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Review

# Prevalence of overweight and obesity in the adult indigenous population in Brazil: A systematic review with meta-analysis

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ABSTRACT

To carry out a systematic review to identify the prevalence of overweight and obesity in the adult indigenous population in Brazil. The databases used were PubMed, Scopus, Virtual Health Library (VHL), and Science Direct, with the following search strategy: "overweight" OR "obesity" AND "indigenous" OR "tribe" AND "Brazil". For the meta-analysis, RStudio® software was used. Were 22 articles included. The combined effect of the meta-analysis studies showed a global prevalence of overweight and obesity of 45%. Approximately half (45%) of indigenous Brazilian adults have excess weight. These findings highlight the need to implement public policies for the prevention and treatment of these morbidities.



**Contents**



## 1. Introduction

Overweight and obesity are defined as excessive accumulation of body fat and are considered risk factors for a number of chronic non-communicable diseases (CNCDs), including diabetes, cardiovascular diseases, and cancer [1]. They are considered a public health problem throughout the world, being a progressive phenomenon in both urban and rural areas. According to data from the World Health Organization, worldwide obesity has almost tripled since 1975. By 2016, about 39% of adults aged 18 or over were overweight and 13% were obese [2].

The prevalence of overweight and obesity has also increased among indigenous populations. Some studies report higher rates of obesity among indigenous peoples when compared to the general population [3–5]. This may be related to socioeconomic transitions, generally linked to changes in subsistence activities and new forms of work, which may lead to changes in eating habits and physical activity practice [6,7]. In recent years, there has been a reduction in traditional hunting and farming activities and an increase in the access to industrialized products [8]. In addition, indigenous dietary habits vary according to geographical location, ethnicity, level of education, and socioeconomic status [9].

Although indigenous people make up less than 5% of the world's

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population, they account for almost 15% of the worlds poor [10]. With limited income, they are more likely to have restricted food choices, particularly with regard to choosing nutritious foods. In addition to the increase in overweight and obesity [3,11,12], many tribes lack health services and specific actions in the field of indigenous health to control CNCDs [6,13].

Indigenous people are recognized for having unique social, cultural, and health needs, but there is a lack of general data on excess weight in indigenous populations [3]. In Brazil, indigenous representativeness in national surveys on nutritional status is small compared to the rest of the population [14]. The I National Survey of Health and Nutrition of Indigenous Peoples (*I Inquérito Nacional de*

**Table 1**
Variables of the studies that identified prevalence of overweight and obesity in Brazilian indigenous adults (n=22).

| Reference | Study design and methodological quality[a] | Sample size | Ethnicity/Place of residence (rural, urban, or village) | Age group | Method used to estimate overweight and obesity | Prevalence of excess weight and other morbidities |
|---|---|---|---|---|---|---|
| [19] | Cross-sectional 15 points | 61 | Parakanã/Village | 18 years or over | BMI | **The prevalence of overweight and obesity were 18.03% and 0%, respectively.** No case of SAH was observed. |
| [20] | Descriptive 15 points | 99 | Parkatêjê/Village | 20 years or over | BMI | **The prevalence of overweight and obesity were 34.4% and 6.1%, respectively.** |
| [21] | Descriptive 16 points | 1,170 | Xavante/Village | 20 years or over | BMI | **In São José, the prevalence of overweight and obesity was 78%. In the Etéñitépa ethnic group, the prevalence of overweight and obesity was 48%.** |
| [22] | NI 17 points | 151 | Guaraní-Mbyá/ Village | 15 years or over | BMI, WC HC and WHR | **The prevalence of overweight and obesity were 21.9% and 4.8%, respectively.** The prevalence of the other morbidities or parameters were: 44.5% for WHR, 4.8% for SAH, 2.8% for lipid alterations in total cholesterol, and 12.6% for triglycerides. |
| [23] | Cross-sectional 16 points | 90 | Parkatêjê/Village | 20 years or over | BMI and WHR | **The prevalence were: 67.8% for overweight, 14.4% for obesity**, 72.2% for central obesity, 4.4% for SAH, 44.4% for dyslipidemia, 5.6% for hyperuricemia, 1.1% for impaired fasting glycemia, and 1.1% for DM. |
| [24] | NI 19 points | 206 | Xavante/Village | 18 years or over | BMI, AC and Triceps skin fold | **The prevalence of overweight and obesity were 69.9% and 19.2%, respectively.** |
| [25] | NI 14 points | 201 | Aruák/Village | 20 years or over | BMI and AC | **The prevalence of overweight and obesity were 51.8% and 15%, respectively.** The other morbidities were dyslipidemia, with 77.1%, and SAH, with 37.7% of prevalence. |
| [26] | NI 19 points | 100 | Wari/Village | 20 years or over | BMI | **The prevalence of obesity was 1%. Most of the population (87.4%) was eutrophic.** |
| [27] | NI 17 points | 252 | Suruí/Village | 20 years or over | BMI, WC, HC AC and Body fat (bioimpedance) | **The prevalence of overweight and obesity were 40.1% and 16.3%, respectively.** |
| [28] | Cross-sectional 17 points | 153 | Xavante/Village | 20 years or over (between 20 and 88) | BMI, WC, AC Triceps and subscapular skin fold | **The prevalence of overweight and obesity was 69%.** |
| [29] | Descriptive 15 points | 251 | Karib/Village | 20 years or over | BMI | **The prevalence of overweight and obesity were 39.3% and 6.8%, respectively.** The prevalence of other morbidities were: 68% for dyslipidemia and 15.4% for SAH. |
| [30] | NI 16 points | 86 | Suyá/Village | 20 years or over | BMI, WC, AC Skin folds (triceps, biceps, subscapulr, and supra-iliac) | **The prevalence of overweight and obesity were 46.5% and 12.8%, respectively.** The prevalence of other morbidities were: 38.4% for central obesity, 26.7% for SAH, 4% for impaired fasting glycemia, 63.9% for dyslipidemia, and 21.9% for MS. |
| [31] | Cross-sectional 13 points | 45 | Kaingang/NI | 20 years or over | BMI and WC | **The prevalence of overweight and obesity were 33.7% and 12.8%, respectively.** |
| [32] | Cross-sectional 16 points | 82 | Kaingang/Village | 15 years or over | BMI, WC, HC and WHR | **The prevalence of overweight and obesity were 37.8% and 26.8%, respectively.** The prevalence of the other morbidities were: 9.8% for fasting hyperglycemia, 4.9% for hypercholesterolemia, 13.4% for reduced HDL cholesterol, 11% for hypertriglyceridemia, 37.8% for abdominal obesity, 26.8% for SAH, and 46.3% for anemia. |
| [33] | Cross-sectional 16 points | 606 | Guarani, Kaiowá, and Terena/Village | Between 18 and 69 years | BMI and WC | **The prevalence of overweight and obesity were 23.4% and 39.6%, respectively.** The prevalence of the other morbidities were: 4.5% for DM, 2.2% for impaired glucose tolerance, and 29.7% for SAH. |
| [34] | Cross-sectional 16 points | 251 | Suruí/Village | 20 years or over | BMI, WC And WHR | **The prevalence of overweight and obesity were 40.2% and 15.9%, respectively.** The prevalence of SAH was 2.8%. |
| [35] | Cohort 13 points | 78 | Khisêdjê Village | 20 years or over | BMI and WC | **The prevalence of excess weight was 30.4%.** The prevalence of the other morbidities were: 37.5% for MS,47.4% for hypertriglyceridemia, 38.9% for SAH, 29.1% for hypercholesterolemia, 25% for low HDL cholesterol, 10.4% for high LDL cholesterol, and 2.9% for DM. |
| [36] | Cross-sectional 18 points | 974 | Xavante/Village | 20 years or over | BMI and Electrical bioimpedance | **The prevalence of obesity was 46%.** |
| [12] | Descriptive and cross-sectional 15 points | 178 | Kaingang and Guarani/Urban | Between 18 and 45 years | BMI | **The prevalence of overweight in the Guaraní and Kaingang groups were 32.2% and 41.0%, respectively, and 3.2% and 12.8% for obesity, respectively.** |
| [6] | Cross-sectional 18 points | 794 | Xukuru do Ororubá/ Village | Between 19.1 and 59 years | BMI | **The prevalence of overweight and obesity were 33.6% and 14.9%, respectively.** The prevalence of malnutrition and eutrophy were 2.6% and 48.9%, respectively. |
| [5] | Cross-sectional 18 points | 1,608 | Kaiowá, Guarani, and Terena/Village | 18 years or over | BMI and WC | **The prevalence of overweight and obesity were 61.0% and 23.2%, respectively.** The prevalence of DM was 5.8%. |
| [37] | Cross-sectional 18 points | 355 | Kaingang/Village | 20 years or over | BMI and WC | **The prevalence of overweight and obesity were 34% and 33.1%, respectively.** The prevalence of SAH was 46.2%. |

