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REVIEW PAPER

South American prevalence of overweight and obesity in children and adolescentes from 2010 to 2020: A systematic review with meta-analysis

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Pediatric Obesity,
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Child,
South America
Systematic Review
Meta-Analysis.

Abstract

Objectives: To identify the South American prevalence of overweight and obesity in children and adolescents from 2010 to 2020. **Methods:** A systematic literature search was conducted in PubMed, SCOPUS, LILACS, IBECS and, MedCarib databases. Only cross-sectional, cohort, case-control and clinical trials studies were included. The methodological quality of the studies was assessed independently by two review authors, using the Newcastle-Ottawa scale. Random effect model by DerSimonian and Laird and inconsistency measure (I^2) were used. **Results:** In total, 532 articles met the inclusion criteria. 88 studies were included in the analysis and 80 were classified as high quality/low bias. The prevalence was: 28.3% (95% confidence interval [$CI_{95\%}$]=22.4;34.2% - I^2=99.98%) of excess body weight, 17.8% of overweight ($CI_{95\%}$=14.3;21.3% - I^2=99.94%) and 13.2% ($CI_{95\%}$=10.1;16.3% - I^2=99.96%) of obesity. **Conclusion:** The South American prevalence of overweight was 17.8% and obesity was 13.2%. Meta-analysis showed high heterogeneity (I^2>99%) probably due to the ethnic, cultural and methodological differences.

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INTRODUCTION

According to the World Health Organization (WHO), overweight and obesity are defined as abnormal or excessive accumulation of body fat, being a health hazzard[1]. Having a multifactorial etiology, obesity is a consequence of a combination of genetic, behavioral and environmental factors[2-3]. Inadequate prenatal care, environmental, socioeconomic[4], and genetic factors,[4,5] and exclusive breastfeeding are some of the determining factors for infant weight. In the short and long term, there are consequences related to overweight and obesity in children and adolescents, such as an increased risk of cardiovascular diseases, hypertension, dyslipidemia,[6-9] respiratory diseases,[10,11] type 2 diabetes mellitus,[12,13] digestive tract diseases[14], in addition to psychosocial consequences, such as low self-esteem and stress[15].

According to the Pan American Health Organization (PAHO) and the Ministry of Health of Brazil (MS), 12.9% of Brazilian children between 5 and 9 years old and 7% of adolescents between 12 and 17 years old are obese[4]. Argentina presents general prevalence of overweight and obesity of 60% and 20%, respectively[16,17]. In addition, a population-based study carried out in Peru found a prevalence of overweight of 39.2% and 18.6% of obesity in adults[18]. About the children age range, according to the Panorama of Food and Nutrition Security in Latin America and the Caribbean, 2.5 million children under five years of age would be overweight in 2017[19].

According to the WHO, most overweight and obese children live in developing countries, mainly in urban centers. It is a fact that these countries are experiencing a process of nutritional transition, evidenced by the decrease in malnutrition and the increase in obesity[1,20,21], with a high amount of saturated fat and sodium, and a decrease in the practice of physical activity, negatively influencing the health of children[3,4].

Among the methods for body assessment and identification of excess weight, the body mass index (BMI) is the main anthropometric measure used. Another parameter is the measurement of abdominal circumference, important for the diagnosis of central adiposity, which, when present, is related to important metabolic changes[22]. There are growth curves, used to monitor the growth of children and adolescents, which are essential in the pediatric routine, as they allow monitoring and assessment of the child's health status[23,24].

To compare the nutritional status of different populations, curves were proposed to represent the growth of children and that could be standardized for global use[23,24]. Initially, the 1977 National Center for Health Statistics (NCHS) curve was recommended by the WHO and adopted in Brazil; however, it was based on a restricted sample[25]. Then, in the year 2000, the Centers for Disease Control and Prevention (CDC) and the NCHS, aiming to correct limitations of the previous curves, created a new reference with a more diversified sample; however they still included children with criticized characteristics on the previous curve[25,26]. Also in 2000, Cole et al developed growth curves based on BMI for age, based on six countries, for definitions of overweight and obesity in children aged 2 to 18 years[27]. Such curves, due to an international character, were recommended by the International Obesity Task Force (IOTF), claiming to be less arbitrary and with greater possibility of comparison between overweight and obesity rates in different countries when compared to the previous curves[27,28].

In 2006 and 2007, the WHO curves were published, created from a multicenter study with more than 8,500 children in six countries with the objective of representing the ideal growth pattern of children and adolescents aged 0 to 19 years. By including in the sample children from each of the 5 continents, from different ethnic groups, they are universally recommended for the assessment of nutritional status[23,24]. However, many countries opt for curves that represent the characteristics of the local population, but that does not allow comparability with data from other countries[24,29-32].

In fact, there is a gap in the literature regarding the prevalence of overweight in the pediatric population and in adolescents in South America. This assessment makes it possible to identify whether, despite the geographical proximity and similar demographic aspects of the countries, there are significant differences in relation to the epidemiological situation and, therefore, to guide public healthcare interventions. From such comparison, one can understand the need for broad or more localized interventions. In addition, determining the prevalence in the last decade not only identifies the current morbidity scenario, but also allows comparison with those from other decades and, therefore, the establishment of its temporal evolution. Thus, the present study aims to identify the South American prevalence of overweight and obesity in children and adolescents from 2010 to 2020.

METHODS

Protocol design and registration

A systematic review was carried out with meta-analysis of cross-sectional studies, cohorts, case-controls and clinical trials, with data collection on the prevalence of overweight and obesity in South American children from 2010 to 2020, that used the 2006/2007 WHO curves in their methodology[33]. The search involved the following PICO strategy:

Patient/problem - Children (2 to 12 years old) and adolescents (12 to 19 years old) residing in South American countries who are overweight, that is, overweight and/or obese;

Intervention - anthropometric measurement of the study population under classification of the WHO 2006/2007 curves;

Comparison - there could or could not be a comparison group, depending on the design of the evaluated studies;

"Outcomes" (outcome) - ratio of overweight patients in the study population.

