption) increases the chances of OW/OB.
Fradkin et al. (2018)[16]	Boys were less likely to have OW and more likely to have OB.
	In relation to the region, in general, living in the south was associated with OB while in girls, living in the north was associated with OW.
	The high economic level was associated with overweight and obesity.
	In relation to population density, living in the urban region was associated with OW in general and in girls.
	Regarding race, black girls were more likely to have OB.

Note. EW: excess weight; BMI: body mass index; OW: overweight; OB: obesity

Table 2. Continued...

Author/year	Associated factors
Leal et al. (2018)[18]	Boys living in households with three or more people per room and those with a monthly family income between 2 and 5 minimum wages had a lower BMI z score. Having a higher frequency of daily intake of sweets was inversely associated with BMI. Having an obese mother and high birth weight were associated with a higher BMI.
	In girls, having a monthly family income below 2.5 minimum wages and an income between 5 and 10 minimum wages was negatively associated with BMI. Having an overweight and obese mother, having high birth weight and a higher frequency of eating sweets were positively associated with BMI.
Martini et al. (2018)[19]	Boys had a higher prevalence of OB and adolescents aged 10 to 14 had a higher prevalence of OW and OB.
Rossi et al. (2018)[25]	Low-income schoolchildren who live in intermediate distances and close to parks/playgrounds had lower BMI compared to schoolchildren who live far from these places.
	Low-income schoolchildren who live at intermediate distances from the beaches have a lower BMI compared to those who live farther away. Schoolchildren who live at intermediate distances and close to soccer fields have higher BMI values.
Reuter et al. (2018)[24]	OW/OB was less prevalent in adolescents aged 11 to 17.
	Having an obese maternal father and grandmother, being overweight at birth and having the genotype (rs9939609) increases the chances of OW/OB.
Silva and Hasselmann (2018)[26]	Girls who receive physical aggression are less likely to have EW.
Andrade et al. (2019)[28]	Post-pubertal adolescents had a higher prevalence of OW and OB.
Barbosa et al. (2019)[30]	Having a family history of dyslipidemia and alcohol intake increases the chances of EW.
Assis et al. (2019)[29]	The older you are, the less likely you are to have OB.
	Children and adolescents residing in urban areas were less likely to be obese.
	Adolescents with higher income tertiles and higher health vulnerability index were more likely to be obese.
Barbosa et al. (2019)[31]	Total sample: adolescents who rated themselves as "fat" had a higher prevalence of EW.
	Boys: not having access to the internet, having less than four family members, spending more than two hours a day in front of the screen on the weekend were factors that increased the likelihood of EW.
	Girls: having self-perceived weight in "normal" and "fat" increased the chances of having EW.
Francesquet et al. (2019)[34]	Having a father with hypertension, having a father and mother with OB increase the chances of having OW / OB.
Gonçalves et al. (2019)[35]	Adolescents who studied in schools that offered food were less likely to have OB compared to those who studied in schools that did not offer food.
Lamarão et al. (2019)[37]	Drinking alcohol, living at home with more than six people and making fashionable diets were positively associated with EW, while practicing physical activities was negatively associated with EW.
Leal et al. (2019)[38]	Living in the South and Southeast, being 13 to 15 years old, having a mother with complete or incomplete higher education, consuming vegetables more than four days a week and consuming sweets four days or less a week increase the chances of having EW.
	Living with more than 3 people reduces the chance of EW.
Li et al. (2019)[39]	Those with low MVPA levels during the week and during the weekend are more likely to have OB.
	Children with high levels of MVPA during the week and low at the weekend and those with low levels of MVPA during the week and at the weekend are more likely to OB.
Rossi et al. (2019)[43]	In public school students, having an obese father or an obese father and mother increases the chances of OW/OB.
	In private school students, having an obese father and consuming canteen snacks increases the chances of OW/OB.
Rossi et al. (2019)[44]	In low-income schoolchildren who live far from parks and playgrounds, they presented higher BMI values.
	Schoolchildren with high family income who live farther from soccer fields had lower BMI values.
Pereira et al. (2019)[42]	The greater the degree of difficulty in maintaining the biological rhythm, the greater the BMI.
Santos et al. (2019)[46]	Having a rented or rented house, light nutritional security, drinking alcohol, perceiving your weight with OW/OB and being in the 10 to 14 age group increase the chances of having EW.

Note. EW: excess weight; BMI: body mass index; OW: overweight; OB: obesity

DISCUSSION

The prevalence of overweight in Brazilian children and adolescents ranged from 8.8% to 22.2%. In boys, this variation was from 6.2% to 21% and in girls from 6.9% to 27.6%. In regard to obesity, the prevalence varied from 3.8% to

24% in the total sample, from 2.4% to 28.9% in boys and from 1.6% to 19.4% in girls. Such evidence should be interpreted with caution because, although most studies have used the WHO criteria[48] for the classification of nutritional status, some studies have used the cutoff points of the IOTF[49,50] and Conde and Monteiro[51]. Nevertheless, the prevalence of overweight and obesity in childhood and adolescence has been considered a cause of concern due to its relationship with cardiovascular, psychological, and social diseases[2,3]. In addition, overweight and obesity at these stages of life increase the likelihood that these conditions will persist into adulthood[4].