[a] NI: Not informed; BMI: Body mass index; WC: Waist circumference; HC: Hip Circumference; WHR: Waist-hip Ratio; AC: Arm circumference; DM: Diabetes mellitus; SAH: Systemic arterial hypertension; MS: Metabolic syndrome. * Evaluation of methodological quality according to the quality score proposed by Downs & Black (1998) [17].

*Saúde e Nutrição dos Povos Indígenas*), conducted between 2008 and 2009, evaluated the nutritional status of children under five years of age and women between 14 and 49 years of age only [15]. Therefore, the objective of this systematic review was to estimate the prevalence of overweight and obesity among the adult indigenous populations of Brazil.

## 2. Materials and method

**Study Design**: A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses guideline- The PRISMA Statement [16].

**Hypothesis**: The prevalence of overweight and obesity in the Brazilian indigenous population is high.

**Guiding question**: "What is the prevalence of overweight and obesity in the adult indigenous population in Brazil?"

**Eligibility criteria**: From the guiding question the "PCOT" was established: "P" (problem situation): Brazilian indigenous population;"C" (condition): Overweight or obesity; "O" (Outcome): Prevalence of excess weight in the adult indigenous population; "T" (Period of time to be studied): No time limit was imposed for the selection of articles. Those articles describing the prevalence of overweight and/or obesity in indigenous adults were considered eligible, with no language restriction. Review articles, editorials, letters to the editor, news items, commentaries, dissertations, and theses were excluded.

**Information sources**: The search for publications was carried out in the PubMed, Scopus, Virtual Health Library, and Science Direct databases, with studies published up to December 14, 2017, without restricting the starting date of the collection, since the objective was to recover the maximum number of articles that estimated the prevalence of overweight and/or obesity in the adult indigenous population, regardless of the year of publication.

**Search strategy**: To perform the search, the options "Advanced search"and"Allfields" were selected. In the Science Direct database the words were inserted in the "Expert search" input field. The keywords were combined with Boolean operators for the search strategy: (overweight OR obesity) AND (indigenous OR tribe) AND (Brazil).

The search was performed independently by two researchers (NRB and JAA) to avoid bias in the selection and exclusion of studies. After selection, in case of disagreement between the two researchers, a third researcher evaluated the manuscript and, by consensus, the final decision of the articles to be included in the present review was made.

**Selection of the studies**: After selection of the articles from

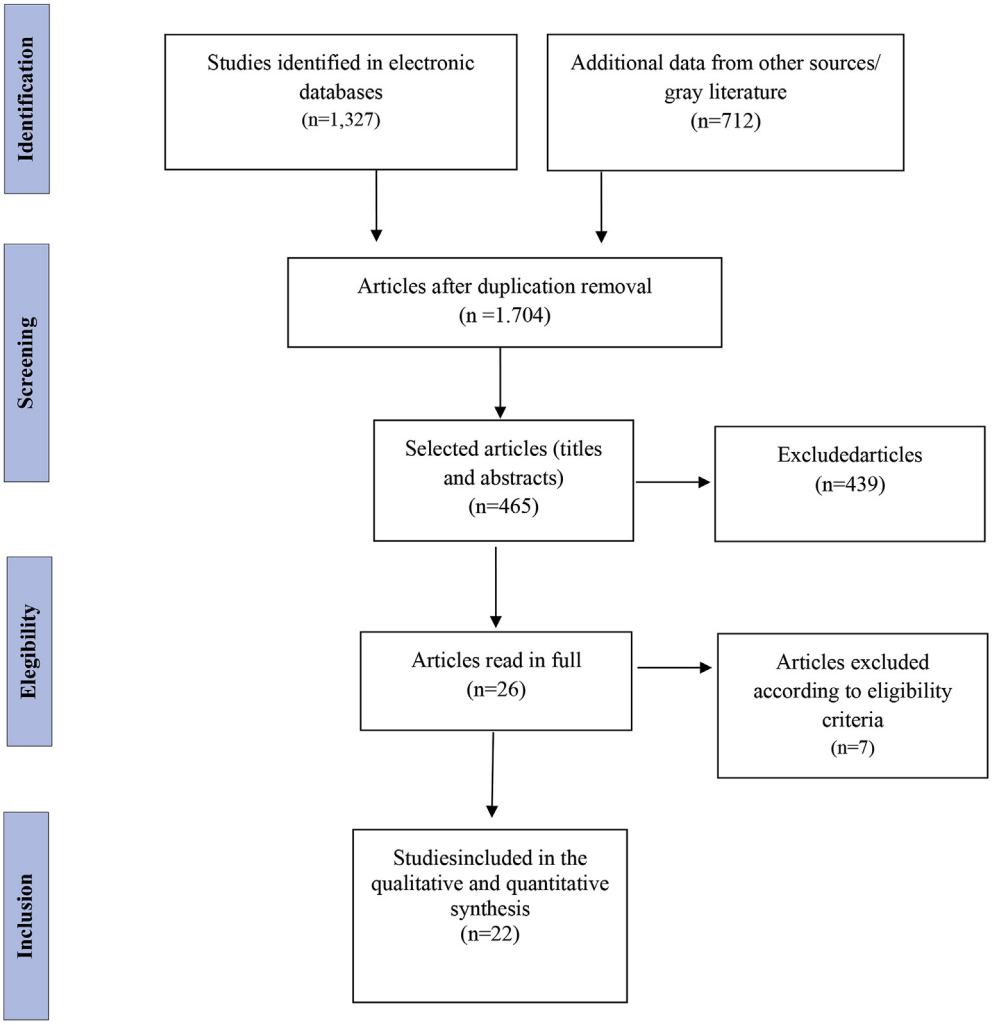


**Fig. 1.** PRISMA flowchart.
*From:* [16]. Preferred Reporting Items for Systematic Reviews and Meta-analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097. For more information, visit: www.prisma-statement.org [16].

each database, the duplicate publications were excluded. To detect any relevant evidence that may not have been retrieved by the search strategy, a search for articles in the reference list of the studies included in the review was also carried out.

**Data collection**: The articles that met the inclusion criteria were read in full, and during this phase the variables collected were: type of study, sample size, ethnicity, place of residence (rural, urban, or village), method used to estimate overweight and/or obesity, and prevalence of excess weightand other morbidities (Table 1).