The selection of studies, data extraction and analysis of bias risk of the evaluated papers were carried out by two authors, independently. Differences that could not be resolved by consensus were discussed with a third independent

evaluator. The research protocol was registered on the Prospero Platform (https://www.crd.york.ac.uk/prospero/) under number CRD42020201229. The report of this study followed the recommendation Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[34].

Eligibility criteria

Papers in Portuguese, English or Spanish published in the last 5 years were included in the review, whose data were collected in the last 10 years, which presented the prevalence of overweight (obesity and overweight), obesity and/or overweight, using the WHO curves and the surveyed population was restricted to South America. Also, studies dealing with a population with children (2 to 12 years old) and adolescents (12 to 19 years old) were eligible.

Exclusion criteria

Papers that did not use the WHO curve for classification, had a population outside the age range of 2 to 19 years; study population that included patients with diseases that affected their nutritional status; studies that used a convenience sample or already obese; theme not consistent with the study; papers that were not scientific; paper not available in full or that did not inform the period of data collection.

Study selection and data extraction

The search, between 09/03/2020 and 09/12/2020, was carried out in the databases PubMed (https://pubmed.ncbi.nlm.nih.gov/), Scopus (https://www.scopus.com /), LILACS (https://lilacs.bvsalud.org/), IBECS (http://ibecs.isciii.es/) and MedCarib (https://libguides.uwi.edu/MedCaribRegionalCoordinatingCenter).

3 search strategies were defined: in PubMed, using the following MeSH terms (https://www.ncbi.nlm.nih.gov/mesh) ((("Obesity"[Mesh] OR "Obesity, Morbid"[Mesh] OR "Overweight"[Mesh]) AND ("Adolescent"[Mesh] OR "Child"[Mesh] OR "Child, Preschool"[Mesh])) OR "Pediatric Obesity"[Mesh]) AND ("Cross-Sectional Studies"[Mesh] OR "Prevalence"[Mesh] OR "Epidemiology"[Mesh] OR "Cross Sectional study" OR Prevalence) AND (y_5[Filter]) AND (humans[Filter]) AND (English[Filter] OR Portuguese[Filter] OR Spanish[Filter]) AND ("South America"[Mesh]).

In the LILACS, IBECS and MedCarib databases, CS terms were used (http://decs.bvs.br/)(((Obesity OR "Obesity, Morbid" OR Overweight) AND (Adolescent OR Child OR "Child, Preschool")) OR "Pediatric Obesity ") AND ("Cross-Sectional Studies" OR Prevalence OR Epidemiology) AND ("South America"). In addition, the publication date filter corresponding to the last 5 years was used.

In the Scopus database, the descriptors were: ("Obesity" OR "Obesity, Morbid" OR "Overweight" AND "Adolescent" OR "Child" OR "Child, Preschool" OR "Pediatric Obesity" AND "South America") AND PUBYEAR > 2015). The selection process was based only on search in the databases described, not considering, therefore, the review of reference articles in systematic reviews found.

For data extraction, we made a spreadsheet using Microsoft Excel software version 2019 (Microsoft Office 365 ProPlus, Redmond-WA, USA).

Assessment of the methodological quality of the included studies

The Newcastle-Ottawa Scale (NOS) for quality assessment was used according to each type of study, cohort, case--control and cross-sectional, analyzing the following criteria:

(1) selection - related to the representativeness of the evaluated sample, as well as the quality of the record;

(2) comparability of groups - related to the suitability of the design for comparison between groups;

(3) study outcome assessment – highlights how the outcome was assessed, possibility of bias in the collection or the record itself, and adequate follow-up time until the outcome;

In the criteria, there is the possibility that the study receives zero, one or two stars according to the presence or absence of the evaluated items. The study that obtained a number greater than seven stars were considered of high quality; medium quality had between four and seven stars; and low quality were those with less than four stars.

Data analysis

The prevalence and 95% confidence interval (95%CI) of excess weight, overweight and obesity were calculated for children in general and the prevalence by gender. The meta--analysis used the combination of data under the random effects of DerSimonian and Laird. The inconsistency measure (I2) was calculated to assess the heterogeneity of the results. The tabulation was performed in the Microsoft Excel© program; the statistical analyzes and the Forest Plot graph were done in the Stata software version 16.0 (StataCorp. 2019. StataStatistical Software: Release 16. CollegeStation, TX: StataCorp LP), at a significance level of 5%.

RESULTS

Database searches found 532 papers (flowchart 1): 486 from PubMed, 40 from Scopus, 3 from LILACS, 2 IBECS and 1 MedCarib. After finding them, 8 duplicate papers were excluded and the papers were screened and checked for eligibility. In the screening, 296 articles were excluded in the first phase and 140 articles in the second phase, and in the second phase, 4 articles were excluded that had only an abstract, but the article was removed from the network in full, showing that it was not available in its entirety.

