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Prevalence of overweight and obesity among Brazilian children and adolescents: systematic review and meta-analysis

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ABSTRACT

The purpose of the study was to investigate the prevalence of overweight and obesity among young Brazilian aged 5 to 19 years through systematic review and meta-analysis of data available in the literature. An electronic search was conducted for articles in the MedLine/PubMed, Scopus, Web of Science, Scielo e Lilacs published from 2000 to 2018 were selected using predefined inclusion/exclusion criteria. Measures of heterogeneity and variability were calculated, and random effect model were used to estimate pooled prevalence rates. Forest-plots graphs were generated by sex and age. Meta-regression models were fitted to identify possible sources of heterogeneity in the prevalence estimates. Of the 1,002 articles initially identified 26 met the inclusion criteria. In children (5-9 years) the pooled prevalence rates of overweight were 16.2% ($_{95\%}$CI 13.2-19.3; Q=411.7, p<0.001; I^2=97.8%) in girls and 14.4% ($_{95\%}$CI 11.5-17.3; Q=403.9, p<0.001; I^2=97.7%) in boys. Obesity, 9.2% ($_{95\%}$CI 5.9-12.3; Q=1111.7, p<0.001; I^2=99.2%) and 9.0% ($_{95\%}$CI 5.5-12.5; Q=1413.1, p<0.001; I^2=99.4%), respectively. Regarding adolescents (10-19 years), in girls 16.4% ($_{95\%}$CI 15.1-17.7; Q=245.6, p<0.001; I^2=92.3%) for overweight and 6.2% ($_{95\%}$CI 4.9-7.5; Q=842.9, p<0.001; I^2=97.7%) for obesity. In boys, 15.3% ($_{95\%}$CI 13.4-17.1; Q=493.7, p<0.001; I^2=96.2%) and 6.7% ($_{95\%}$CI 5.0-8.5; Q=1200.4, p<0.001; I^2=98.4%), respectively. Geographic region, year of data collection and diagnostic criteria had a significant impact on the heterogeneity of the prevalence of overweight and obesity. The review identified increasing trends in the prevalence rates, highlighting the urgent need to promote healthy lifestyles from the young ages, in order to effectively address the presence of excess body weight.

Keywords: nutritional status; overweight; obesity; lifestyle; adolescent; Brazil.

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INTRODUCTION

Overweight and obesity in the young population has been an important factor of concern in the area of public health[1]. Estimates indicate that, in keeping with current trends, in 2030 there will be approximately 2.2 billion overweight adults worldwide, and more than 1.1 billion obese people, which should account for 60% of the world population[2]. In Brazil, a survey carried out in 2015 reveals that, depending on the region

considered, between 32% and 59% of the population over 18 years old is overweight or obese[3]. This implies higher rates of morbidity in the population, a significant increase in the need to use medical services and a major economic impact on the health system[4]. However, specifically in children and adolescents, worldwide, including the Brazilian population, studies are dispersed and less accurate.

It is well established that the pathological process of overweight and obesity results in immediate cardiometabolic changes in the young body, such as high blood pressure, modified plasma lipids, altered blood glucose, insulin resistance, compromised inflammatory markers and atherosclerosis, among others[1]. Likewise, the long-term consequences include the persistence of excess body weight in adulthood with associated comorbidities, including cardiovascular diseases, diabetes, some types of cancer, orthopedic deformities and premature death[5]. In this context, there is a growing concern of national[6] and international[7] entities, in the sense of idealizing intervention actions to contain the increasingly high prevalence of excess body weight in children and adolescents.

Considering that Brazil is a country of continental dimensions, with a population of approximately 200 million inhabitants spread over five geographic regions with very diverse socioeconomic and cultural characteristics, nationally representative studies are scarce. However, over the past few decades, several studies have been carried out in specific segments of the young Brazilian population to identify the prevalence of overweight and obesity. In this regard, the findings differ considerably. Several factors may be contributing to these differences, including the age range of the young population considered, the methodology used to select the sample, the geographical region of focus and the time of data collection. However, despite the differences in their findings, these studies provide important evidence that highlights overweight and obesity in children and adolescents in Brazil as a critical public health problem.

It becomes important for health professionals and government managers to better understand the magnitude of overweight and obesity in children and adolescents to develop more effective policies and actions aimed at promoting an anti-obesogenic lifestyle that can contribute to the prevention of excess body weight.

In this context, the objective of the study was to describe the prevalence of overweight and obesity in children and adolescents aged between 5 and 19 years through a systematic review and meta-analysis of studies available in the literature and, thus, to measure the magnitude of the problem in Brazil.

METHODS

The study was carried out according to recommendations described in the MOOSE Checklist (Meta-analysis Of Observational Studies in Epidemiology)[8]. The systematic review is registered with PROSPERO CRD 42018107282.