**Additional analyses**: The Kappa coefficient was used to assess the degree of agreement between the two evaluators (NRB and JAA). This test was performed with 95% confidence intervals with Stata software, version 11.0. This systematic review was registered in PROSPERO: CRD42017057409.

**Quality evaluation**: To evaluate the quality of the studies included in the review, the methodological quality score proposed by Downs and Black (1998) was used [17]. It is a tool composed of 27 scoring items, which allows the evaluation of internal validity, external validity, and the statistical power of the study. Five items referring to experimental studies were excluded. In all, 22 items were evaluated, and to be categorized as presenting high methodological accuracy, the studies had to have scores higher than 16 points and a classification higher than 70% in the methodological evaluation. Quality assessment was performed independently by two researchers (GCSA and NRB), and divergences between assessments were resolved by reaching a consensus with a third researcher.

**Data analysis**: After reading the studies in full, data were extracted from each study and inserted into a Microsoft Excel spreadsheet. In the cases of studies in which the data of interest for meta-analysis were not described in the manuscripts, e-mails were sent to corresponding authors to obtain the necessary information. The meta-analysis was calculated with a random effect model, with a 95% confidence interval (CI), using RStudio® software and the meta and metafor packages and metaprop commands. The statistical heterogeneity between the studies was analyzed by the random effect model, and inconsistency was estimated by the I-square statistic ($I^2$) considering up to 50%. The existence of publication bias was evaluated through the visual inspection of the funnel graph and the calculation of the Begg'stest. The results of the meta-regression were presented in bubble charts.

## 3. Results

A total of 1,327 articles were identified, of which 83 were duplicates. After reading the titles and abstracts, two researchers (NRB and JAA) selected 24 articles each, with 22 articles in common. The degree of agreement between the two researchers was considered almost perfect (kappa coefficient = 0.9150) [18]. After discussion among the authors, 26 articles were selected for full reading. Full analysis of these articles revealed that 19 studies fulfilled the inclusion criteria (Fig. 1).

The reasons to exclude seven articles were: absence of data on prevalence of overweight and/or obesity (n = 3), different articles with data from the same study (n = 2), indigenous people over 40 years of age (n = 1), and absence of accurate weight information (the weight was estimated) (n = 1). From the 19 articles selected, the list of references (712 papers) was analyzed and three publications were chosen, totaling 22 articles included in the review sample.

The studies were arranged in chronological order to facilitate the identification of historical evolution. It was observed that there was a predominance of studies performed in the following regions of Brazil: Center-west, 45.4% (n = 10), followed by North, 27.3% (n = 6), South, 18.2% (n = 4), Southeast, 4.5% (n = 1), and Northeast, 4.5% (n = 1). Regarding study design, 50.0% (n = 11) were transversal, followed by studies that did not inform the design 27.3% (n = 6), descriptive 13.6% (n = 3), descriptive transversal 4.5% (n = 1), and cohort studies 4.5% (n = 1). The sample size of the studies ranged from 45 to 1,608 people [5,31].

Concerning ethnicity, it was found that 18.2% (n = 4) of the sample belonged to the Xavante; 13.6% (n = 3) Kaingang; 9.1% (n = 2) Parkatêjê; 9.1% (n = 2) Kaiowá, Guarani and Terena; 9.1% (n = 2) Suruí; 4.5% (n = 1) Parakanã; 4.5% (n = 1) Guaraní-Mbyá;

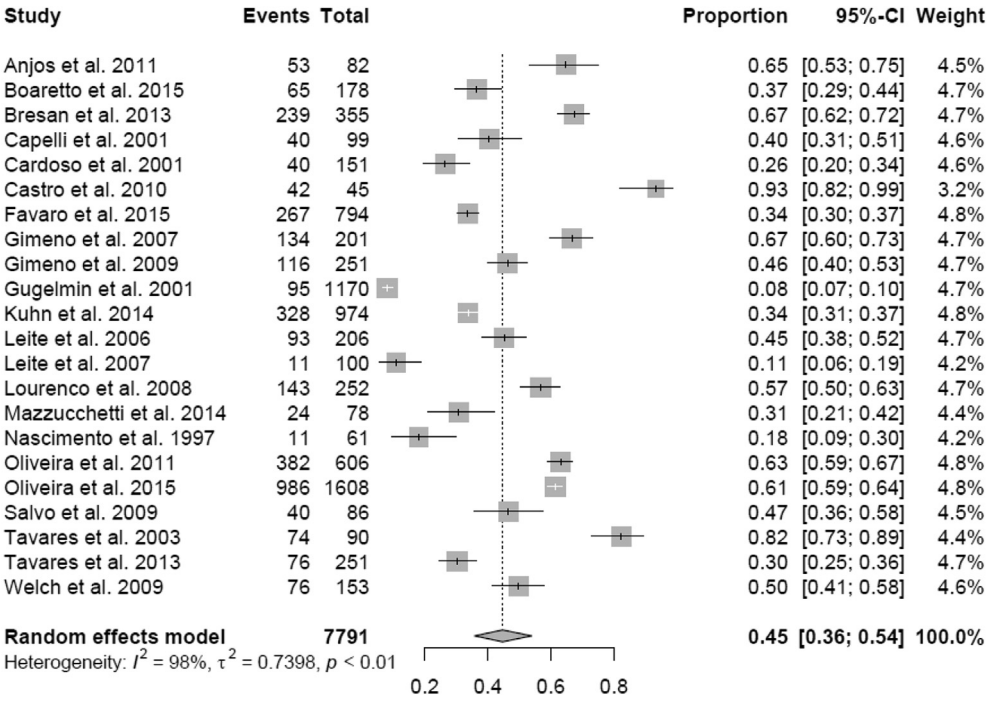


**Fig. 2.** Forest plot of the prevalence of obesity and overweight Brazilian indigenous populations.

4.5% (n = 1) Aruák; 4.5% (n = 1) Wari; 4.5% (n = 1) Karib; 4.5% (n = 1) Suyá; 4.5% (n = 1) Khisêdjê; 4.5% (n = 1) Kaingangand Guarani; and 4.5% (n = 1) to the Xukuru do Ororubá.

The majority of the examined indigenous people lived in villages (90.9%, n = 20), followed by urban areas (4. %, n = 1) and not informed ocations (4.5%, n = 1). Only 18.2% (n = 4) of the studies presented the age group of the participants, the others only cited the starting age from which the people were included in the sample. Most studies (63.6%, n = 14) considered the adult population as aged 20 years and over, followed by 18 years (22.7%, n = 5), 15 years (9.1%, n = 2), and 19.1 years (4.5%, n = 1).

Body mass index (BMI) was the method used to estimate overweight and obesity in all studies. Seven investigations used only BMI, and the others (15 articles) also resorted to other anthropometric measures: waist circumference (n = 11), waist-hip ratio (n = 5), arm circumference (n = 5), hip circumference (n = 3), triceps (n = 3), subscapular skinfold (n = 2), biceps (n = 1), suprailiac (n = 1), and bioimpedance (n = 2).

Among the 22 articles analyzed, 12 (54.5%) presented a description of some type of morbidity: systemic arterial hypertension (SAH) (n = 10), diabetes mellitus (DM) (n = 5), dyslipidemia (n = 5), hyperuricemia (n = 1), glucose tolerance (n = 2), impaired fasting glycemia (n = 3 central obesity (n = 3), total cholesterol (n = 3), triglycerides (n = 2), metabolic syndrome (MS) (n = 2), hypercholesterolemia, reduced high density lipoprotein (HDLc) (n = 1), elevated low density lipoprotein (LDLc) (n = 1), and anemia (n = 1) (Table 1).