In the meantime, 88 were analyzed quantitatively and qualitatively. Of the papers selected for the meta-analysis analyzed using the New Castle – Ottawa scale, 80 were classified as high quality, 8 as intermediate quality and none classified as low quality (Table 1)[35-123]The following were extracted from these studies: (1) name of the first author; (2) study design; (3) year of publication;(4) country; (5) population characteristics (age distribution and sample size); (6) data collection time; and (7) prevalence of overweight/obesity and obesity (Table 2). In the

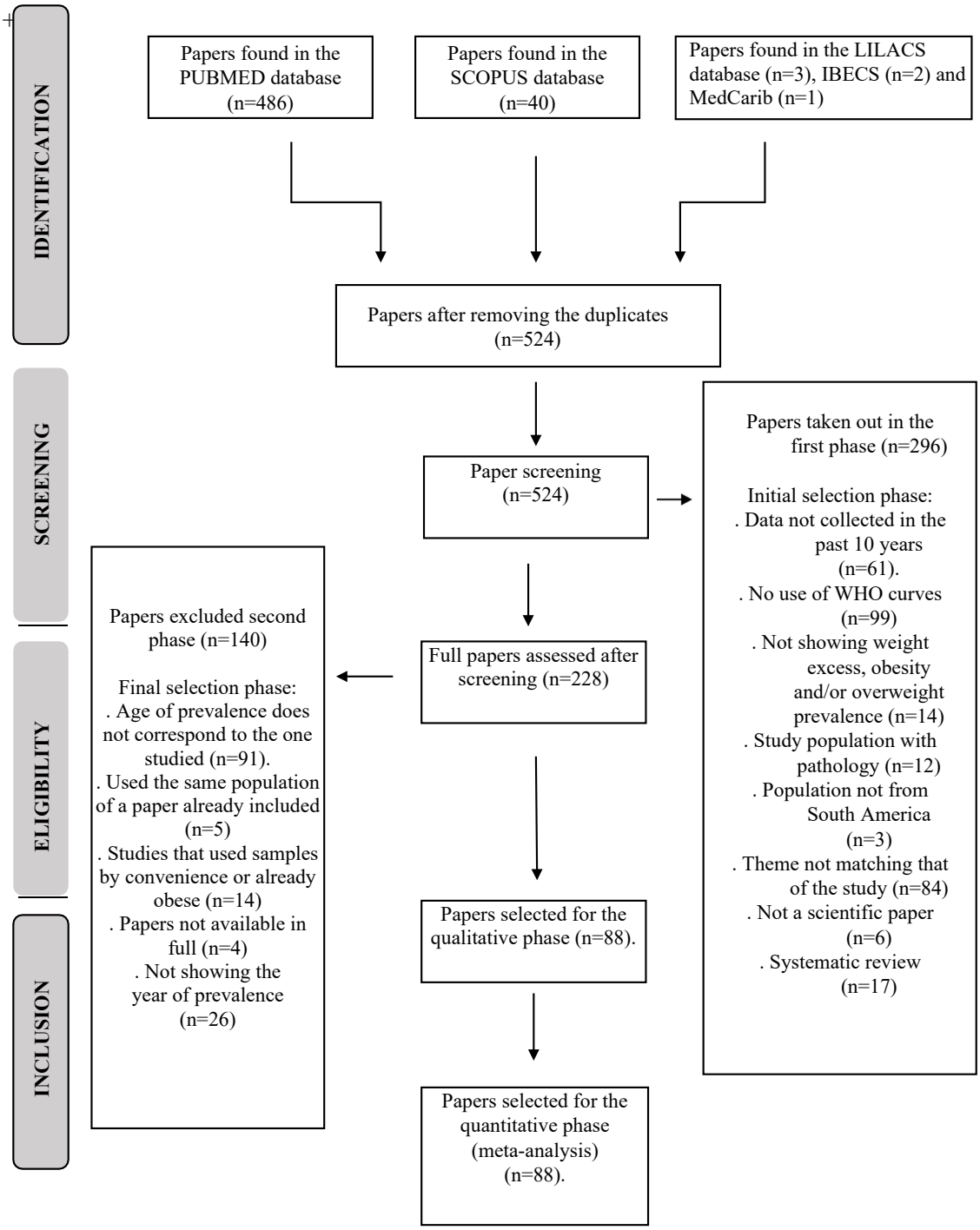


Figure 1. Paper search, selection and inclusion process.

studies, the number of participants was 1,488,175, with samples ranging from 33 to 630,968 children. Due to the research and inclusion and exclusion factors, we found no papers from all South American countries that fit this systematic review criteria. Articles from the following countries were analyzed: Brazil (60), Chile (9), Colombia (7), Argentina (5), Peru (3), Ecuador (2) and Uruguay (1). One of the articles combined data from Brazil, Chile, Colombia, Argentina, Peru and Uruguay (Table 2).

Of the investigated studies, the highest proportion of overweight was observed by Fierro M. J. et. al., in Chile (60.4%),[44] while the smallest was identified by Romo L. M. et. al., in Ecuador (0.6%)[61]. The highest prevalence of obesity was identified by Quadros T.M.B. et. al. in Brazil[43], with 38.7%, while the lowest prevalence was identified by Hernándes-Vásquez et. al., 0.6%, in Peru[111]. Regarding overweight, the highest proportion was found by Fierro M. J. et. al., in Chile (30.2%)[44] and the lowest proportion was identified by Romo L. M. et. al., in Ecuador (0.6%)[61].

Table 1. Assessing the quality of the papers included using the New Castle – Ottawa scale.