According to the results found in the present study, it was possible to identify that the groups most exposed to overweight/obesity are boys[13,16,19], black and indigenous[12,16] and of low[12] and high economic status[16,29]. In addition, those residing in the South[12,16,38], Southeast [38] and North[16] regions are the ones most likely to have the outcome. Still, children of mothers with complete or incomplete higher education[38], post-pubertal[28], who have a rented or rented house[46], and those who do not have access to the internet[31].

It was observed that boys are more susceptible to overweight and obesity than girls. One of the possible assumptions regarding this result may be due to the fact that girls are more concerned with their body appearance and dieting to keep their bodies slim[52], which consequently generates greater concern for the body and decreases the chances of overweight and obesity in adolescents. However, it should be noted that among adolescents on a diet the likelihood of being overweight and obese increases[37]. Thus, there still seems to be a divergence in the associations between overweight/obesity and diet.

In addition, it was observed that black and indigenous children and adolescents were the groups most exposed to overweight and obesity. It is believed that this predisposition may happen due to the stresses triggered as a result of ethnic discrimination[53]. Stress induces hormonal changes that can stimulate appetite and reduce satiety, contributing to an increase in body weight[54]. Despite this evidence, it should be noted that socioeconomic conditions and lifestyle habits may be the most relevant factors for differences in the prevalence of overweight and obesity than, in fact, skin color.

Regarding the economic level, it seems that, regardless of the economic level, overweight and obesity are present, although we still see evidence pointing out that children and adolescents with a high economic level are more likely to end up. This pattern can be attributed to access to consumer goods and services, which, in part, may be related to the consumption of more caloric foods, and also to greater contact with technological means, which favor less engagement in regular health practice of physical activities[55].

In this context, the higher prevalence of overweight and obesity observed in the most developed regions of the country (South and Southeast), can be explained by the higher purchasing power in relation to the other Brazilian regions[56]. These results may be linked to the higher average monthly household income, as observed by PNAD[56], in which in the Southeast region the monthly household income is R$ 1,720, while in the North and Northeast regions, monthly incomes are, respectively, R$ 872 and R$ 884. In other words, a higher income can influence the acquisition of foods, which are not always healthy, which can contribute to the increase in body weight.

Another group which is more exposed to overweight and obesity are children and adolescents whose mothers have a higher level of education. A higher level of

education may represent better socioeconomic conditions[57], which corroborates the associations between higher economic levels and obesity[58].

Also in this context, having a rented or rented house and not having access to the internet, seen as factors associated with being overweight, can be indicators of worse socioeconomic conditions. Adolescents who do not have access to the internet and who do not live in their own home may not have the same economic conditions as their peers, making it impossible to have access to better nutritional quality food and leisure activities, such as practicing formal sports[59,60].

It was found in this review that the post-pubertal stage was associated with overweight/obesity. This association is explained by the sexual maturation process, a period in which the peak of growth occurs, characterized by an increase in height and body weight, an accelerated increase in muscle mass in boys and in adipose tissue in girls[61]. Thus, it is assumed that the weight gain acquired during the entire maturation process has been maintained by these adolescents.

Having a family history of dyslipidemia[30], having a hypertensive father and having an obese father, mother and maternal grandmother increase the chances of overweight/obesity in childhood and adolescence[18,24,25,34]. In addition, it was observed that adolescents with the rs9939609 (FTO) genotype are more susceptible to overweight/obesity[34]. The home environment, especially family habits, significantly influences the formation of eating behaviors and physical activity in children and adolescents[62,63]. Confirming this, Todendi et al.[64] found that parents' weight contributes to their children's obesity.

Among the genetic polymorphisms of obesity, the FTO (rs9939609) was previously associated with obesity[64]. The FTO variant accelerates weight gain in childhood[65-67], once it plays an important role in energy metabolism and in the regulation of human body homeostasis[68].

In general, the studies included pointed out that physical inactivity/low levels of physical activity[14,39], high screen time[14,31], low fiber consumption[14], eating fad diets[37], food inadequate[9,14,38], having restaurants in the vicinity of the residence[13], consuming vegetables four or more days a week[38], having perceived weight with overweight/obesity[31,46], presenting health vulnerability more discharge[29] and consuming alcohol and cigarettes[14,37,46] increase the chances of being overweight.

The relationship between low levels of physical activity and excess weight has been strongly emphasized in the literature, as there is a tendency among individuals with insufficient levels of physical activity to be more predisposed to overweight/obesity. One of the possible justifications for such an association may be linked to excessive time in sedentary behavior[69] and, consequently, a greater intake of unhealthy foods[70].