Regarding the methodological quality of the articles, 68.2% (n = 15) had scores higher than 16 points, with a response-rate ratio higher than 70%, and were considered studies with high methodological quality. The remaining 31.8% (n = 7) were considered well-designed studies but did not detail the distribution of the main confounding factors. No study was excluded because of insufficient methodological quality.

The data grouped into meta-analysis combining the prevalence of obesity and overweight in 22 studies with 7,791 indigenous people did not show significant differences in the prevalence of obesity and overweight indigenous populations (Fig. 2). The prevalence of the overall combined effect was 45% (95% CI = 0.36; 0.54); with significant ($p < 0.01$) and considerable ($I^2 = 98\%$) heterogeneity. To explore this heterogeneity between the studies, analyses of subgroups of indigenous people with obesity and overweight by region and ethnicity, and by meta-regression were performed.

Regarding the estimated combined effect in the analyses of

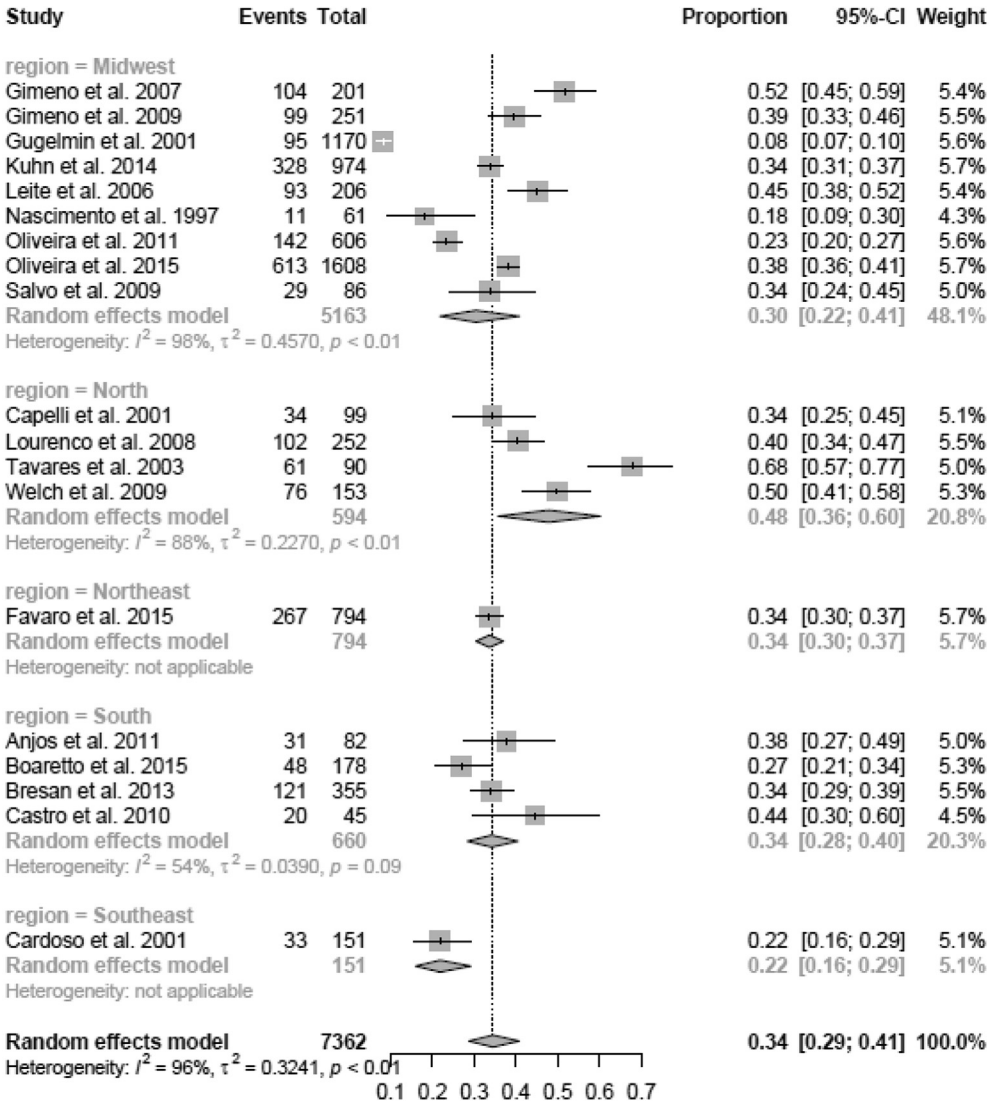


**Fig. 3.** Forest plot of prevalence of overweight in Brazilian indigenous populations by region.

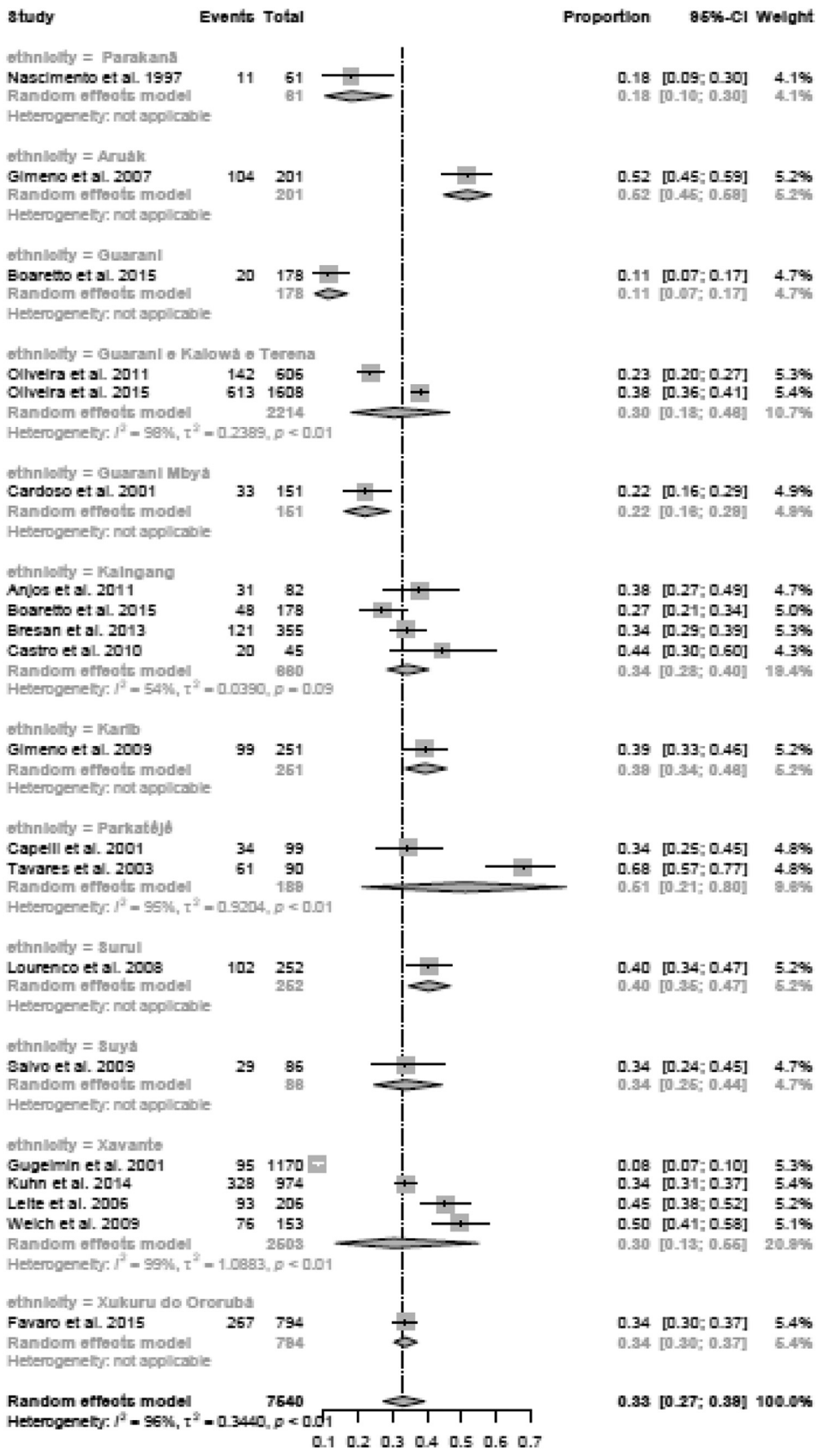


**Fig. 4.** Forest plot of prevalence of overweight in Brazilian indigenous populations by ethnicity.

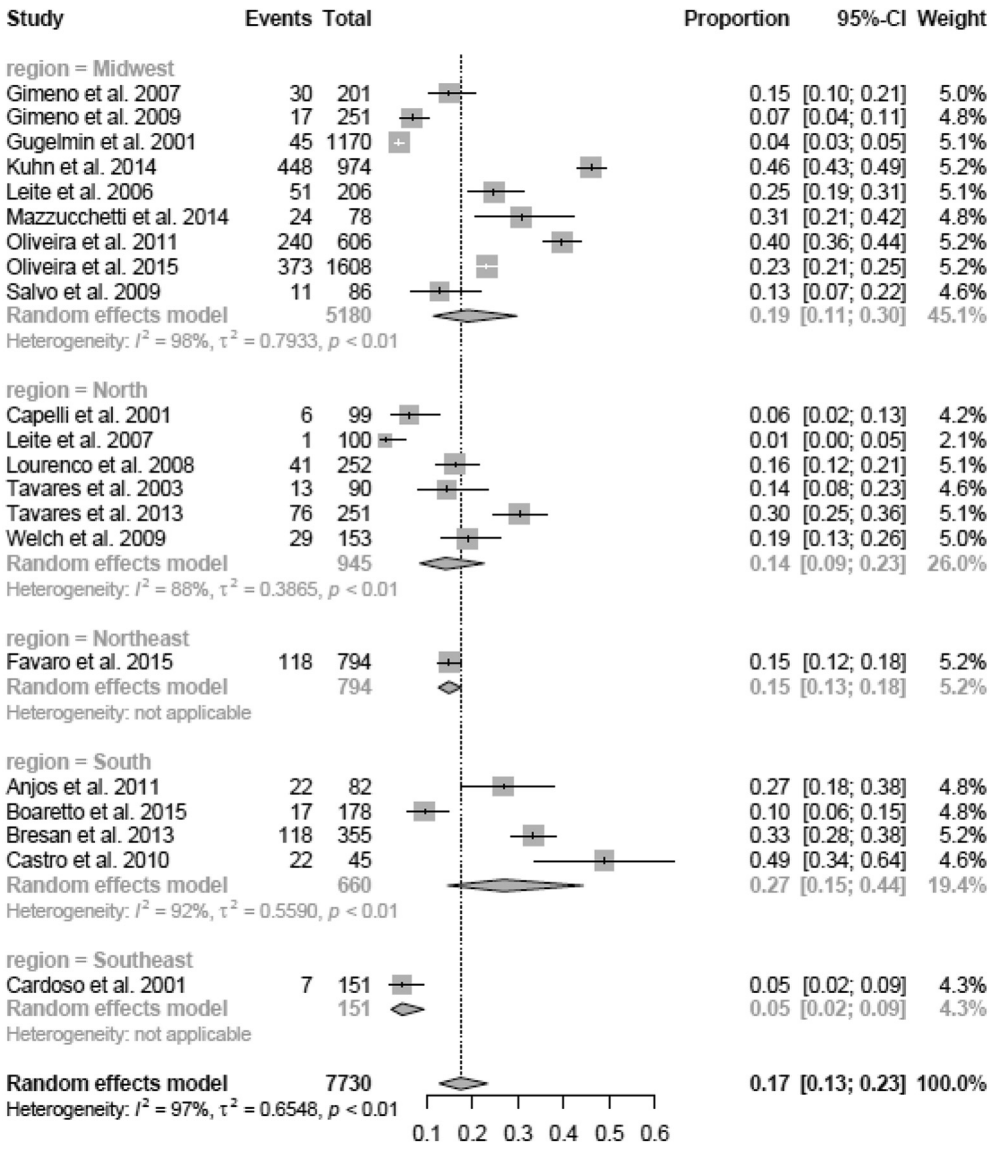


**Fig. 5.** Forest plot of the prevalence of obesity in Brazilian indigenous populations by region.

subgroups by region and ethnic group, overweight was more prevalent in two ethnic groups, Parkatêjê (68%) and Aruák (52%). In the Northern region, the prevalence was 48% (95% CI = 0.36; 0.60) (Figs. 3 and 4).