Studies analyzed	Selection	Comparability	Outcome	Total	Classification[a]
Palacio-Agüero A *et al.*	*****	**	***	10*/10*	High quality
Rocha SGMO *et al.*	*****	**	***	10*/10*	High quality
Santos NF *et al.*	*****	**	***	10*/10*	High quality
Lourenço AEP *et al.*	*****	**	***	10*/10*	High quality
Uzêda JCO *et al.*	*****	**	***	10*/10*	High quality
Kain J *et al.*	**	**	**	6*/9*	Medium quality
Soria L *et al.*	****	**	***	9*/10*	High quality
Sousa TM *et al.*	****	**	***	9*/10*	High quality
Quadros TMB *et al.*	*****	**	***	10*/10*	High quality
Fierro MJ *et al.*	**	**	*	5*/9*	Medium quality
Palafox ML *et al.*	**	*	**	5*/10*	Medium quality
Aristizábal JC *et al.*	*****	**	***	10*/10*	High quality
González-Zapata LI *et al.*	*****	**	***	10*/10*	High quality
Guimarães FR *et al.*	****	**	***	9*/10*	High quality
Todendi PF *et al.*	*****	**	***	10*/10*	High quality
Martinez-Ospina A *et al.*	*****	**	***	10*/10*	High quality
Tarqui-Mamani C *et al.*	****	**	***	9*/10*	High quality
Cordero ML *et al.*	*****	**	***	10*/10*	High quality
Silva AP *et al.*	*****	**	***	10*/10*	High quality
Pereira JL *et al.*	*****	**	***	10*/10*	High quality
Vieira-Ribeiro SA *et al.*	****	**	***	9*/10*	High quality
Hoke MK *et al.*	****	**	***	9*/10*	High quality
Todendi PF *et al.*	*****	**	***	10*/10*	High quality
Paes-Silva RP *et al.*	*****	**	***	10*/10*	High quality
Pedroso J *et al.*	*****	**	***	10*/10*	High quality
Calbano AG *et al.*	*****	**	***	10*/10*	High quality
Romo LM *et al.*	****	**	***	9*/10*	High quality
Garcia-Espinosa V *et al.*	****	**	***	9*/10*	High quality
Rossi CE *et al.*	*****	**	***	10*/10*	High quality
Assis MM *et al.*	*****	**	***	10*/10*	High quality
Alvim RO *et al.*	****	**	***	9*/10*	High quality
Ledo DL *et al.*	*****	**	***	10*/10*	High quality
Hormazábal-Peralta A *et al.*	***	**	***	8*/10*	High quality
Herrera JC *et al.*	*****	**	***	10*/10*	High quality
Carmo CDS *et al.*	****	**	***	9*/10*	High quality
Cuesta LL *et al.*	*****	**	***	10*/10*	High quality
Moraes FGL *et al.*	****	**	***	10*/10*	High quality
Fávaro TR et. al.	*****	**	***	10*/10*	High quality
Gonçalves WSF *et al.*	*****	**	***	10*/10*	High quality
Alexius SL *et al.*	*****	**	***	10*/10*	High quality
Assis MM *et al.*	*****	**	***	10*/10*	High quality
Saboia ZMRM *et al.*	**	**	***	7*/10*	Medium quality
Araújo EPS *et al.*	*****	**	***	10*/10*	High quality

Continued **table 1.**

Farias ES *et al.*	*****	**	***	10*/10*	High quality
Lima, TR *et al.*	*****	**	***	10*/10*	High quality
Dumith SC *et al.*	*****	**	***	10*/10*	High quality
Filgueiras MS *et al.*	****	**	***	9*/10*	High quality
Ciaccia MCC *et al.*	*****	**	***	10*/10*	High quality
Ripka WL *et al.*	***	**	***	8*/10*	High quality
Carneiro CS *et al.*	*****	**	***	10*/10*	High quality
Dunker KLL *et al.*	****	**	**	8*/9*	High quality
Anjos LAD *et al.*	*****	**	**	9*/10*	High quality
BergelSanchís ML *et al.*	***	**	***	8*/10*	High quality
Araujo AM *et al.*	*****	**	***	10*/10*	High quality
Santana DD *et al.*	*****	**	***	10*/10*	High quality
Moran CA *et al.*	***	**	***	8*/10*	High quality
Araujo DS *et al.*	****	**	***	9*/10*	High quality
Flor-Garrido P *et al.*	****	**	***	9*/10*	High quality
Navarro-Pérez CF *et al.*	****	**	***	9*/10*	High quality
López-Fuenzalida A *et al.*	***	**	***	8*/10*	High quality
Campos RO *et al.*	****	**	***	9*/10*	High quality
Gómez-Campos R *et al.*	**	**	***	7*/10*	Medium quality
Catalani F *et al.*	*****	*	***	9*/10*	High quality
Dutra GF *et al.*	****	**	***	9*/10*	High quality
Sánchez U *et al.*	****	*	***	8*/10*	High quality
Bloch KV *et al.*	****	**	***	9*/10*	High quality
Santos LP *et al.*	***	**	***	8*/10*	High quality
Leme AC *et al.*	****	**	***	9*/9*	High quality
Barbosa Filho VC *et al.*	****	**	***	9*/10*	High quality
Koppen IJ *et al.*	***	**	***	8*/10*	High quality
Costa LCF *et al.*	****	**	***	9*/10*	High quality
Rodríguez-Escobar G *et al.*	***	**	***	8*/10*	High quality
Aristizabal JC *et al.*	***	**	***	8*/10*	High quality
Lander RL *et al.*	***	**	***	8*/10*	High quality
Burrows R *et al.*	**	**	**	6*/9*	Medium quality
Moreira NF *et al.*	***	**	***	8*/10*	High quality
Hernández-Vásquez A *et al.*	****	**	***	9*/10*	High quality
Corrêa EN *et al.*	*****	**	***	10*/10*	High quality
Araújo ML *et al.*	***	**	**	7*/9*	High quality
Madruga JG *et al.*	**	**	***	7*/10*	Medium quality
Todendi PF *et al.*	*****	**	***	10*/10*	High quality
Monteiro AR *et al.*	***	**	***	8*/10*	High quality
Batista MDSA *et al.*	***	**	***	8*/10*	High quality
Cecon RS *et al.*	***	**	***	8*/10*	High quality
Melo EM *et al.*	**	**	***	7*/10*	Medium quality
Vieira CENK *et al.*	*****	**	***	10*/10*	High quality
Sparrenberger K *et al.*	***	**	***	8*/10*	High quality
Lopes AF *et al.*	***	**	***	8*/9*	High quality

[a] For the studies, we considered High quality (>7*), medium quality (4*-7*) and low quality (<4*). For the cross-sectional studies, the highest considered was 10* and for cohort, case-control and clinical Trial studies, the maximum considered was 9*.