The relationship between overweight/obesity and screen time can be explained by the increase in food consumption[71-73]. Nowadays children and adolescents have at their disposal a multitude of options for digital games on cheap or free platforms on a variety of devices, which lead these individuals to spend a long time in front of the screen[74]. Despite such evidence, a systematic review conducted by Kracht et al.[74] revealed that the association between obesity and the use of video games is inconclusive, mainly due to the scarcity of longitudinal studies that evaluated the direct contribution of gambling to weight gain in children.

With regard to the association between inadequate diet and overweight/obesity, it is highlighted that one of the main factors that can explain this relationship is related to the easy access, the practicality and the low cost of ultra-processed foods when compared to better nutritional quality foods[75,76].

A nationwide study revealed that there is an inverse relationship between the price of ultra-processed foods and obesity, highlighting that a 1% increase in the price of processed ultrasound would result in a reduction of 0.33% and 0.59% in the prevalence of overweight and obesity, respectively[77]. To improve this situation, it is up to government authorities to rethink the effectiveness of the numerous existing public policies, in addition to raising the awareness of those responsible for schoolchildren about the importance of a diet with nutritional quality, as children and adolescents normally do not have autonomy for food choices.

The evidence regarding the relationship between alcohol consumption and obesity is still conflicting. If there is no control over several other factors (which may be the main limitations of the studies), such as sex, frequency and quantity of alcohol intake, the type of drink ingested, physical activity, sleep, among others, the associations may be biased[78]. However, alcohol appears to be a risk factor in certain cases, especially if consumption is in excess[78].

In relation to smoking, associations with obesity are also controversial. Evidence suggests that smoking is related to increased abdominal fat[79], once smoking can increase insulin resistance, changing the distribution of body fat to the central region[80]. Nonetheless, the association observed in this study legitimates the findings by Chiolero et al.[81], who identified that as the number of cigarettes smoked per day increases, the chances of obesity are greater.

The association between perception of overweight/obesity and excess weight was confirmed by a systematic review that identified strong longitudinal evidence that perceiving being overweight was associated with greater weight gain or increased likelihood of developing overweight/obesity in the course of of time[82]. It is likely that these adolescents who perceive themselves to be overweight do not have effective attitudes to control their body weight and consequently continue with their weight above what is considered healthy.

The study by Corrêa et al.[13], included in the review, identified that having restaurants around the residence was associated with overweight/obesity, however, the use of these restaurants did not show any association. It is possible that, despite living close to restaurants, individuals choose to consume food from other establishments that have not been investigated, such as shopping centers, schools, friends' houses, or even the use of delivery applications[13]. In addition, in order to understand these associations, the local characteristics of the investigated municipality must be taken into account, such as the number and diversity of restaurants and tourist activity.

Regarding the association between a higher index of vulnerability to health and overweight, the evidence suggests that living in neighborhoods with greater social deprivation increases the chances of having inappropriate health behaviors[29]. In this scenario, it is assumed that in economically disadvantaged neighborhoods there are fewer opportunities for physical activity, as well as less access to stores and restaurants that offer healthier food.

Among the limitations of the present study, the following stand out: most studies were conducted in the three most developed regions of the country, which limits the generalization of results to all Brazilian regions. In addition, the use of different cutoff points to classify the outcomes characterizes the heterogeneity of the included studies, making it difficult to combine results. Furthermore, the inclusion of inappropriate participants in the studies was not controlled in the present review, which can skew the findings in any direction

in the estimates. Other limitations include the heterogeneity of the studies in terms of sample selection, standardization of measurements between evaluators and calibration of the equipment used to obtain the measurements and the confounding variables used in the analyzes. Finally, the potential publication bias cannot be ruled out, which would make the inclusion of smaller studies unfeasible, with null results that tend not to be published.

CONCLUSION

According to the evidence observed in the present systematic review, it is concluded that the prevalence of overweight and obesity in Brazilian children and adolescents are worrisome and that most risk factors associated with outcomes are subject to modifications from the adoption of a style healthier lifestyle.

COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

This research is in accordance with the standards set by the Declaration of Helsinki

Conflict interests

The authors have no conflict of interests to declare.

Authors Contributions

Conceived and designed the study: AP, AAP and MAB. Performed the data extraction: MAB, FUS and KSSK. Analyzed the data: AP and MAB. Wrote the paper: AP and MAB. All authors read and approved the final version of the manuscript.

REFERENCES

1. Abarca-Gómez L, Abdeen ZA, Hamid ZA, Abu-Rmeileh NM, Acosta-Cazares B, Acuin C, et al. Worldwide trends in body mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. Lancet 2017;390(10113):2627-42. http://dx.doi.org/10.1016/S0140-6736(17)32129-3. PMid:29029897.
2. Raj M. Obesity and cardiovascular risk in children and adolescents. Indian J Endocrinol Metab 2012;16(1):13-9. http://dx.doi.org/10.4103/2230-8210.91176. PMid:22276248.
3. Djalalinia S, Qorbani M, Peykari N, Kelishadi R. Health impacts of obesity. Pak J Med Sci 2015;31(1):239-42. PMid:25878654.

4. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. Obes Rev 2016;17(2):95-107. http://dx.doi.org/10.1111/obr.12334. PMid:26696565.

5. Galvão TF, Pansani TDSA, Harrad D. Principais itens para relatar revisões sistemáticas e meta-análises: a recomendação PRISMA. Epidemiol Serv Saude 2015;24(2):335-42. http://dx.doi.org/10.5123/S1679-49742015000200017.

6. Simões CF, Lopes WA, Remor JM, Locateli JC, Lima FB, Cordeiro dos Santos TL, et al. Prevalence of weight excess in Brazilian children and adolescents: a systematic review. Rev Bras Cineantropom Desempenho Hum 2018;20(4):517-31. http://dx.doi.org/10.5007/1980-0037.2018v20n4p517.

7. National Institutes of Health. Quality assessment tool for observationalcohort and cross-sectional studies. Bethesda: National Institutes of Health, Department of Health and Human Services; 2014 [cited 2007 Mar 17]. Avaliable from: http://www.nhlbi.nih.gov/health-pro/guidelines/in-develop/cardiovascular-risk-reduction/tools/cohort

8. de Assunção Bezerra MK, Freese de Carvalho E, Souza Oliveira J, Pessoa Cesse EÂ, Cabral de Lira PI, Galvão Tenório Cavalcante J, et al. Health promotion initiatives at school related to overweight, insulin resistance, hypertension and dyslipidemia in adolescents: a cross-sectional study in Recife, Brazil. BMC Public Health 2018;18(1):1-12. PMid:29415700.

9. Borges CA, Marchioni DML, Levy RB, Slater B. Dietary patterns associated with overweight among Brazilian adolescents. Appetite 2018;123:402-9. http://dx.doi.org/10.1016/j.appet.2018.01.001. PMid:29355584.

10. Chaput JP, Barnes JD, Tremblay MS, Fogelholm M, Hu G, Lambert EV, et al. Thresholds of physical activity associated with obesity by level of sedentary behaviour in children. Pediatr Obes 2018;13(7):450-7. http://dx.doi.org/10.1111/ijpo.12276. PMid:29573239.

11. Cnop MLD, Monteiro LS, Rodrigues PRM, Estima CCP, Veiga GVD, Pereira RA. Meal habits and anthropometric indicators in adolescents from public and private schools of the metropolitan region of Rio de Janeiro. Rev Nutr 2018;31(1):35-47. http://dx.doi.org/10.1590/1678-98652018000100004.

12. Conde WL, Mazzeti CMDS, Silva JC, Santos IKSD, Santos AMDR. Estado nutricional de escolares adolescentes no Brasil: a Pesquisa Nacional de Saúde dos Escolares 2015. Rev Bras Epidemiol 2018;21(Suppl 1):e180008. http://dx.doi.org/10.1590/1980-549720180008.supl.1. PMid:30517459.

13. Corrêa EN, Rossi CE, das Neves J, Silva DAS, de Vasconcelos FAG. Utilization and environmental availability of food outlets and overweight/obesity among schoolchildren in a city in the south of Brazil. J Public Health 2018;40(1):106-13. http://dx.doi.org/10.1093/pubmed/fdx017. PMid:28334847.

14. Cureau FV, Sparrenberger K, Bloch KV, Ekelund U, Schaan BD. Associations of multiple unhealthy lifestyle behaviors with overweight/obesity and abdominal obesity among Brazilian adolescents: a country-wide survey. Nutr Metab Cardiovasc Dis 2018;28(7):765-74. http://dx.doi.org/10.1016/j.numecd.2018.04.012. PMid:29843935.

15. Dumith SC, Muraro MDFR, Monteiro AR, Machado KP, Dias M, Oliz MM, et al. Propriedades diagnósticas e pontos de corte para predição de excesso de peso por indicadores antropométricos em adolescentes de Caracol, Piauí, 2011. Epidemiol Serv Saude 2018;27(1):e201715013. http://dx.doi.org/10.5123/S1679-49742018000100013. PMid:29451609.

16. Fradkin C, Valentini NC, Nobre GC, Dos Santos JO. Obesity and overweight among Brazilian early adolescents: Variability across region, socioeconomic status, and gender. Front Pediatr 2018;6:81. http://dx.doi.org/10.3389/fped.2018.00081. PMid:29682495.

17. Jardim TV, Gaziano TA, Nascente FM, Carneiro CDS, Morais P, Roriz V, et al. Multiple cardiovascular risk factors in adolescents from a middle-income country: Prevalence and

associated factors. PLoS One 2018;13(7):e0200075. http://dx.doi.org/10.1371/journal.pone.0200075. PMid:29975756.