The prevalence of obesity was higher in the Guarani, Kaiowá, and Terena ethnic groups, with 31% of a population of 2,214 indigenous people examined in two studies, and in the South region, with 27% (95% CI = 0.15; 0.44) (Figs. 5 and 6).

The meta-regression analysis revealed no association between the heterogeneity found and average age, sample size, or proportion of men in the studies examined. In general, there was a wide variation in estimates of prevalence of overweight and obesity, and a progressive increase in prevalence over the years, predominantly in 12 studies [5–7,9,10,13–18,22], but this variable explains only 5.56% of the heterogeneity found in the studies. Both methodological and statistical heterogeneity contributed to the increase in the inconsistency found (Fig. 7).

Funnel chart shows asymmetry between the investigations, pointing out the probability of studies with small samples or investigations with negative results not having been published (Fig. 8). The value of the coefficient calculated in Begg's test was p = 0.8879.

## 4. Discussion

The present systematic review showed high rates of overweight and obesity in the Brazilian indigenous population, with a prevalence of 33% and 16% of these conditions, respectively, after analysis of the grouped data. Overweight was more prevalent in the Parkatêjê (68%) and Aruák (52%) ethnic groups, and the prevalence of obesity was higher in the Guarani, Kaiowá, Terena (31%) and Khisêdjê (31%) ethnic groups. These results corroborate the fact that overweight and obesity are a public health challenge for the entire population, including developing countries and indigenous groups.