Table 2. Characteristics of the studies included

Author	Study design	Year of publication	Country	Age range	Sample size	Study period	Overweight prevalence	General overweight prevalence	General obesity prevalence
Palacio-Agüero A *et al.*	Cross-sectional study	2020	Chile	10 - 17	491	2018	160	116	44
Rocha SGMO *et al.*	Cross-sectional study	2020	Brazil	2 - 6 years	2.059	2017	371	223	148
Santos NF *et al.*	Cross-sectional study	2019	Brazil	10 - 19	179	2015	36	24	12
Lourenço AEP *et al.*	Cross-sectional study	2019	Brazil	2 - 6 years	962	2012 - 2014	174	113	61
Uzêda JCO *et al.*	Cross-sectional study	2019	Brazil	13 - 17 years	10.770	2015	2631	-	-
Kain J *et al.*	Cohort	2019	Chile	4 years	483.509	2011 - 2015	249288	134899	114389
Soria L *et al.*	Cross-sectional study	2019	Brazil	2 - 14 years	205	2016	49	26	23
Sousa TM *et al.*	Cross-sectional study	2019	Brazil	6 - 18 years	299	2013 - 2014	60	40	20
Quadros TMB *et al.*	Cross-sectional study	2019	Brazil	6 - 17 years	1.139	2011 - 2012	-	-	441
Fierro MJ *et al.*	Case control study	2019	Chile	(3 - 5 base year)	265	2016	160	80	80
Palafox ML *et al.*	Cross-sectional study	2019	Colombia	6 a 13 years	33	2015 - 2016	16	8	8
Aristizábal JC *et al.*.	Cross-sectional study	2019	Colombia	10 - 18 years	346	2015	67	51	16
González-Zapata LI *et al.*	Cross-sectional study	2019	Argentina, Peru, Colombia, Uruguay, Chile e Brazil	3 - 17 years	1035	2016 - 2017	193	121	72
Guimarães FR *et al.*	Cross-sectional study	2019	Brazil	12 - 18 years	997	2013	273	189	84
Todendi PF *et al.*	Cross-sectional study	2019	Brazil	7 - 17 years	871	2014 - 2015	381	219	162
Martinez-Ospina A *et al.*	Cross-sectional study	2019	Colombia	7 - 13 years	715	2015	203	127	76
Tarqui-Mamani C *et al.*	Cross-sectional study	2018	Peru	5 & 13 years	2801	2013 - 2014	742	446	296
Cordero ML *et al.*	Cross-sectional study	2018	Argentina	8 - 12 years	666	2015	334	153	181
Silva AP *et al.*	Cross-sectional study	2018	Brazil	5 - 18 years	1125	2012 - 2013	364	195	169

Continued **table 2.**

Pereira JL *et al.*	Cross-sectional study	2018	Brazil	12 - 19 years	520	2015	149	101	48
Vieira-Ribeiro SA *et al.*	Cross-sectional study	2018	Brazil	4 - 7 years	403	2014	103	95	8
Hoke MK *et al.*	Cross-sectional study	2018	Peru	3 - 14 years	929	2015	120	106	14
Todendi PF *et al.*	Cross-sectional study	2018	Brazil	6 - 17 years	1471	2014 - 2015	604	339	265
Paes-Silva RP *et al.*	Cross-sectional study	2018	Brazil	2 - 19 years	411	2013	114	71	43
Pedroso J *et al.*	Cross-sectional study	2018	Brazil	5 - 9 years	548	2015	187	117	70
Calbano AG *et al.*	Cross-sectional study	2018	Argentina	8 - 14 years	1531	2011	559	335	224
Romo LM *et al.*	Cross-sectional study	2018	Ecuador	3 - 4 years	155	2015	1	1	-
Garcia-Espinosa V *et al.*	Cross-sectional study	2018	Uruguay	4 - 17 years	609	2016	-	-	171
Rossi CE *et al.*	Cross-sectional study	2018	Brazil	7 - 14 years	2506	2012 - 2013	826	511	315
Assis MM *et al.*	Cross-sectional study	2018	Brazil	7 - 14 years	661	2011 - 2012	-	-	92
Alvim RO *et al.*	Cross-sectional study	2019	Brazil	8 - 14 years	296	2016 - 2017	62	-	-
Ledo DL *et al.*	Cross-sectional study	2018	Brazil	6 - 12 years	719	2012	223	143	80
Hormazábal-Peralta A *et al.*	Cross-sectional study	2018	Chile	14 - 18 years	73	2014	31	11	20
Herrera JC *et al.*	Cross-sectional study	2017	Chile	5 - 8 years	189.055	2013	-	-	45545
Carmo CDS *et al.*	Cross-sectional study	2018	Brazil	17 - 18 years	405	2014 - 2016	55	37	18
Cuesta LL *et al.*	Cross-sectional study	2018	Argentina	6 - 14 years	1296	2013	557	318	239
Moraes FGL *et al.*	Cross-sectional study	2017	Brazil	9 - 11 years	485	2012 - 2013	220	112	108
Fávaro TR *et al.*	Cross-sectional study	2019	Brazil	2 - 10 years	363	2010	20	-	-
Gonçalves WSF *et al.*	Cross-sectional study	2019	Brazil	3 - 5 years	318	2017	109	-	-
Alexius SL *et al.*	Cross-sectional study	2018	Brazil	11 - 14 years	975	2012 - 2013	279	-	-