18. Leal DB, Assis MAAD, Conde WL, Lobo AS, Bellisle F, Andrade DFD. Individual characteristics and public or private schools predict the body mass index of Brazilian children: a multilevel analysis. Cad Saude Publica 2018;34(5):e00053117. http://dx.doi.org/10.1590/0102-311x00053117. PMid:29846407.

19. Martini MCS, Assumpção DD, Barros MBDA, Barros ADA Fo. Insatisfação com o peso corporal e estado nutricional de adolescentes: estudo de base populacional no município de Campinas, São Paulo, Brasil. Cien Saude Colet 2020;25(3):967-75. PMid:32159666.

20. Murphy R, Stewart AW, Hancox RJ, Wall CR, Braithwaite I, Beasley R, et al. Obesity, underweight and BMI distribution characteristics of children by gross national income and income inequality: Results from an international survey. Obes Sci Pract 2018;4(3):216-28. PMid:29951212.

21. Pereira JL, Vieira DAS, Alves MCGP, César CLG, Goldbaum M, Fisberg RM. Excess body weight in the city of São Paulo: panorama from 2003 to 2015, associated factors and projection for the next years. BMC Public Health 2018;18(1):1332. http://dx.doi.org/10.1186/s12889-018-6225-8. PMid:30509223.

22. Pereira JL, Félix PV, Mattei J, Fisberg RM. Differences over 12 years in food portion size and association with excess body weight in the city of São Paulo, Brazil. Nutrients 2018;10(6):696. http://dx.doi.org/10.3390/nu10060696. PMid:29848971.

23. Previato HDRA, Behrens JH. Nutritional status and food pattern of adolescents. Nutr Food Sci 2018;48(5):846-55. http://dx.doi.org/10.1108/NFS-05-2018-0130.

24. Reuter CP, de Mello ED, da Silva PT, Borges TS, Klinger EI, Franke SIR, et al. Overweight and obesity in schoolchildren: Hierarchical analysis of associated demographic, behavioral, and biological factors. J Obes 2018;2018:1-6. http://dx.doi.org/10.1155/2018/6128034. PMid:30254759.

25. Rossi CE, Correa EN, Neves JD, Gabriel CG, Benedet J, Rech CR, et al. Body mass index and association with use of and distance from places for physical activity and active leisure among schoolchildren in Brazil. Cross-sectional study. Sao Paulo Med J 2018;136(3):228-36. http://dx.doi.org/10.1590/1516-3180.2017.0347020118. PMid:29924287.

26. Silva AMVLD, Hasselmann MH. Associação entre maus-tratos familiares e excesso de peso e de gordura em escolares do município do Rio de Janeiro/RJ, Brasil. Cien Saude Colet 2018;23(12):4129-42. http://dx.doi.org/10.1590/1413-812320182312.28032016. PMid:30539997.

27. Silva JN Fo, Ybargollin MA. Prevalencia de sobrepeso y obesidad en estudiantes de una ciudad de la región sureste del Brasil. Rev Cuba Med Mil 2019;48(4):752-63.

28. Andrade VMB, de Santana MLP, Fukutani KF, Queiroz ATL, Arriaga MB, Conceição-Machado MEP, et al. Multidimensional analysis of food consumption reveals a unique dietary profile associated with overweight and obesity in adolescents. Nutrients 2019;11(8):1946. http://dx.doi.org/10.3390/nu11081946. PMid:31430906.

29. Assis MM, Leite MA, Carmo AS, Andrade ACS, Pessoa MC, Pereira M No, et al. Food environment, social deprivation and obesity among students from Brazilian public schools. Public Health Nutr 2019;22(11):1920-7. http://dx.doi.org/10.1017/S136898001800112X. PMid:29747717.

30. Barbosa IA, Lopes JR, Dangelo MFSV, Pinho LD, Brito MFSF, Barbosa DA. Prevalence and factors associated with excess body weight in adolescents. Acta Paul Enferm 2019;32(5):485-92. http://dx.doi.org/10.1590/1982-0194201900068.

31. Barbosa LMA, Arruda IKG, Canuto R, Lira PIC, Monteiro JS, Freitas DL, et al. Prevalence and factors associated with excess weight in adolescents in a low-income neighborhood - Northeast, Brazil. Rev Bras Saúde Mater Infant 2019;19(3):661-70. http://dx.doi.org/10.1590/1806-93042019000300010.

32. Dalmaso SB, Sant'ana PG, Cordeiro JP, Rodrigues AL, Ferreira LG, Leopoldo AS, et al. Prevalence of overweight and obesity in elementary school students of Vitória, ES. O Mundo da Saúde 2019;43(1):61-82.

33. Fávaro TR, Ferreira AA, Cunha GMD, Coimbra CE Jr. Excesso de peso em crianças indígenas Xukuru do Ororubá, Pernambuco, Brasil: magnitude e fatores associados. Cad Saude Publica 2019;35(35, Suppl 3):e00056619. http://dx.doi.org/10.1590/0102-311x00056619. PMid:31433030.