Search strategy

The systematic review and meta-analysis sought to find articles published from 2000 to 2018 available in the electronic databases: MedLine/PubMed, Scopus, Web of Science, SciELO and Lilacs. The last search in the databases was carried out on January 31, 2019. The search was conducted in Portuguese and/or English, using all possible combinations of three blocks of descriptors: (a) terms related to age ("youth", "young", "child", "childhood", "teenager", "adolescent", "adolescence", "student"); (b) terms related to the outcome ("prevalence", "nutritional status", "overweight", "obesity"); and (c) terms related to the country ("Brazil", "Brazilian", name of each state separately). The Boolean operator "OR" was used to establish combinations between descriptors within each block and the Boolean operator "AND" to combine blocks. Also, when necessary, specific trick symbols were used in each database platform to capture all suffix variations.

Eligibility criteria

Articles that met the following criteria were included in the review: (a) cross-sectional studies that presented original data; (b) school-based or home-based studies that used designs to ensure the representativeness of the target population (random samples); (c) samples that included children (5 years ≥ age <10 years) and/or adolescents (10 years ≥ age ≤ 19 years), even if involving other age groups, as long as prevalence data were available for child subgroups and/or teenagers separately; and (d) studies in which overweight and/or obesity were defined as primary outcomes and were diagnosed by calculating the body mass index.

Study selection

Two independent authors examined the eligibility of articles found. Initially, screening was performed based on the title analysis, then the abstracts were reviewed, and only potentially eligible articles were selected for full reading. Both sets of pre-selected articles were then compared in committee and cases in disagreement were resolved by consensual discussion between the authors. Still, the references of the included articles were examined to check for the existence of some article not found through the original search.

To assess potential risk of bias and methodological quality of the studies, each study was critically analyzed using an adapted version of the tool proposed by Downs-Black[9]. Items on the original checklist for experimental studies and items that did not apply to the present study were excluded. In this case, the version of the tool used consisted of 12 items. The studies selected in the systematic review were classified as high quality (≥10 points), moderate quality (9 to 6 points) and low quality (≤5 points). Then, in order to avoid studies with a higher risk of bias could affect the meta-analysis, a sensitivity analysis was performed, in which studies with low methodological quality were excluded.

Analysis and presentation of data

For data analysis and synthesis, the Comprehensive Meta-Analysis™ software, version 2.070[10] was used. Forest plots were constructed for the prevalence of overweight, obesity and overweight + obesity separately by sex and age (children and adolescents). For global prevalence estimates, logit transformations were initially performed to deal with asymmetric distribution. These prevalence were weighted by the inverse logit variance. Then, the combined values were converted back to prevalence.

Degree of heterogeneity was calculated using Cochran's test (Q). Statistics I^2 was used to describe the variability between studies. Based on the values of Q and I^2, a model was selected to identify the global prevalence rates and their associated confidence intervals ($_{95\%}$CI). Considering that high heterogeneity was identified (I^2> 50%), a random effects model was used[11]. The presence of publication bias was analyzed by direct observation of the funnel plot (funnel plots) and through the Begg and Mazumdar rank correlation tests (B-M)[12] and the Egger regression[13]. Robustness of the estimates was assessed through a leave-one-out sensitivity analysis to identify the impact that the results of each study had on the overall prevalence[14].

Meta-regression models were adjusted to identify possible sources of heterogeneity between prevalence. Geographic region, study scope (home and school), sample size, year of data collection and diagnostic criteria for overweight and obesity were considered as independent variables. Initially, univariable models were adjusted including all independent variables. Then, variables with p-values ≤0.20 were selected for inclusion in multivariate models. To establish comparisons between the subgroups of each variable, odds ratio (OR) calculations and respective confidence intervals ($_{95\%}$CI) were used.

RESULTS

Study selection

In the databases considered, 997 studies were found. Additionally, a manual search allowed adding five more studies, increasing the total number of studies included in the review to 1002. After excluding duplicates and screening the title and abstract, 108 studies were considered potentially eligible and selected for detailed analysis of the full text. Of these, 75 studies were disregarded for not meeting the proposed inclusion criteria, and 33 studies were selected for qualitative synthesis (Figure 1).