Continued **table 2.**

Assis MM *et al.*	Cross-sectional study	2018	Brazil	6 - 15 years	408	2011 - 2014	140	-	-
Saboia ZMRM *et al.*	Cross-sectional study	2018	Brazil	14 - 19 years	56	2015	11	-	-
Araújo EPS *et al.*	Cross-sectional study	2017	Brazil	15 - 19 years	220	2015	50	-	-
Farias ES *et al.*	Cross-sectional study	2019	Brazil	14 - 18 years	2,694	2015	652	-	-
Lima, TR *et al.*	Cross-sectional study	2018	Brazil	14 - 19 years	1110	2014	-	266	-
Dumith SC *et al.*	Cross-sectional study	2018	Brazil	13 - 19 years	1075	2011	109	-	-
Filgueiras MS *et al.*	Cross-sectional study	2018	Brazil	4 - 9 years	788	2012 - 2015	229	-	-
Ciaccia MCC *et al.*	Cross-sectional study	2017	Brazil	5 - 13 years	1,05	2015	427	177	250
Ripka WL *et al.*		2017	Brazil	12 - 17 years	374	2015-2016	100	78	22
Carneiro CS *et al.*	Cross-sectional study	2017	Brazil	12-18 years	1,169	2011	248	165	83
Dunker KLL *et al.*	Clinical trial	2018	Brazil	12-14 years (only girls)	139	2015	-	-	22
Anjos LAD *et al.*	Cross-sectional study	2017	Brazil	3 - 17 years	20.113	2012	6035	3531	2504
BergelSanchís ML *et al.*	Cross-sectional study	2017	Argentina	3-6 years	1435	2010 - 2012	456	300	156
Araujo AM *et al.*	Cross-sectional study	2017	Brazil	2-5 years	548	2012	23	23	0
Santana DD *et al.*	Cross-sectional study	2017	Brazil	12-18.9 years	314	2010	97	72	25
Moran CA *et al.*	Cross-sectional study	2017	Brazil	8-10 years	40	Cep as of 2010	17	6	11
Araujo DS *et al.*	Cross-sectional study	2016	Brazil	8-10 years	313	2012-2013	-	67	54
Flor-Garrido P *et al.*	Cross-sectional study	2016	Ecuador	12-19 years	314	2014	71	62	9
Navarro-Pérez CF *et al.*	Cross-sectional study	2016	Colombia	9-17.9 years	4885	2014-2015	1307	922	385
López-Fuenzalida A *et al.*	Cross-sectional study	2016	Chile	6-10 years	388	2014	176	104	72
Campos RO *et al.*	Cross-sectional study	2016	Brazil	6-14 years	1212	2013-2014	285	184	101
Gómez-Campos R *et al.*	Cross-sectional study	2016	Chile	8-17 years	280	2014	-	-	43
Catalani F *et al.*	Cross-sectional study	2016	Argentina	13 years	711	2014	288	188	100

Continued **table 2.**

Dutra GF *et al.*	Cross-sectional study	2016	Brazil	8 years	616	2011	-	126	104
Sánchez U *et al.*	Cross-sectional study	2016	Chile	7-10 years	1058	2010-2011	542	289	253
Bloch KV *et al.*	Cross-sectional study	2016	Brazil	12-17 years	73399	2013-2014	18692	12591	6101
Santos LP *et al.*	Cross-sectional study	2016	Brazil	6 years	3350	2010-2011	1154	591	563
Leme AC *et al.*	Clinical trial	2016	Brazil	14-18 years	111	2015	-	-	5
Barbosa Filho VC *et al.*	Cross-sectional study	2016	Brazil	6-11 years	2035	2012	-	-	192
Koppen IJ *et al.*	Cross-sectional study	2016	Colombia	8-18 years	2820	2014	712	524	188
Costa LCF *et al.*	Cross-sectional study	2015	Brazil	7-10 years	1530	2012-2013	561	356	205
Rodríguez-Escobar G *et al.*	Cross-sectional study	2015	Colombia	5-16 years	785	2014	147	112	35
Aristizabal JC *et al.*	Cross-sectional study	2015	Colombia	2-5 years	232	2014	112	29	83
Lander RL *et al.*	Cross-sectional study	2015	Brazil	3-6 years	364	2010	52	40	12
Burrows R *et al.*	Cohort	2016	Chile	16-17 years	667	2010	-	-	108
Moreira NF *et al.*	Cross-sectional study	2018	Brazil	13.5-19 years	968	2010	246	174	72
Hernández-Vásquez A *et al.*	Cross-sectional study	2016	Peru	3 - 5 years	2 318 980	2014	51248	36804	14444
Corrêa EN *et al.*	Cross-sectional study	2018	Brazil	7-14 years	2195	2012-2013	735	-	-
Araújo ML *et al.*	Cohort	2017	Brazil	15-18 years	382	2012	-	-	-
Madruga JG *et al.*	Cross-sectional study	2016	Brazil	10-17 years	1030	2012	305	-	-
Todendi PF *et al.*	Cross-sectional study	2016	Brazil	7-17 years	1254	2010	365	-	-
Monteiro AR *et al.*	Cross-sectional study	2016	Brazil	13-19 years	1088	2011	114	-	-
Batista MDSA *et al.*	Cross-sectional study	2017	Brazil	5 - 14 years	7017	2014	2147	-	-
Cecon RS *et al.*	Cross-sectional study	2017	Brazil	10- 19 years	2123		447	-	-
Melo EM *et al.*	Cross-sectional study	2016	Brazil	11-19 years	196	2010-2012	58*	-	-
Vieira CENK *et al.*	Cross-sectional study	2016	Brazil	12-18 years	347	2013	100	-	-
Sparrenberger K *et al.*	Cross-sectional study	2015	Brazil	2-10 years of age	204	2012-2014	68	-	-
Lopes AF *et al.*	Cohort	2016	Brazil	2-3 years	463	2014	28	23	5