Brazil has one of the lowest relative frequencies of indigenous populations, since this group represents 0.4% of the population of the country. Despite the reduced number of indigenous people in Brazil, they have a marked ethnic and linguistic diversity. Currently, more than 300 indigenous ethnic groups with 274 different languages live in the country. In the present investigation, the most studied ethnicity was the Xavante, a fact that can be reinforced by

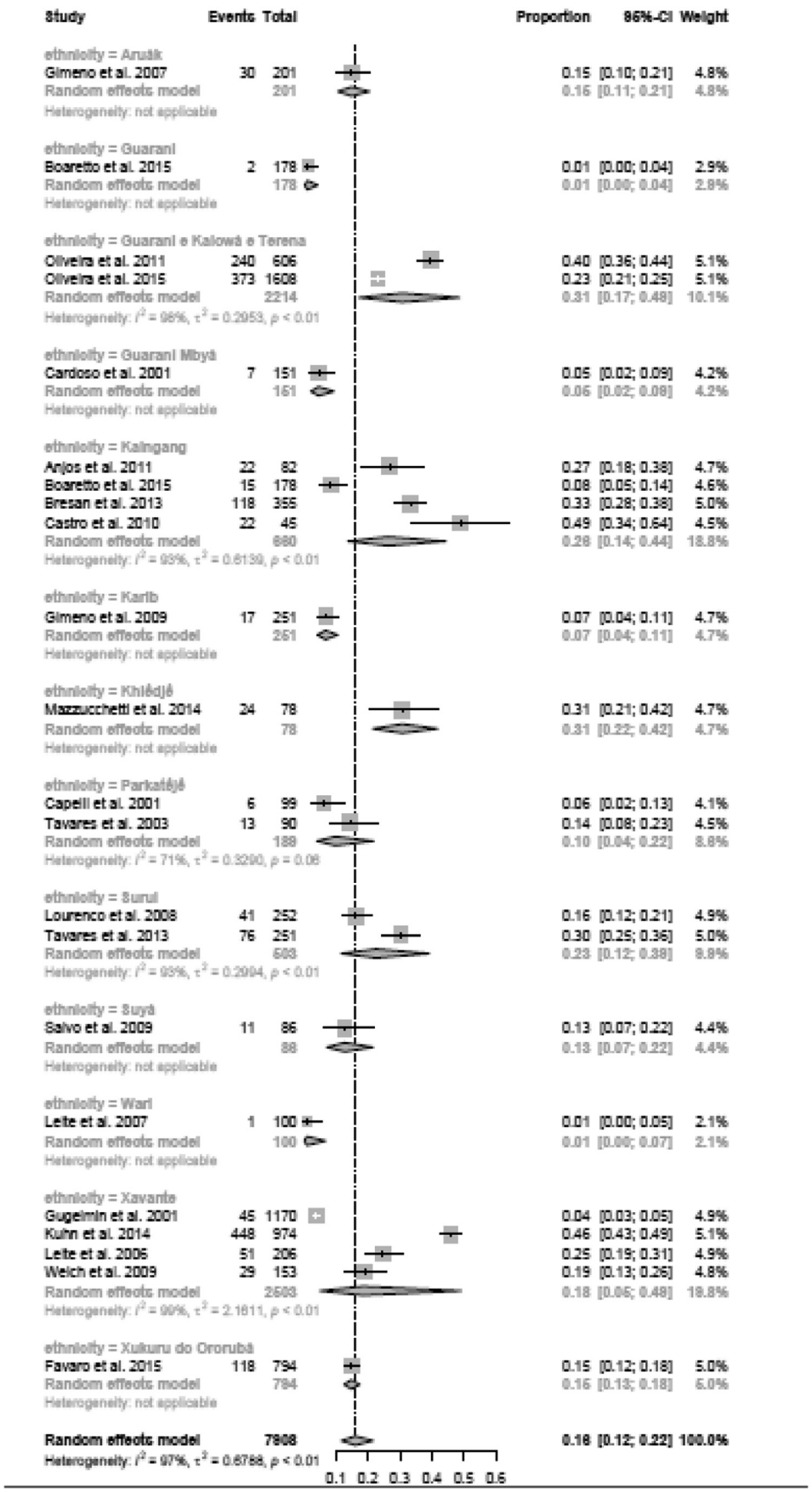


**Fig. 6.** Forest plot of the prevalence of obesity in Brazilian indigenous populations by ethnicity.

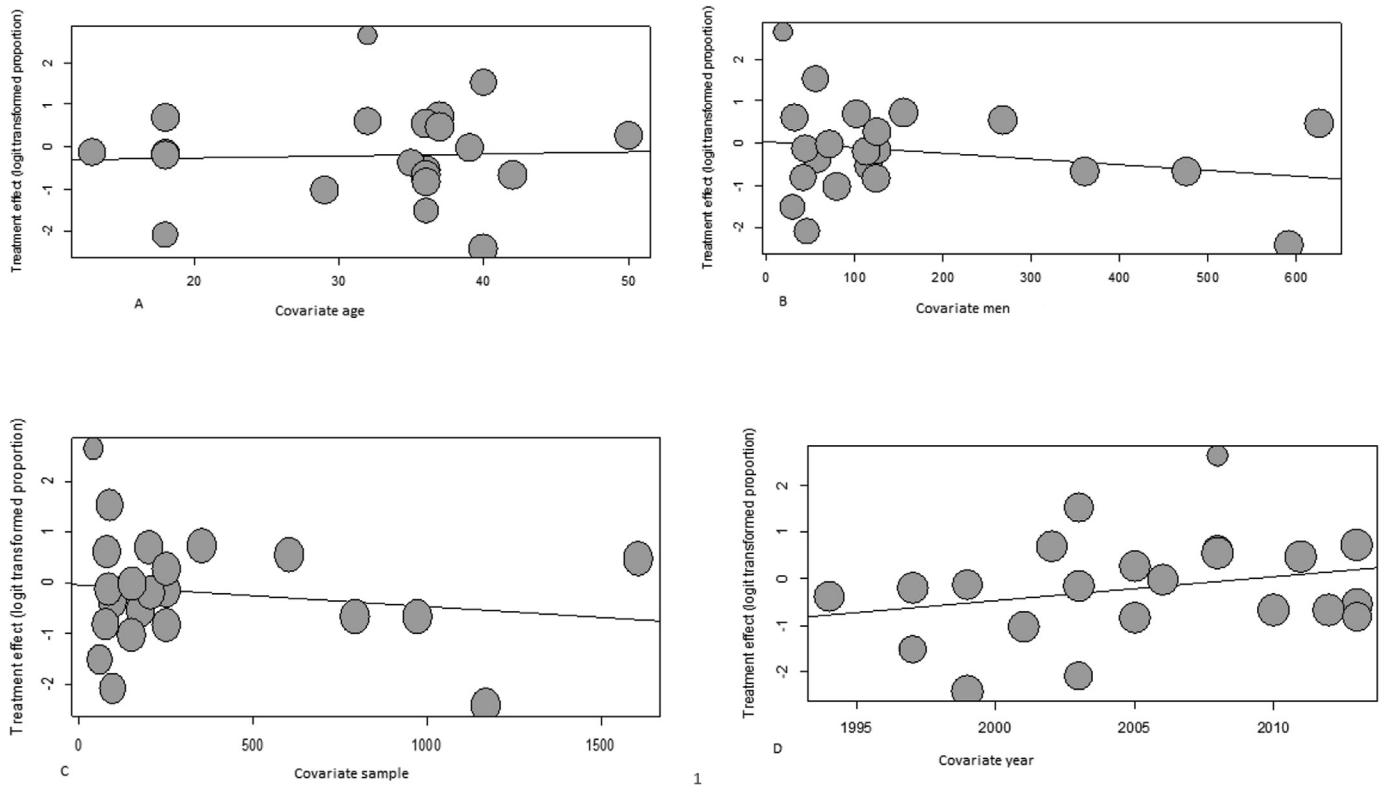


**Fig. 7.** Meta-regression analysis: (A) age; (B) baseline proportion of mean; (C) sample size; (D) study year.

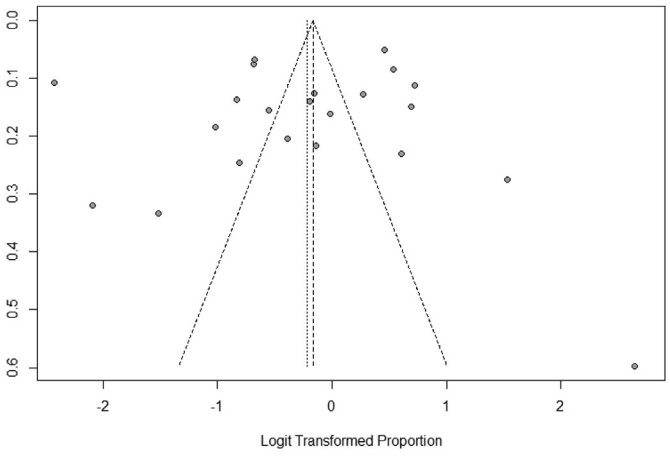


**Fig. 8.** Funnel chart exhibiting the prevalence of overweight and obesity in Brazilian indigenous populations.

the data obtained in the 2010 census. This survey identified 305 ethnic groups, and Xavante is one of the 15 ethnic groups with the highest number of indigenous people in Brazil [38]. In addition, the prominence of the Xavante group can be justified by the location of the villages, which may favor the access of researchers, and the easiness of communication, given that indigenous people from this group speak Portuguese.