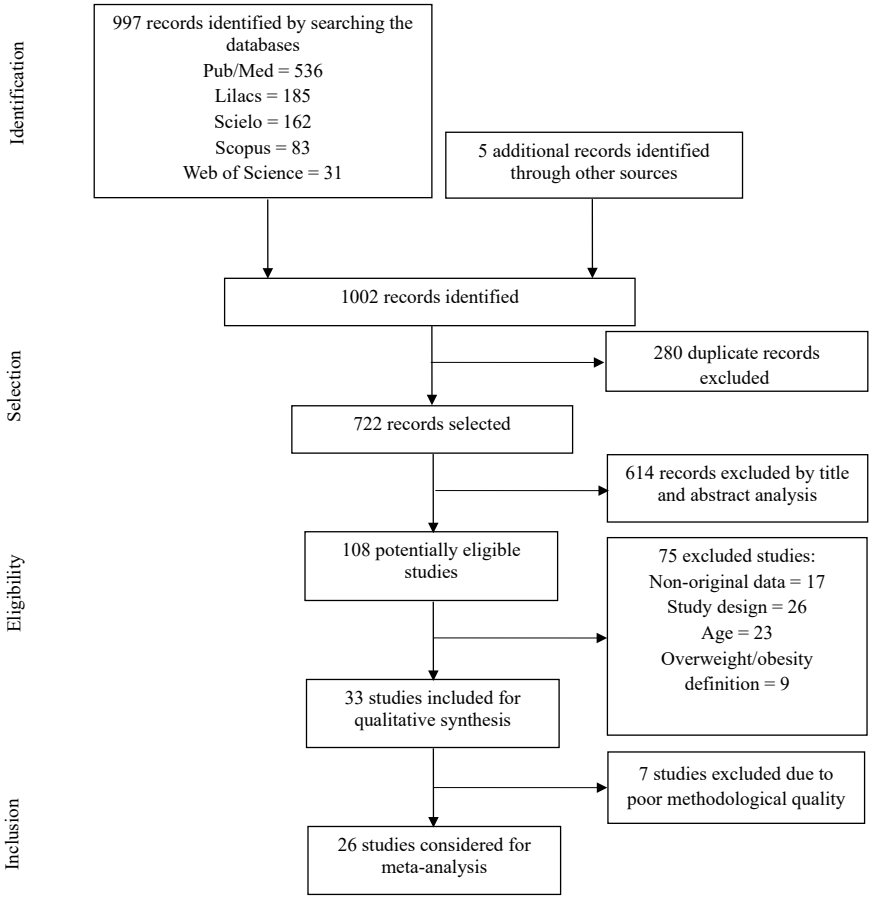

Figure 1: Flowchart with description of the stages of carrying out the systematic review and meta-analysis.

The general characteristics of the studies included in the systematic review can be seen in Table 1. The set of selected studies cover data from the five Brazilian geographic regions; however, most studies were carried out in locations in the southern region (12 studies), followed by the southeast (9 studies) and northeast (6 studies) regions. A single study was carried out in locations in the central-west and north regions. Still, four national studies were considered with stratified data for the five geographic regions of Brazil. Most studies used a school-based design (26 studies), while seven studies involved home recruitment[15-47] (Table 1).

Scores attributed to the methodological quality of the studies located and selected to carry out the meta-analysis showed a range of variation from 3 to 12 points and an average score equivalent to 8.6±1.5 points. Taking into account the totality of studies included in the systematic review, 14 of them achieved scores ≥10 (high quality) and 12 studies scored between 6-9 (moderate quality); however, seven studies had scores ≤5, which were excluded due to their low methodological quality. Therefore, data from 26 studies were considered to perform the meta-analysis.

Estimated prevalence rates

In the case of children, the prevalence of overweight in girls ranged from 8.4% to 24.1%, while in boys, the prevalence ranged between 8.7% and 21.8%. With regard to obesity, the prevalence was between 1.5% and 15.8%, and 1.7% and 20.3%, in girls and boys, respectively. In general, the highest prevalence of overweight and obesity was found in studies conducted in the southern region. When comparing data separately by sex, there is a tendency for girls to have a higher prevalence of overweight and obesity (Figure 2).

The overall prevalence rates of overweight were equivalent to 16.2% ($_{95\%}$CI 13.2-19.3; Q=411.7, p<0.001; I^2=97.8%) for girls and 14.4% ($_{95\%}$CI 11.5-17.3; Q=403.9, p<0.001; I^2=97.7%) for boys. On the other hand, the global obesity prevalence rates were equivalent to 9.2% ($_{95\%}$CI 5.9-12.3; Q = 1111.7, p<0.001; I^2=99.2%) and 9.0 % ($_{95\%}$CI 5.5-12.5; Q=1413.1, p<0.001; I^2=99.4%) for girls and boys, respectively. The designs of the funnel plots for overweight and obesity showed asymmetrical views of prevalence (p<0.001), which shows the presence of publication bias. This was confirmed by the B-M test and the Egger test (p<0.001). Leave-one-out sensitivity analysis revealed that the overall prevalence of overweight and obesity was more impacted by the data collected in the cities of Santos, São Paulo, Southeast (overweight)[27], Montes Claros, Minas Gerais, Southeast[30] and Vale do Jequitinhonha, Minas Gerais, Southeast (obesity)[31], Sorocaba, São Paulo, Southeast[29] and Pelotas, Rio Grande do Sul, South (overweight and obesity)[40].

Regarding adolescents, the variations in the prevalence of overweight in girls ranged between 9.8% and 22.8%, while in boys the lowest prevalence was 5.6% and the highest was 21.6%. Regarding obesity, prevalence rates ranged from 1.2% to 11.6% for girls and 1.1% to 14.4% for boys. Regarding the combined prevalence (overweight + obesity) the extreme rates were between 11.4% and 27.2%, and 9.5% and 26.9% in girls and boys, respectively. Similar to what was identified in children, in general, the highest prevalence of overweight and obesity was found in studies conducted in the southern region. However, girls and boys had similar prevalence rates (Figure 3).