* Showed only the prevalence of female overweight

According to the meta-analysis performed, the prevalence of overweight among children in general found in 74 papers was 28.3% (95% confidence interval [$_{95\%}$CI]=22.4;34.2% - I^2= 99.98%), while overweight and obesity had a prevalence of 17.8% ($_{95\%}$CI=14.3;21.3% - I^2=99.94%) and 13.2% ($_{95\%}$CI=10.1 ;16.3% - I^2=99.96%), with data obtained from 58 and 65 studies, respectively. We had 44 studies addressing female overweight, with a mean prevalence of 30% ($_{95\%}$CI=25;36% - I^2=99.82%) and overweight prevalence was 20% ($_{95\%}$CI=17; 23% - I^2=99.22%) in females in 31 of the papers analyzed. The prevalence of obesity was 13% ($_{95\%}$CI=10;17% - I^2=99.84%) in girls, verified in 33 studies (Table 3).

In male children, 41 studies addressed overweight, with a prevalence of 31% ($_{95\%}$CI=23;39%). Of 29 studies that dealt with overweight, the prevalence was 17% ($_{95\%}$CI= 14;20%) and in 33 studies that analyzed obesity, the prevalence was 15% ($_{95\%}$CI= 13;18%). By observing the overlap between the confidence intervals for the prevalence of excess weight, overweight and obesity, there was no significant difference between the genders (Table 3). Figure 2 shows a similar distribution of the prevalence of excess weight between the genders in the different studies, with the summary measure in the female sex being 30% ($_{95\%}$CI= 25; 36%) and in the male sex 31% ($_{95\%}$CI= 23; 39%); therefore, without significant differences. It is noteworthy that, for all analyses, heterogeneity was substantial (I^2>99%).

DISCUSSION

The present study aims to identify the South American prevalence of overweight from 2010 to 2020 in children and adolescents, filling the gap regarding these data in the continent.

The South American prevalence of excess weight, overweight and obesity between 2010 and 2020 seen by the present study were 28.3%, 17.8% and 13.2%, respectively. Another study, also carried out in South America with data from 2009 to 2013, found very similar findings, with a prevalence of overweight in the 12-15 age group of 20.3% (18.3–22.3%) and obesity 11 .6% (9.2–13.9%)[124].

When compared to other continents, the prevalence of overweight in the present study is lower than data from Europe - 21.3% (18.6-24.0%); and higher in relation to Asia (9.7%) and Africa (11. 7%).

The prevalence of overweight and obesity was higher among boys; while overweight was higher among girls in our study. However, there was no association between excess weight, overweight and obesity and gender of children and adolescents.

A study carried out with 6,970 Chinese (2002-204) showed that adolescent boys are more likely to be overweight or obese[125]. Another study with children aged 6 to 9 years old, Europeans (2007-2013) concluded that, although it varied greatly, the prevalence was generally higher among boys compared to girls[126]. Adolescent boys were also reported to exhibit behaviors and perceptions susceptible to weight gain in a 2011 Chinese study[127]. The literature also reports a study with 18 South American countries, from 2009 to 2013, in which the prevalence of obesity was slightly higher in males (12.1%) compared to females (10.9%); while the prevalence of overweight was higher among females (21.1%) when compared to males (19.3%)[124], with no significant difference between the genders, also corroborating our findings.

As for the etiology of excess weight, despite being multifactorial, environmental factors seem to be the most important for pandemic levels to have been reached in the last 50 years among children and adolescents[128]. Behavioral changes such as the exponential increase in screen time and increased consumption by ultra-processed food families, culminated in a similar distribution of illness between the genders, given that there are no differences in exposure to these factors. It is also worth noting that obesity has an autosomal polygenic character, which corroborates the reported lack of difference between genders[129].

Statistical analysis showed high heterogeneity (I2 > 99%) in the present study, which can be attributed to the diversity between the methodologies used by the studies, the different sample sizes, in addition to highlighting the diversity between the studied populations. Although the WHO curves are a tool that makes it possible to compare the nutritional status of different populations[23,24], the high heterogeneity may suggest that the use of local curves would more appropriately characterize the nutritional status of the children.

This diversity among the studied populations has also been found in studies from different countries around the world. A cohort of seven European countries (Belgium, Cyprus, Germany, Hungary, Italy, Spain, Sweden), with prevalence from 2007 to 2010, evaluated the heterogeneity between countries. Differences between countries regarding the assessment of growth by BMI were already observed during early childhood and increased with increasing age up to 12 years[130]. A systematic review involving low-income countries of the world also showed high heterogeneity between populations vis-à-vis childhood obesity and metabolic syndrome due to population differences between countries[131].

Table 3 . Prevalence of weight excess; overweight and obesity, according to gender in the studies analyzed.

	General	Heterogeneity (I^2)	Females	Heterogeneity (I^2)	Males	Heterogeneity (I^2)
Weight excess	74 studies 28.3% (CI 22.4-34.2%)	99.98%	44 studies 30% (CI 25-36%)	99.82%	41 studies 31% (CI 23-39%)	99.93%
Overweight	58 studies 17.8% (CI 14.3-21.3%)	99.94%	31 studies 20% (CI 17-23%)	99.22%	29 studies 17% (CI 14-20%)	99.40%
Obesity	65 studies 13.2% (CI 10.1-16.3%)	99.96%	33 studies 13% (CI 10-17%)	99.84%	33 studies 15% (CI 13-18%)	99.64%