Regarding the place of residence, the majority of the indigenous people lived in villages, which can be a positive point, since in these places they conserve their traditional habits such as fishing, hunting, and planting food, compared to the indigenous people who share an environment with the non-indigenous population. However, a systematic review with indigenous Australians showed that members of remote communities had malnutrition, excessive smoking, lower levels of HDLc, and a sedentary lifestyle [39]. Therefore, the ideal scenario is that indigenous people are assisted by indigenous health teams that can guide them on health issues. Ideally, these professionals should speak the same language as the indigenous population and know and respect the culture of that population.

It was observed that there was no consensus on the threshold of adulthood. The authors of each study examined in the present review considered a different age. The lack of standardization of adulthood is one of the obstacles to an accurate nutritional diagnosis, since reference values for adolescents, adults, and elderly people are different. Given this situation, a study that standardizes the age of the indigenous population would be relevant.

Most of the studies used BMI to estimate overweight and obesity, and this can be justified by the simplicity, low operational cost, and speed of the method. However, it is a questionable technique because this index expresses only the total body mass, making it impossible to differentiate between lean mass and fat mass [40,41]. Therefore, individuals with more developed muscle mass may be considered obese, such as athletes and some supposedly more active populations [42]. The same case may apply to the indigenous population because many of their daily activities favor a greater development of lean mass, which gives them a high BMI. However, it is important to discuss the adequacy of this index to assess the nutritional status of indigenous populations, since it is a method widely used by researchers.

There was a high prevalence of SAH, DM, and MS among the investigated indigenous people, which are morbidities known to be related to excess weight. In addition to the high prevalence of excess weight among indigenous people, there has also been a profound change in their lifestyles in the last decades, with a decrease in traditional practices and limited access to fresh and

minimally processed foods.

These have been replaced by products with a high density of calories, sugars, saturated fats, and sodium, and low levels of protein, fibers, and micronutrients [43,44]. Indigenous health is a problem not only in Brazil. A study by Morisako et al. (2017) with Hawaiian natives showed that indigenous people frequently experience social marginalization and racial discrimination in the health environment, which leads to unfavorable health outcomes [45].

The prevalence of overweight and obesity was 33% and 16%, respectively. In Brazil, few studies assessed the state of health of the indigenous population because of barriers that still exist to carry out research with this population. These findings corroborate worldwide data that in the non-indigenous adult population, about 39% of adults presented overweight and 13% obesity [2]. A systematic review conducted in Canada aiming to assess the prevalence of excess weight presented a lower rate of 29.7% [46].

## 5. Conclusion

It was concluded that overweight is more prevalent in two ethnic groups, Parkatêjê (68%) and Aruák (52%), based on the analysis of studies on the prevalence of overweight and obesity in Brazilian adult indigenous populations. The highest prevalence of obesity occurred in the Guarani, Kaiowá, and Terena ethnic groups (31%). Considering the overall combined effect, the prevalence of overweight and obesity was 45%, respectively. Given this evidence, efficient and lasting nutritional food surveillance becomes an important measure, which should be incorporated in indigenous health services and health information systems. Scientific evidence on indigenous health is important to develop specific responses and appropriate policies for these populations.