In girls, the overall prevalence rate was equivalent to 16.4% ($_{95\%}$CI 15.1-17.7; Q=245.6, p<0.001; I^2=92.3%) for overweight and 6.2 % ($_{95\%}$CI 4.9-7.5; Q=842.9, p<0.001; I^2=97.7%) for obesity. In boys, the overall prevalence rates were equivalent to 15.3% ($_{95\%}$CI 13.4-17.1; Q = 493.7, p<0.001; I^2=96.2%) and 6.7% ($_{95\%}$CI % 5.0-8.5; Q=1200.4, p<0.001; I^2=98.4%) for overweight and obesity, respectively. In the case of combined prevalence (overweight + obesity), the girls had an overall prevalence rate of 19% ($_{95\%}$CI 17.2-20.9; Q=436.7, p<0.001; I^2=95.4%) and boys 20% ($_{95\%}$CI 17.8-22.1; Q=598.1, p<0.001; I^2=96.7%). The designs of the funnel plots equivalent to the prevalence of overweight and obesity showed the presence of publication bias (p<0.001), confirmed by the B-M test and the Egger test (p<0.001). Through leave-one-out analysis, it was proved that the data collected in the Study of Cardiovascular Risks in Adolescents (ERICA), involving the five macro-regions of the country[17] and in the study carried out in the cities of Vale do Jequitinhonha, Minas Gerais, Southeast[31] had a stronger impact on the definition overall prevalence.

Table 2 shows the meta-regression parameters. Through adjustments made by univariable models, it was identified that the scope of the study and sample size did not show significant associations with variations in the prevalence of overweight and obesity, both for children and adolescents. Thus, the modulators included in the multivariate models were geographic region, year of data collection and diagnostic criteria. In the children's stratum, some subgroups of modulators from the geographic region of data collection did not present a sufficient number of studies to make the comparisons effective. It was the specific case of the Midwest, North and Northeast regions. Fixing the southeast region as a reference category, the data found in adolescents in the northeast region were defined as the main source of heterogeneity among the identified prevalences of overweight and obesity. In children and adolescents, the data collected in the years between 2014 and 2018 were also defined as a source of significant heterogeneity. As for the diagnosis, the International Obesity Task Force (IOTF) criterion had a statistically significant impact on the heterogeneity of overweight and obesity prevalence; especially in adolescents (Table 2).

DISCUSSION

In essence, this review and meta-analysis study documented that around 22-25% of the young Brazilian population is

Table 1: Main characteristics of the studies selected in the systematic review.