34. Francesquet M, Silva PTD, Schneiders LDB, Silveira JFDCD, Soares SS, Tornquist D, et al. Youth overweight/obesity and its relationship with cardiovascular disease and parental risk factors. Arch Endocrinol Metab 2019;63(4):411-6. http://dx.doi.org/10.20945/2359-3997000000156. PMid:31365629.

35. Gonçalves VS, Duarte EC, Dutra ES, Barufaldi LA, Carvalho KM. Characteristics of the school food environment associated with hypertension and obesity in Brazilian adolescents: a multilevel analysis of the Study of Cardiovascular Risks in Adolescents (ERICA). Public Health Nutr 2019;22(14):2625-34. http://dx.doi.org/10.1017/S1368980019001010. PMid:31112113.

36. Guimarães RF, Silva MPD, Mazzardo O, Martins RV, Watanabe PI, Campos WD. Metabolic risk factors clustering among adolescents: a comparison between sex, age and socioeconomic status. Cien Saude Colet 2019;24(2):545-52. http://dx.doi.org/10.1590/1413-81232018242.01352017. PMid:30726386.

37. Lamarão SKM, Alberto ÁAD, Carvalho AP, Assis DFO, Moreira DC. Prevalência de excesso de peso em adolescentes de escolas quilombolas e os fatores associados. RBONE 2019;13(81):750-8.

38. Leal MABF, Paiva SSC, Sousa SSL, Lima CEB, Silva ARV, Nascimento FF, et al. Fatores sociodemográficos e comportamentais associados ao excesso de peso em adolescentes brasileiros-2015. Adolesc Saude 2019;16(2):16-26.

39. Li N, Zhao P, Diao C, Qiao Y, Katzmarzyk PT, Chaput JP, et al. Joint associations between weekday and weekend physical activity or sedentary time and childhood obesity. Int J Obes (Lond) 2019;43(4):691-700. http://dx.doi.org/10.1038/s41366-019-0329-9. PMid:30705394.

40. Neves FS, Fontes VS, Pereira PML, Lombelo-Campos AA, Batista AP, Machado-Coelho GLL, et al. Estudo EVA-JF: aspectos metodológicos, características gerais da amostra e potencialidades de uma pesquisa sobre o estilo de vida de adolescentes brasileiros. Adolesc Saude 2019;16(4):113-29.

41. Oliveira G, Silva TLND, Silva IBD, Coutinho ESF, Bloch KV, Oliveira ERAD. Agregação dos fatores de risco cardiovascular: álcool, fumo, excesso de peso e sono de curta duração em adolescentes do estudo ERICA. Cad Saude Publica 2019;35(12):e00223318. http://dx.doi.org/10.1590/0102-311x00223318. PMid:31800793.

42. Pereira LR, Moreira FP, Reyes AN, Bach SDL, Amaral PLD, Motta JDS, et al. Biological rhythm disruption associated with obesity in school children. Child Obes 2019;15(3):200-5. http://dx.doi.org/10.1089/chi.2018.0212. PMid:30694701.

43. Rossi CE, Costa LDCF, Machado MS, Andrade DF, Vasconcelos FDAG. Fatores associados ao consumo alimentar na escola e ao sobrepeso/obesidade de escolares de 7-10 años de Santa Catarina, Brasil. Cien Saude Colet 2019;24(2):443-54. http://dx.doi.org/10.1590/1413-81232018242.34942016. PMid:30726377.

44. Rossi CE, Patrícia de Fragas H, Corrêa EN, das Neves J, de Vasconcelos FAG. Association between food, physical activity, and social assistance environments and the body mass index of schoolchildren from different socioeconomic strata. J Public Health (Oxf) 2019;41(1):e25-34. http://dx.doi.org/10.1093/pubmed/fdy086. PMid:29846685.

45. Santos PCD, Silva KSD, Silva JAD, Santos CESD, Duca GFD, Lopes ADS, et al. Change in overweight and obesity over a decade according to sociodemographic

factors in Brazilian adolescents. Cien Saude Colet 2019;24(9):3335-44. http://dx.doi.org/10.1590/1413-81232018249.29052017. PMid:31508754.

46. Santos NFD, Lira PICD, Tavares FCDLP, Leal VDS, Oliveira JS, Pessoa JT, et al. Overweight in adolescents: food insecurity and multifactoriality in semiarid regions of pernambuco. Rev Paul Pediatr 2019;38:e2018177. http://dx.doi.org/10.1590/1984-0462/2020/38/2018177. PMid:31778411.

47. Soria L, Teixeira DDS, Polesel DN, Fernandes MT. Evaluation of predictive measurements of excess weight in brazilian children. Rev Assoc Med Bras 2019;65(5):663-8. http://dx.doi.org/10.1590/1806-9282.65.5.663. PMid:31166443.

48. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ 2007;85(9):660-7. http://dx.doi.org/10.2471/BLT.07.043497. PMid:18026621.

49. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000;320(7244):1240-3. http://dx.doi.org/10.1136/bmj.320.7244.1240. PMid:10797032.

50. Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. BMJ 2007;335(7612):194. http://dx.doi.org/10.1136/bmj.39238.399444.55. PMid:17591624.

51. Conde WL, Monteiro CA. Body mass index cutoff points for evaluation of nutritional status in Brazilian children and adolescents. J Pediatr (Rio J) 2006;82(4):266-72. http://dx.doi.org/10.2223/JPED.1502. PMid:16858504.

52. Pich J, Bibiloni MDM, Pons A, Tur JA. Weight self-regulation process in adolescence: the relationship between control weight attitudes, behaviors, and body weight status. Front Nutr 2015;2:14. http://dx.doi.org/10.3389/fnut.2015.00014. PMid:26284248.

53. Gee GC, Ro A, Gavin A, Takeuchi DT. Disentangling the effects of racial and weight discrimination on body mass index and obesity among Asian Americans. Am J Public Health 2008;98(3):493-500. http://dx.doi.org/10.2105/AJPH.2007.114025. PMid:18235065.

54. Björntorp P. Do stress reactions cause abdominal obesity and comorbidities? Obes Rev 2001;2(2):73-86. http://dx.doi.org/10.1046/j.1467-789x.2001.00027.x. PMid:12119665.

55. Azambuja AP, Netto-Oliveira ER, de Oliveira AA, Azambuja MA, Rinaldi W. Prevalence of overweight/obesity and economical status of schoolchildren. Rev Paul Pediatr 2013;31(2):166-71. http://dx.doi.org/10.1590/S0103-05822013000200006. PMid:23828052.

56. IBGE: Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional por Amostra de Domicílios Contínua. Rio de Janeiro: IBGE; 2019.

57. Ahmad A, Zulaily N, Shahril MR, Syed Abdullah EFH, Ahmed A. Association between socioeconomic status and obesity among 12-year-old Malaysian adolescents. PLoS One 2018;13(7):e0200577. http://dx.doi.org/10.1371/journal.pone.0200577. PMid:30044842.

58. Dinsa GD, Goryakin Y, Fumagalli E, Suhrcke M. Obesity and socioeconomic status in developing countries: a systematic review. Obes Rev 2012;13(11):1067-79. http://dx.doi.org/10.1111/j.1467-789X.2012.01017.x. PMid:22764734.

59. Muthuri SK, Wachira LJM, Leblanc AG, Francis CE, Sampson M, Onywera VO, et al. Temporal trends and correlates of physical activity, sedentary behaviour, and physical fitness among school-aged children in Sub-Saharan Africa: a systematic review. Int J Environ Res Public Health 2014;11(3):3327-59. http://dx.doi.org/10.3390/ijerph110303327. PMid:24658411.

60. Monteiro CA, Moura EC, Conde WL, Popkin BM. Socioeconomic status and obesity in adult populations of developing countries: a review. Bull World Health Organ 2004;82(12):940-6. PMid:15654409.

61. Castilho SD, de Azevedo Barros-Filho A. Anthropometry in Relation to Sexual Maturation. In: Preedy V, organizador. Handbook of anthropometry. New York, NY: Springer; 2012 http://dx.doi.org/10.1007/978-1-4419-1788-1_84.

62. Xu H, Wen LM, Rissel C. Associations of parental influences with physical activity and screen time among young children: a systematic review. J Obes 2015;2015:546925. http://dx.doi.org/10.1155/2015/546925. PMid:25874123.

63. Mehdizadeh A, Nematy M, Vatanparast H, Khadem-Rezaiyan M, Emadzadeh M. Impact of parent engagement in childhood obesity prevention interventions on anthropometric indices among preschool children: a systematic review. Child Obes 2020;16(1):3-19. http://dx.doi.org/10.1089/chi.2019.0103. PMid:31479311.

64. Todendi PF, Martínez JA, Reuter CP, Klinger EI, Fiegenbaum M, Rosane de Moura Valim A. Influence of FTO (Fat mass and obesity) gene and parental obesity on Brazilian children and adolescents adiposity. J Pediatr Endocrinol Metab 2020;33(8):975-82. http://dx.doi.org/10.1515/jpem-2019-0594. PMid:32697757.

65. Liu C, Mou S, Cai Y. FTO gene variant and risk of overweight and obesity among children and adolescents: a systematic review and meta-analysis. PLoS One 2013;8(11):e82133. http://dx.doi.org/10.1371/journal.pone.0082133.

66. Ferreira Todendi P, de Moura Valim AR, Klinger E, Reuter CP, Molina S, Martínez JA, et al. The role of the genetic variants IRX3 rs3751723 and FTO rs9939609 in the obesity phenotypes of children and adolescents. Obes Res Clin Pract 2019;13(2):137-42. http://dx.doi.org/10.1016/j.orcp.2019.01.005. PMid:30713021.