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## References

[1] World Health Organization. Obesity. Available in, http://www.who.int/topics/obesity/en/. Access in: Oct, 2017.
[2] World Health Organization. Obesity and overweight. Available in, http://www.who.int/mediacentre/factsheets/fs311/en/. Cited in: Oct. 2017.
[3] Kuhnlein HV, Recevuer O, Soueida R, Egeland GM. Arctic Indigenous Peoples experience the nutrition transition with changing dietary patterns and obesity. J Nutr 2004;134:1447–53.
[4] Snodgrass JJ, Leonard WR, Sorensen MV, Tarskaia LA, Alekseev VP, Krivoshapkin V. The emergence of obesity amongst Indigenous Siberians. J Physiol Anthropol 2006;25:75–84.
[5] Oliveira GF, Oliveira TR, Ikejiri AT, Galvao TF, Silva MT, Pereira MG. Prevalence of obesity and overweight in an indigenous population in Central Brazil: a population-based cross-sectional study. Obes Facts 2015;8:302–10.
[6] Fávaro TR, Santos RV, Cunha GM, Leite IC, Coimbra Jr CEA. Obesidade e excesso de peso em adultos indígenas Xukuru do Ororubá, Pernambuco, Brasil: magnitude, fatores socioeconômicos e demográficos associados. Cad Saúde Pública 2015;31:1685–97.
[7] Leite MS, Santos RV, Coimbra Jr CEA, Gugelmin SA. Alimentação e nutrição dos povos indígenas no Brasil. In: Kac G, Sichieri R, Gigante DP, editors. Epidemiologia nutricional. Rio de Janeiro: Editora Fiocruz/Editora Atheneu; 2007. p. 503–17.
[8] Johnson-Down L, Labonte ME, Martin ID, Tsuji LJ, Nieboer E, Dewailly E, et al. Quality of diet is associated with insulin resistance in the Cree (Eeyouch) indigenous population of northern Québec. Nutr Metabol Cardiovasc Dis 2015;25:85–92.
[9] Obesity Working Group (OWG) for the National Preventative Health Taskforce. Australia. The healthiest country by 2020 – technical report 1 obesity in Australia: a need for urgent action. Canberra: Commonwealth of Australia; 2009.
[10] United Nations Development Programme. Human Development Report 2014. Sustaining human progress: reducing vulnerability and building resilience. New York: United Nations; 2014.
[11] Esler D, Raulli A, Pratt R, Fagan P. Hypertension: high prevalence and a positive association with obesity among Aboriginal and Torres Strait Islander youth in far north Queensland. Aust N Z J Public Health 2015;40:565–9.
[12] Boaretto JD, Molena-Fernandes CA, Pimentel GGA. Estado nutricional de indígenas Kaingang e Guarani no estado do Paraná, Brasil. Ciência Saúde Coletiva 2015;20:2323–8.
[13] Butler DC, Petterson S, Bazemore A, Douglas KA. Use of measures of socioeconomic deprivation in planning primary health care workforce and defining health care need in Australia. Aust J Rural Health 2010;18(5):199–204.
[14] Monteiro CA, Benício MHDA, Conde WL, Popkin BM. Shifting obesity trends in Brazil. Eur J Clin Nutr 2000;54:342–6.
[15] Coimbra Jr CEA, Santos RV, Welch JR, Cardoso AM, de Souza MC, Garnelo L, Rassi E, et al. The first national survey of indigenous people's health and nutrition in Brazil: rationale, methodology, and overview of results. BMC Public Health 2013;13:52.
[16] Moher D, LiberatiA Tetzlaff J, Altman DG, PRISMA Group. The PRISMA Group. Preferred reporting items for systematic reviews and MetaAnalyses: the PRISMA statement. PLoS Med 2009;6(7). e1000097.
[17] Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and nonrandomised studies of health care interventions. J Epidemiol Community Health 1998;52:377–84.
[18] Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159–74.
[19] Nascimento JRL, Miranda RA, Xavier FB, Menezes RC. Pressão arterial e índice de massa corporal de índios adultos da tribo Parakanã, Amazônia Oriental Brasileira. Revista Paraense de Medicina 1997;11:21–5.
[20] Capelli JCS, Koifman S. Avaliação do estado nutricional da comunidade indígena Parkatêjê, Bom Jesus do Tocantins, Pará, Brasil. Cad Saúde Pública 2001;17:433–7.
[21] Gugelmin S, Santos RV. Ecologia humana e antropometria nutricional de adultos Xavánte, Mato Grosso, Brasil. Cad Saúde Pública 2001;17:313–22.
[22] Cardoso AM, Mattos IE, Koifman RJ. Prevalência de fatores de risco para doenças cardiovasculares na população Guaraní-Mbyá do Estado do Rio de Janeiro. Cad Saúde Pública 2001;17:345–54.
[23] Tavares EF, Vieira-Filho JP, Andriolo A, Sañudo A, Gimeno SG, Franco LJ. Metabolic profile and cardiovascular risk patterns of an Indian tribe living in the amazon region of Brazil. Hum Biol 2003;75:31–46.
[24] Leite MS, Santos R, Gugelmin SA, Coimbra Jr CEA. Crescimento físico e perfil nutricional da população indígena Xavánte de Sangradouro-Volta Grande, Mato Grosso, Brasil. Cad Saúde Pública 2006;22:265–76.
[25] Gimeno SGA, Rodrigues D, Pagliaro H, Cano EN, Lima EES, Baruzzi RG. Perfil metabólico e antropométrico de índios Aruák: mehináku, Waurá e Yawalapití, Alto Xingu, Brasil Central, 2000/2002. Cad Saúde Pública 2007;23:1946–54.
[26] Leite MS, Santos RV, Coimbra Jr CEA. Seasonality and nutritional status of indigenous peoples: the case of Wari' in Rondônia State, Brazil. Cad Saúde Pública 2007;23:2631–42.
[27] Lourenço AE, Santos RV, Orellana JD, Coimbra Jr CEA. Nutrition transition in Amazonia: obesity and socioeconomic change in the Suruí Indians from Brazil. Am J Hum Biol 2008;20:564–71.
[28] Welch JR, Ferreira AA, Santos RV, Gugelmin AS, Werneck G, Coimbra Jr . Nutrition transition, socioeconomic differentiation, and gender among adult Xavante Indians, Brazilian amazon. Hum Ecol 2009;37:13–26.
[29] Gimeno SGA, Rodrigues D, Canó EM, Lima EE, Schaper M, Pagliaro H, et al. Cardiovascular risk factors among Brazilian Karib indigenous peoples: upper Xingu, Central Brazil, 2000-3. J Epidemiol Community Health 2009;63(4):299–304.
[30] Salvo VLMA, Rodrigues D, Baruzzi RG, Pagliaro H, Gimeno SGA. Perfil metabólico e antropométrico dos Suyá. Parque Indígena do Xingu, Brasil Central. Rev bras Epidemiol 2009;12:458–68.
[31] Castro TG, Schuch I, Conde WL, Veiga J, Leite MS, Dutra CLC, et al. Estado nutricional dos indígenas Kaingáng matriculados em escolas indígenas do Estado do Rio Grande do Sul, Brasil. Cad Saúde Pública 2010;26:1766–76.
[32] Anjos HNK, Toledo MJO, Mota LT, Previdelli ITS, Anjos AF, Saruhashi TR, et al. Prevalence of metabolic syndrome among Kaingang native Americans in southern Brazil. Braz arch biol Technol 2011;54:81–9.
[33] Oliveira GF, Oliveira TRR, Rodrigues FF, Corrêa LF, Ikejiri AT, Casulari LA. Prevalência de diabetes melito e tolerância à glicose diminuída nos indígenas da Aldeia Jaguapiru. Brasil. *Rev.* panam 2011;29:315–21. salud pública.
[34] Tavares FG, Coimbra Jr CEA, Cardoso AM. Níveis tensionais de adultos indígenas Suruí, Rondônia, Brasil. Ciência Saúde Coletiva 2013;18:1399–409.
[35] Mazzucchetti L, Galvão PPO, Tsutsui MLS, Santos KM, Rodrigues DA, Mendonça SB, et al. Incidência de síndrome metabólica e doenças associadas na população indígena Khisêdjê do Xingu, Brasil Central, no período de 1999-2000 a 2010-2011. Cad Saúde Pública 2014;30:2357–67.
[36] Kuhn PC, Vieira Filho JP, Franco L, Dal Fabbro A, Franco LJ, Moises RS. Evaluation of body adiposity index (Bai) to estimate percent body fat in an indigenous population. Clin Nutr 2014;33:287–90.
[37] Bresan D, Bastos JL, Leite MS. Epidemiologia da hipertensão arterial em indígenas Kaingang, Terra Indígena Xapecó, Santa Catarina, Brasil, 2013. Cad Saúde Pública 2015;31:[331]–[344].
[38] Instituto Brasileiro de Geografia e Estatística (IBGE). Available in: http://indigenas.ibge.gov.br/. Access in: Oct, 2017.
[39] Lyons JG, O'Dea K, Walker KZ. Evidence for low high-density lipoprotein

cholesterol levels in Australian indigenous peoples: a systematic review. BMC Publ Health 2014;2:545.
[40] Gugelmin SA, Santos RV. Uso do Índice de Massa Corporal na avaliação do estado nutricional de adultos indígenas Xavánte, Terra Indígena Sangradouro-Volta Grande, Mato Grosso, Brasil. Cad Saúde Pública 2006;22:1865–72.
[41] Ribeiro LC, Sartorelli DS. Métodos empregados em epidemiologia nutricional. In: Franco LJ, editor. Passos ADC. Fundamentos de Epidemiologia. 2ª ed. Barueri: Editora Manole; 2011. p. 300–18.
[42] Porto LG, Nogueira RM, Nogueira EC, Molina GE, Farioli A, Junqueira Jr LF, et al. Agreement between BMI and body fat obesity definitions in a physically active population. Arch Endocrinol Metab 2016;60:515–25.
[43] Souza Filho ZA, Ferreira AA, Santos BS, Pierin AMG. Prevalência de hipertensão arterial em indígenas do Brasil: uma revisão sistemática com meta-análise. Rev Esc Enferm USP 2015;49:1016–26.
[44] Ferreira AA, Souza-Filho ZA, Gonçalves MJF, Santos J, Pierin AM. Relationship between alcohol drinking and arterial hypertension in indigenous people of the Mura ethnics, Brazil. PLoS One 2017;12(8). e0182352.
[45] Morisako AK, Tauali'i M, Ambrose AJH, Withy k. Beyond the ability to pay: the health status of native hawaiians and other pacific islanders in relationship to health insurance. Hawai'i J Med Public Health 2017;76:36–41.
[46] Kolahdooz F, Sadeghirad B, Corriveau A, Sharma S. Prevalence of overweight and obesity among indigenous populations in Canada: a systematic review and meta-analysis. Crit Rev Food Sci *Nutr* 2017;57. 1316-132.