Selected articles	Data collection	Local/Region	Study scope	Age (years)	Sample size	Sex (girls %)	Classification criteria	Study quality
More than one macro-region of the country								
Brasil[15]	2002-3	5 Macro regions of the country	Domiciliary	10-19	37696	47.9	CDC-2000	High
Brasil[16]	2008-9	5 Macro regions of the country	Domiciliary	5-19	52811	48.7	WHO-2007	High
Bloch *et al*.[17]	2013-14	5 Macro regions of the country	Domiciliary	12-17	73399	55.4	WHO-2007	High
Conde et al.[18]	2015	5 Macro regions of the country	Domiciliary	11-19	16556	49.7	IOTF-2000	High
North								
Krinski *et al*.[19]	2008	Vilhena, Rondônia	School	6-17	5883	53.0	Conde & Monteiro	Low
Northeast								
Oliveira *et al*.[20]	2001	Feira de Santana, Gahía	School	5-9	699	52.0	IOTF-2000	Low
Tassitano *et al*.[21]	2006	Cities of the State of Pernambuco	School	14-19	4210	59.8	IOTF-2000	High
Mendonça *et al*.[22]	2007	Maceió, Alagoas	School	7 – 17	1253	56.4	CDC-2002	Low
Marques *et al*.[23]	2008	Salvador, Bahía	School	10-17	1396	56.7	WHO-2007	Moderate
Nascimento-Ferreira *et al*.[24]	2013	Imperatriz, Maranhão	School	14-19	1014	54.8	IOTF-2000	Moderate
Monteiro *et al*.[25]	2011	Caracol, Piauí	School	13-19	1088	53.0	WHO-2007	Moderate
Southeast								
Ramos & Barros-Filho[26]	2000	Bragança Paulista, São Paulo	School	11-18	1334	59.7	Must-1991	Low
Costa *et al*.[27]	2002	Santos, São Paulo	School	7-10	10822	51.8	CDC-2000	Moderate
Vanzelli *et al*.[28]	2005	Jundiaí, São Paulo	School	10-18	662	51.0	Must-1991 / IOTF-2000	Moderate
Martins *et al*.[29]	2006	Sorocaba, São Paulo	School	6-10	11290	49.8	CDC-2000	Moderate
Guedes *et al*.[30]	2007	Montes Claros, Minas Gerais	School	6-18	2849	51.1	IOTF-2000	High
Guedes & Mendes[31]	2007	Vale do Jequitinhonha, Minas Gerais	School	6-18	5100	53.5	IOTF-2000	High
Bispo *et al*.[32]	2008-9	Belo HorizonteMinas Gerais	Domiciliary	11-17	1030	4.5	WHO-2007	High
Vasconcellos *et al*.[33]	2010	Niterói, Rio de Janeiro	School	10-18	328	67.1	WHO-2007	High
Pozza *et al*.[34]	2014	Itatiba, São Paulo	School	5-15	6829	50.3	WHO-2007	Moderrate
South								
Terres *et al*.[35]	2001-2	Pelotas, Rio Grande do Sul	Domiciliary	15-18	960	51.2	IOTF-2000	High
Dutra *et al*.[36]	2003	Pelotas, Rio Grande do Sul	Domiciliary	10-19	810	49.8	WHO-1995	High
Guedes *et al*.[37]	2004	Apucarana, Paraná	School	7-18	4319	48.3	IOTF-2000	High
Sune *et al*.[38]	2004	Capão da Canoa, Rio Grande do Sul	School	11-13	719	50.2	IOTF-2000	Low
Pelegrini *et al*.[39]	2007	Florianópolis, Santa Catarina	School	14-18	653	64.0	IOTF-2000	Moderate
Vieira *et al*.[40]	2004	Pelotas, Rio Grande do Sul	School	6-9	14739	51.8	IOTF-2000	Moderate
Cureau *et al*.[41]	2008	Santa Maria, Rio Grande do Sul	School	14-18	424	45.3	Conde & Monteiro	Low
Panazzolo et al.[42]	2010	Feliz, Rio Grande do Sul	School	6-9	633	46.8	CDC-2010	High
Hobold & Arruda[43]	2012	Entorno Lago Itaipu, Paraná	School	6-17	5962	50.7	IOTF-2000	Moderate
D'Avila *et al*.[44]	2012-13	Florianópolis, Santa Catarina	School	11-14	962	58.9	WHO-2007	Low
Silva *et al*.[45]	2014	Cascavel, Paraná	School	7-10	2180	48.9	WHO-2007	Moderate
Silva *et al*.[46]	2014	São José, Santa Catarina	School	14-19	1132	53.0	WHO-2007 / IOTF-2000 Conde & Monteiro	Moderate
Midwest								
Carneiro *et al*.[47]	2011	Goiânia, Goiás	School	12-18	1169	53.1	WHO-2007	High

overweight (overweight + obesity). In comparison with data collected in other countries, it appears that this prevalence rate is approximately two to three times higher than that identified in countries in Africa (9.7%) and Southeast Asia (8.1%); however, lower than that found in the United States (31%) and similar to that reported in some European countries such as Portugal, Spain, France, England and Germany[48]. In Latin America, a recent systematic review pointed out the combined national prevalence of overweight and obesity in the population aged 5 to 19 years between 16.6% and 36.9%[49].

When analyzing the rates of overweight and obesity in children and adolescents gathered in the systematic review, it was found that the overall prevalence showed different patterns between the sexes. If, on one hand, no differences were found between estimates of the overall prevalence of overweight in children and adolescents, on the other, girls showed higher prevalence than boys. Regarding obesity, girls and boys had similar global prevalence; however, in both sexes, children had higher rates than adolescents. Assuming that the greatest accumulation of body weight at young ages is associated with the close interaction of socio-cultural, behavioral and biological moderators50, these findings confirm the hypothesis that the specific exposure environment may impact girls and boys differently in childhood and adolescence[51].

To our knowledge, this systematic review and meta-analysis study is a pioneer and the first of its kind to employ multivariate models of meta-regression to identify sources of heterogeneity in the prevalence rates of overweight and obesity in Brazilian children and adolescents. Immediately, it was identified that the geographic region in which children and adolescents were sampled contributed significantly to explain variations between the prevalence reported in the studies gathered in the meta-analysis. Studies carried out in the south and southeast regions tended to have higher prevalence rates than studies carried out in the other three Brazilian regions. Although this finding is viewed with