67. Jiang Y, Mei H, Lin Q, Wang J, Liu S, Wang G, et al. Interaction effects of FTO rs9939609 polymorphism and lifestyle factors on obesity indices in early adolescence. Obes Res Clin Pract 2019;13(4):352-7. http://dx.doi.org/10.1016/j.orcp.2019.06.004. PMid:31402168.

68. Moleres A, Ochoa MC, Rendo-Urteaga T, Martínez-González MA, Azcona San Julián MC, Martínez JA, et al. Dietary fatty acid distribution modifies obesity risk linked to the rs9939609 polymorphism of the fat mass and obesity-associated gene in a Spanish case-control study of children. Br J Nutr 2012;107(4):533-8. http://dx.doi.org/10.1017/S0007114511003424. PMid:21798115.

69. Fang K, Mu M, Liu K, He Y. Screen time and childhood overweight/obesity: A systematic review and meta-analysis. Child Care Health Dev 2019;45(5):744-53. http://dx.doi.org/10.1111/cch.12701. PMid:31270831.

70. Shang L, Wang J, O'Loughlin J, Tremblay A, Mathieu MÈ, Henderson M, et al. Screen time is associated with dietary intake in overweight Canadian children. Prev Med Rep 2015;2:265-9. http://dx.doi.org/10.1016/j.pmedr.2015.04.003. PMid:26844082.

71. Hu EY, Ramachandran S, Bhattacharya K, Nunna S. Obesity among high school students in the united states: risk factors and their population attributable fraction. Prev Chronic Dis 2018;15:E137. http://dx.doi.org/10.5888/pcd15.180122. PMid:30412690.

72. Ghobadi S, Hassanzadeh-Rostami Z, Salehi-Marzijarani M, Bellissimo N, Brett NR, Totosy de Zepetnek JO, et al. Association of eating while television viewing and overweight/obesity among children and adolescents: a systematic review and meta-analysis of observational studies. Obes Rev 2018;19(3):313-20. http://dx.doi.org/10.1111/obr.12637. PMid:29266643.

73. Dutra GF, Kaufmann CC, Pretto AD, Albernaz EP. Television viewing habits and their influence on physical activity and childhood overweight. J Pediatr (Rio J) 2015;91(4):346-51. http://dx.doi.org/10.1016/j.jped.2014.11.002. PMid:25619605.

74. Kracht CL, Joseph ED, Staiano AE. Video games, obesity, and children. Curr Obes Rep 2020;9(1):1-14. http://dx.doi.org/10.1007/s13679-020-00368-z. PMid:32077041.

75. Claro RM, Maia EG, Costa BVDL, Diniz DP. Preço dos alimentos no Brasil: prefira preparações culinárias a alimentos ultraprocessados. Cad Saude Publica 2016;32(8):e00104715. PMid:27580234.

76. Maia EG, Dos Passos CM, Levy RB, Bortoletto Martins AP, Mais LA, Claro RM. What to expect from the price of healthy and unhealthy foods over time? The case from Brazil. Public Health Nutr 2020;23(4):579-88. http://dx.doi.org/10.1017/S1368980019003586. PMid:31937385.

77. Passos CM, Maia EG, Levy RB, Martins APB, Claro RM. Association between the price of ultra-processed foods and obesity in Brazil. Nutr Metab Cardiovasc Dis 2020;30(4):589-98. http://dx.doi.org/10.1016/j.numecd.2019.12.011. PMid:32139251.

78. Traversy G, Chaput JP. Alcohol consumption and obesity: an update. Curr Obes Rep 2015;4(1):122-30. http://dx.doi.org/10.1007/s13679-014-0129-4. PMid:25741455.

79. Clair C, Chiolero A, Faeh D, Cornuz J, Marques-Vidal P, Paccaud F, et al. Dose-dependent positive association between cigarette smoking, abdominal obesity and body fat: cross-sectional data from a population-based survey. BMC Public Health 2011;11:23. http://dx.doi.org/10.1186/1471-2458-11-23. PMid:21223575.

80. Chiolero A, Faeh D, Paccaud F, Cornuz J. Consequences of smoking for body weight, body fat distribution, and insulin resistance. Am J Clin Nutr 2008;87(4):801-9. http://dx.doi.org/10.1093/ajcn/87.4.801. PMid:18400700.

81. Chiolero A, Jacot-Sadowski I, Faeh D, Paccaud F, Cornuz J. Association of cigarettes smoked daily with obesity in a general adult population. Obesity (Silver Spring) 2007;15(5):1311-8. http://dx.doi.org/10.1038/oby.2007.153. PMid:17495208.

82. Haynes A, Kersbergen I, Sutin A, Daly M, Robinson E. A systematic review of the relationship between weight status perceptions and weight loss attempts, strategies, behaviours and outcomes. Obes Rev 2018;19(3):347-63. http://dx.doi.org/10.1111/obr.12634. PMid:29266851.

Supplementary Material

Supplementary material accompanies this paper.

Supplementary file 1. Bias risk assessment. Free access in: https://osf.io/4k5r8/

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