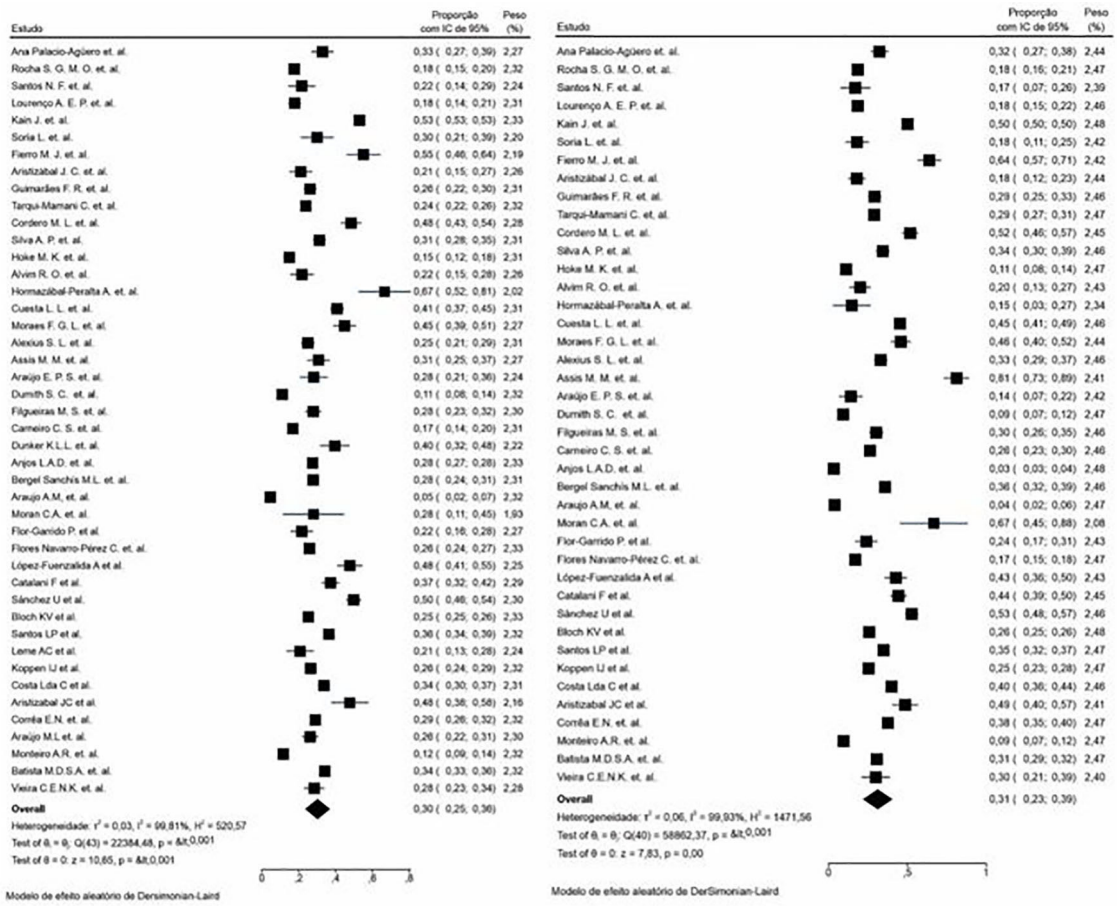


Figure 2. Weight excess prevalence among females (2A) and Males (2B).Heterogeneidade = heterogeneity.

Some countries such as South Africa, Hong Kong, Germany and the United Kingdom compared the use of the WHO curves with their local references, reporting divergences in the diagnosis of child growth[29-32,132,133]. Considering these differences, China, Denmark, Belgium, Czechoslovakia, Bolivia and Norway opted to use their own charts to assess growth[29].

Furthermore, the influence of genetic factors on child growth is widely discussed in the literature. There is evidence that heredity influences BMI[134,135], especially in obesogenic environments[136], also pointing to the role of environmental and behavioral factors in the etiology of obesity. The interaction of all these factors could explain the differences found in the samples and the heterogeneity of the present study.

Despite the importance of monitoring the child's development and nutritional status through the growth curves, it is essential to value the clinical examination, relating this to the analysis of the curves in the pediatric routine for an adequate diagnosis of any alterations in the child's development, as well as to prevent future complications such as hypertension, diabetes and cardiovascular disease[2,3].

As for the strengths of the study, the PRISMA protocol was strictly followed. In addition, to ensure the quality of the included studies and the reliability of this paper, the New Castle - Ottawa scale was used, with few studies classified as medium quality and no papers classified as low quality in the literature studies or official data regarding the South American prevalence of excess weight, overweight and obesity in children and adolescents, sustaining that the gap in the literature was filled.

Not all South American countries were included due to non-compliance with the study's eligibility criteria. Although only 7 of the 13 countries that make up the region were included, these are also the ones with the largest populations, which may have contributed to obtaining results that adequately characterize the continent's population[26] studies were excluded for not accurately presenting publication data ensuring methodological rigor.

It is important to point out that in several papers there was no separation by age groups, making it impossible to carry out a more accurate analysis according to the age groups of children (0 to 9 years) and adolescents (10 to 19 years) defined by the WHO. In addition, there was great variation in the size

of the samples and heterogeneity of the results found, possibly introducing some analytical and measurement bias. However, the results found in this study agree with those found recently in other parts of the world, which leads us to conclude that the impact of such factors is of little importance[137].

This systematic review with meta-analysis found a high South American prevalence of excess weight, overweight and obesity in children and adolescents. Such findings are comparable with data from other continents in the literature, verifying a higher prevalence of obesity in the studied population, with no difference between the sexes. There was a high heterogeneity (I2=99%) in the results, probably due to the great ethnic and cultural differences between the South American populations and the methodological variability of the studies. Finally, Brazil was the country with the largest number of eligible papers for this meta-analysis, making it necessary to have more papers with methodological quality with populations from all countries in South America, so that new public policies can be elaborated and directed on the mainland.

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