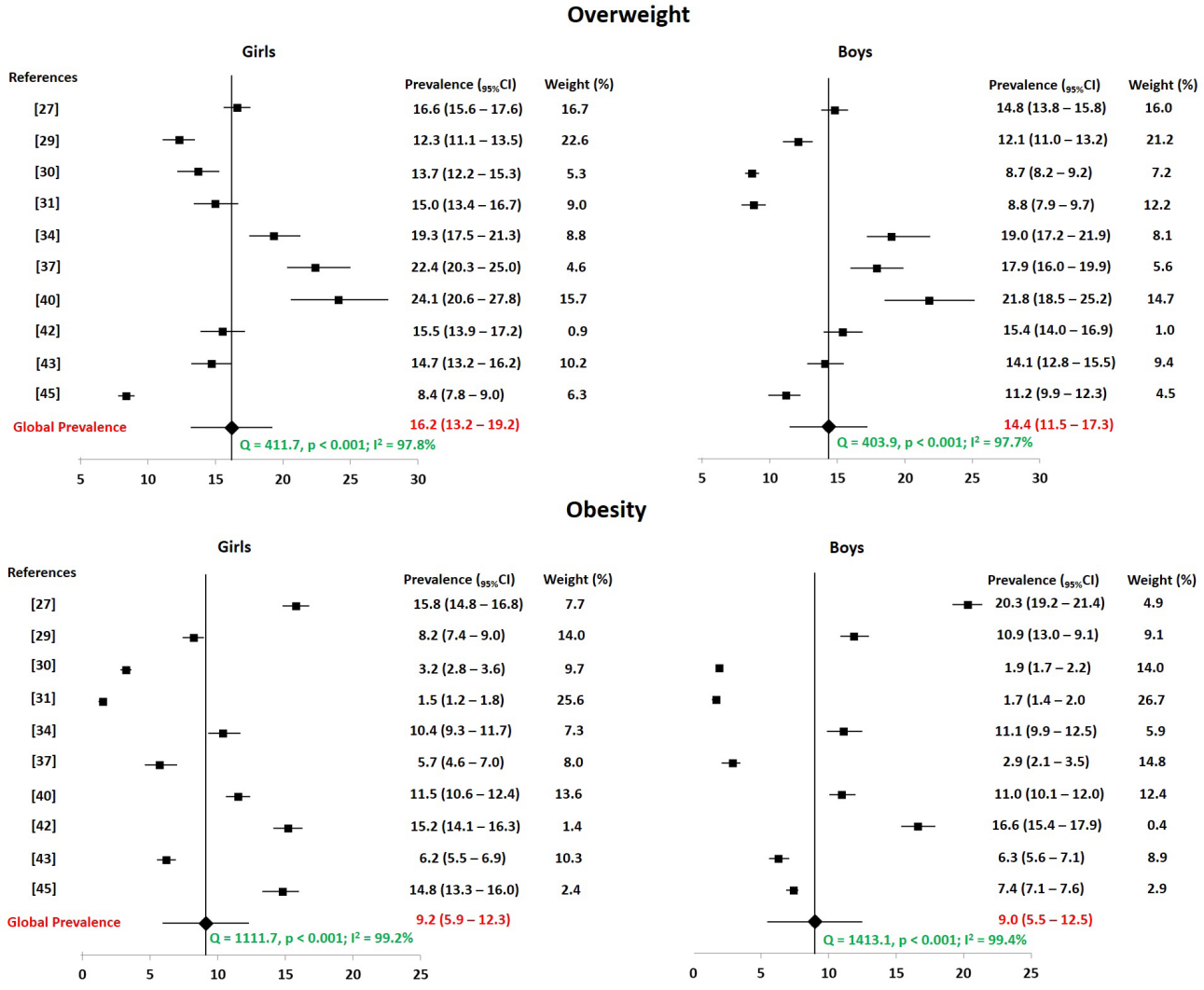

Figure 2: Forest plots of studies reporting prevalence rates of overweight and obesity in Brazilian children.

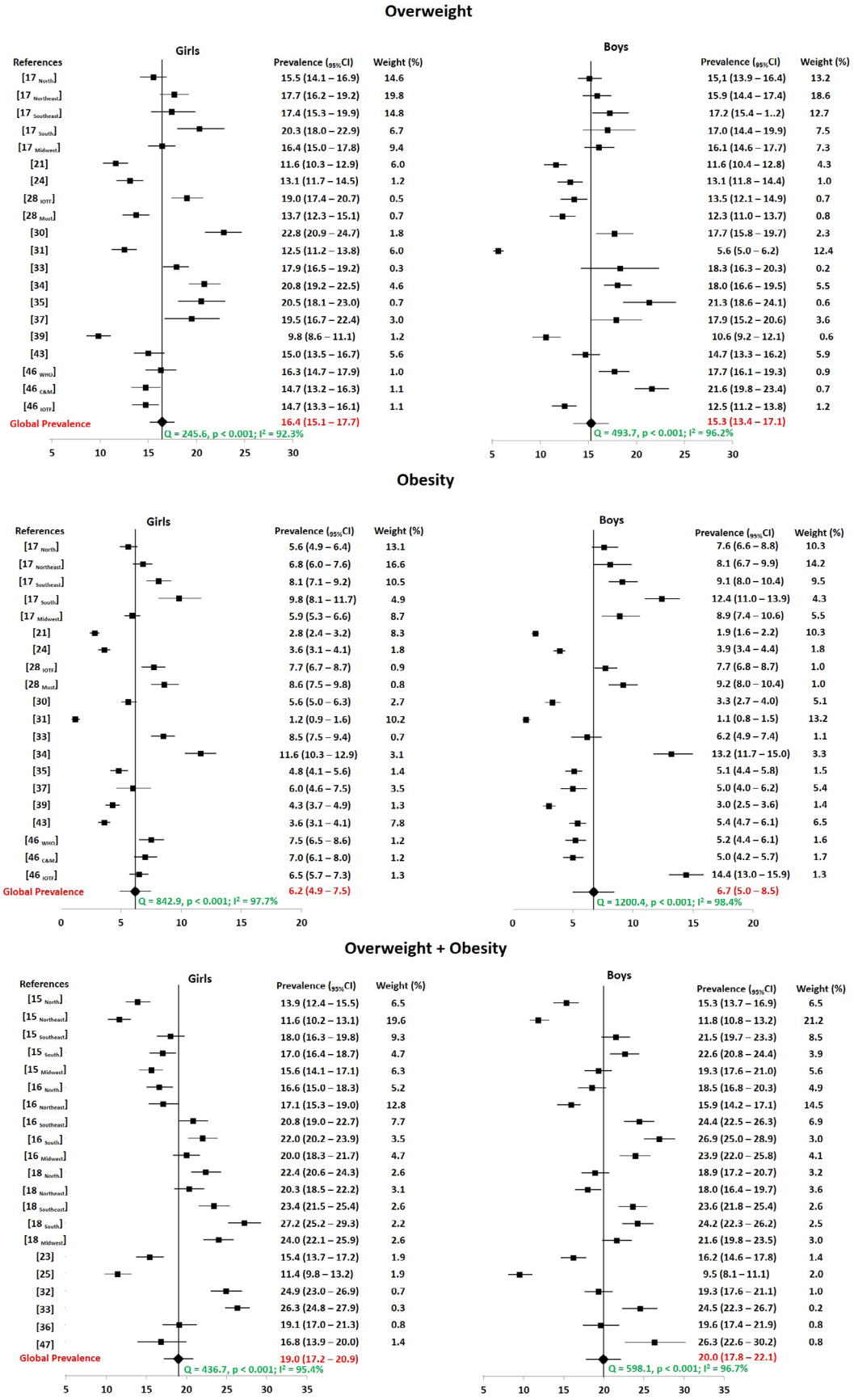

Figure 3: Forest plots of studies that report prevalence rates of overweight and obesity in Brazilian adolescents.

some caution due to the greater concentration of studies focusing on the south and southeast regions, while few studies have been conducted in the central west and north regions, geographic disparities in the prevalence of overweight and obesity among young populations in the same country have already been pointed out by the literature[52-54]. In Brazil, there are marked socio-cultural, economic and urbanization inequalities between geographic regions, which impacts on young people's lifestyles, with emphasis on access and choices of dietary practices, sedentary behavior time and physical activity[55,56]. It is also noteworthy that, economically, the south and southeast regions contribute 71% of the national gross domestic product (GDP)[57], thus boosting the predisposition for an eventual obesogenic environment.

The year of data collection also partially explained the heterogeneity of prevalences reported by different studies. The lowest prevalence rates were identified in studies with data collections carried out in 2000-08, while studies that collected data in 2014-18 pointed to significantly higher prevalence rates. The prevalence rates reported in the studies with the most recent data collection highlight the growing problem in the public health context associated with the excess body weight of Brazilian children and adolescents and corroborate previous findings of temporal trends carried out in developing countries[58,59]. However, it differs from other findings from studies involving children and adolescents from developed countries, which showed stabilization or a slight reduction in this trend[60-62]. In this way, it can be extracted that, probably, the young populations of developed countries are approaching the end of the nutritional transition process, while the young populations of developing countries are still evolving.

Some factors may justify the increasing increases in the prevalence rates of overweight and obesity among young people in recent decades. Restriction of physical space for active leisure, increase in urban violence, incentive to use motorized transport, concomitantly with greater offer of electronic equipment for the occupation of free time (TV, computers, video games, iphone) have contributed decisively to reduce opportunities for physical activity[63]. Important changes in eating habits observed more recently have also contributed to this scenario. High consumption

Table 2: Meta-regression parameters related to the prevalence of overweight and obesity separately by sex.

	Overweight		Obesity	
	Girls	Boys	Girls	Boys
Children				
Region				
Southeast	Reference	Reference	Reference	Reference
South	1.17 (0.91–1.70)	1.29 (0.98–1.90)	1.33 (0.95–2.48)	1.31 (0.96–2.24)
Midwest	-	-	-	-
North	-	-	-	-
Northeast	-	-	-	-
Year of data collection				
2000-08	Reference	Reference	Reference	Reference
2009-13	1.36 (0.97–2.27)	1.32 (0.99–2.19)	1.46 (1.08–2.33)	1.43 (1.07–2.29)
2014-18	1.41 (1.03–2.19)	1.38 (1.04–2.32)	1.54 (1.14–2.41)	1.49 (1.11–2.38)
Diagnostic Criteria				
WHO	Reference	Reference	Reference	Reference
CDC	0.87 (0.61–1.22)	0.82 (0.54–1.18)	0.85 (0.58–1.24)	0.89 (0.61–1.26)
IOTF	0.62 (0.33–0.94)	0.69 (0.39–1.02)	0.58 (0.27–0.93)	0.67 (0.38–1.00)
Adolescents				
Region				
Southeast	Reference	Reference	Reference	Reference
South	1.24 (0.84–2.29)	1.31 (0.90–2.34)	1.19 (0.81–2.25)	1.26 (0.92–1.77)
Midwest	0.89 (0.51–1.47)	0.93 (0.58–1.50)	1.03 (0.70–1.65)	1.26 (0.90–2.21)
North	0.91 (0.55–1.43)	0.84 (0.45–1.38)	0.87 (0.52–1.42)	0.89 (0.55–1.36)
Northeast	0.56 (0.29–0.98)	0.57 (0.32–0.97)	0.58 (0.30–0.98)	0.51 (0.22–0.92)
Year of data collection				
2000-08	Reference	Reference	Reference	Reference
2009-13	1.34 (0.98–2.05)	1.27 (0.93–1.91)	1.43 (1.05–2.24)	1.52 (1.13–2.39)
2014-18	1.41 (1.04–2.26)	1.39 (1.05–2.18)	1.50 (1.15–2.38)	1.61 (1.20–2.53)
Diagnostic criteria				
WHO	Reference	Reference	Reference	Reference
CDC	0.93 (0.54–1.47)	0.90 (0.51–1.42)	0.98 (0.60–1.57)	0.96 (0.59–1.53)
IOTF	0.61 (0.32–0.95)	0.58 (0.31–0.97)	0.59 (0.22–0.96)	0.55 (0.23–0.94)

WHO: World Health Organization.
CDC: Center for Disease Control and Prevention.
IOTF: International Obesity Task Force.

of processed, ultra-processed foods and sugary/soft drinks, lower consumption of fruits/vegetables and replacement of traditional meals and preparations with quick snacks are often pointed out in population surveys involving young Brazilians[64]. Still, less awareness about the risks and consequences of excess body weight at young ages is another factor to be considered[63].

The diagnostic criterion used to define overweight and obesity was another modulator that partially explained the heterogeneity of prevalence reported by different studies. In fact, the results showed that studies based on the World Health Organization (WHO) and Center for Disease Control (CDC) criteria provided significantly higher prevalence of overweight and obesity than those using the IOTF criterion, which is consistent with data available in the literature[65-67]. In adults, there is consensus on the diagnostic criterion to identify excess body weight from the BMI; however, due to implications related to the processes of physical growth and biological maturation, this is not the case in children and adolescents. In view of this, different diagnostic criteria have been proposed and have been used to identify overweight and obesity specifically in young people.

In this context, for some scholars, the IOTF criterion may be more suitable for employing cutoff points defined from associations with increased risks for the presence of health outcomes in early adulthood, while the WHO and CDC criteria take on probabilistic resources in which, regardless of any other additional data related to the aggressions of excess body weight, BMI values equivalent to the 85th and 95th percentiles were identified to identify overweight and obese young people, respectively[68]. However, for others, the IOTF criterion has an important limitation in the sense that the BMI classification at young ages may not necessarily correspond to comparable amounts of body fat in all populations, and is therefore highly variable and dependent on the ethnic component[69].

Thus, there is no consensus on the most suitable criterion for the diagnosis of overweight and obesity in children and adolescents, which leads to obtaining different prevalence, according to the criterion employed. Thus, in order to minimize any misinterpretation of interpretation and enable comparisons between surveys, it is important that in future studies systematically provide estimates of overweight and obesity prevalence using at least the two most accepted international criteria (IOTF and WHO).

Although informative, the results of this review and meta-analysis should be interpreted with caution due to the identification of some limitations. Immediately, although data from the five Brazilian geographic regions have been gathered, it is perceived as a regional imbalance, with 60% of studies carried out in the southeastern and southern regions. Still, prevalence rates were not found separately for overweight and obesity in children from three geographic regions (North, Northeast and Midwest). Thus, it is likely that when more data on under-represented regions becomes available, more reliable information can be achieved. Also, funnel plots and equivalent statistical tests denounced asymmetric distributions of prevalence rates, which suggests the presence of publication bias. In addition, even using random effects models to minimize the impact of variability between studies, a more robust meta-analysis approach would be possible if the heterogeneity of prevalence was not so high.

Despite the limitations described, it is concluded that representative studies on the prevalence of overweight and obesity in young Brazilians are scarce. The review identified a reduced number of studies in the North, Northeast and Midwest Brazilian regions; especially in children. The findings reinforce the need to standardize the use of diagnostic criteria to identify and monitor the prevalence of overweight and obesity in children and adolescents in Brazil. The results found support considerable and increasing prevalence rates of overweight and obesity in the last two decades, which represents a serious public health problem, with implications for the current health of young people and, if the trends observed persist, the future health of the entire population. Thus, it becomes imperative to plan and implement appropriate interventions aimed at promoting healthy lifestyles and behaviors, with a view to effectively preventing and controlling the burden of excess body weight in the young population of our country.

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