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Increasing trends in obesity prevalence from 2013 to 2019 and associated factors in Brazil

Aumento nas prevalências de obesidade entre 2013 e 2019 e fatores associados no Brasil

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ABSTRACT: ***Objective:*** To investigate the variation of anthropometric indicators from 2013 to 2019 and the factors associated with obesity in Brazil, using information from the National Health Survey. ***Methods:*** Cross-sectional study with cluster sampling and simple random sampling in the three stages. Measurements of weight and height among participants in 2013 (n=59,592) and in 2019 (n=6,672) were used. Differences in obesity prevalence were tested by Student's t test for independent samples. To identify the sociodemographic factors and health problems associated with obesity, we used Poisson regression models with robust variance and crude and age-adjusted prevalence ratios to test the associations. ***Results:*** From 2013 to 2019, prevalence of obesity increased significantly, from 20.8 to 25.9%. Among men, the greatest increases were found in the 40-59 age group (9.1%) and in the median income category (8.3%). Among women, the greatest rises were found among those with low education (8.7%) and non-white ones (6.0%). For both males and females, factors associated with obesity were age, to live with a partner, level of instruction directly associated among men, and inversely associated among women. In 2019, for males, the crude and adjusted prevalence ratios were significant for high cholesterol, high blood pressure and at least one chronic non-communicable disease and, for females, for poor self-rated health, high blood pressure, diabetes, and at least one chronic non-communicable. ***Conclusion:*** It is necessary to implement intersectoral policies to promote changes in eating habits and encourage the practice of physical activity, taking into account economic, social, cultural, and environmental aspects.

Keywords: obesity. noncommunicable diseases. health surveys. body mass index. Brazil.

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RESUMO: ***Objetivo:*** Investigar as variações de indicadores antropométricos entre 2013 e 2019 e os fatores associados à obesidade no Brasil, utilizando as informações da Pesquisa Nacional de Saúde. ***Métodos:*** Estudo transversal com amostra por conglomerados e seleção aleatória simples nos três estágios. Foram usadas as medidas aferidas de peso e altura em 2013 (n=59.592) e em 2019 (n=6.672). As diferenças nas prevalências de obesidade entre 2013 e 2019 foram testadas pelo teste t de Student para amostras independentes. Para identificar os fatores sociodemográficos e os problemas de saúde associados à obesidade, utilizaram-se modelos de regressão de Poisson com variância robusta e razões de prevalência brutas e ajustadas por faixa etária para testar as associações. ***Resultados:*** De 2013 a 2019, a prevalência de obesidade aumentou significativamente, de 20,8 para 25,9%. Entre os homens, os maiores aumentos ocorreram no grupo etário 40–59 anos (9,1%) e na faixa de renda mediana (8,3%), e, entre as mulheres, as de baixa escolaridade (8,7%) e não brancas (6,0%). Para ambos os sexos, os fatores associados à obesidade foram idade, viver com companheiro e escolaridade, diretamente entre homens e inversamente entre mulheres. Em 2019, para o sexo masculino, as razões de prevalência brutas e ajustadas foram significativas para colesterol alto, hipertensão arterial e alguma doença crônica não transmissível, e, para o feminino, para autoavaliação de saúde não boa, hipertensão arterial, diabetes, alguma doença crônica não transmissível. ***Conclusões:*** É preciso implementar políticas intersetoriais para promover mudanças nos hábitos de alimentação e incentivar a prática de atividade física, levando em consideração os aspectos econômicos, sociais, culturais e ambientais.

Palavras-chave: obesidade. doenças crônicas não transmissíveis. inquéritos epidemiológicos. índice de massa corporal. Brasil.

INTRODUCTION

Currently, obesity is one of the most important global health problems and is considered a global epidemic due to its progressive increase in recent decades in many developed and developing countries[1,2]. Between 2000 and 2018, obesity showed a marked growth trend worldwide, increasing, on average, 11% in the period[3].

In Latin America and the Caribbean, obesity shows a growing trend, due to the accelerated disordered urbanization and improvements in the socioeconomic level of these countries, in parallel with the decrease in malnutrition and consumption of family farm foods and the increase in physical inactivity and consumption of ultra-processed foods[4]. The highest prevalence of obesity has been observed in Chile, Mexico, Brazil, Argentina, and Paraguay[5]. The large growth of obesity in developing countries has caused the prevalence to reach the same level as in several developed countries, with the exception of the United States, with much higher levels of obesity[5].

Obesity is associated with several noncommunicable diseases (NCDs), such as high blood pressure, diabetes, cardiovascular diseases, kidney diseases[6-8], and musculoskeletal disorders[9]. Several types of cancer, such as colorectal, are also related to obesity[10,11]. As it is associated with a series of damages to health, obesity is responsible for a substantial part of premature deaths, functional limitations, and loss of quality of life[12,13].

Obesity has multifactorial causes and results from a complex interaction between genetic predisposition, environment, and lifestyles[14]. Characterized by the accumulation of body fat resulting from the prolonged imbalance between food consumption and energy expenditure[15], unhealthy eating, consumption of high-calorie ultra-processed foods, and physical inactivity have been considered the main behavioral factors associated with obesity[16-19]. In turn, by influencing individuals' lifestyles, psychological, social, cultural, and environmental aspects are considered equally relevant[20].

Monitoring the prevalence of obesity is essential for public health. Obtaining anthropometric measurements through health surveys allows monitoring overweight/obesity trends in different geographic areas and identifying the main associated factors, allowing to subsidize public health policies to prevent obesity, promote healthier lifestyles, as well as encouraging healthy eating habits, and encouraging regular physical activity since childhood[4,21].

In large health surveys in Brazil, anthropometry has often been approached with a view to monitoring the nutritional status of the population. In the survey known as Vigitel (Surveillance of Chronic Diseases by Telephone Survey – *Vigilância das doenças crônicas por inquérito telefônico*), weight and height measurements have been self-reported since 2006. The measurement of anthropometric measurements during fieldwork was carried out for the first time in the National Study of Family Expenditure (*Estudo Nacional de Despesa Familiar* – ENDEF), 1974-75, followed by the National Survey on Health and Nutrition (*Pesquisa Nacional sobre Saúde e Nutrição* – PNSN), in 1989, and the Family Budget Survey (*Pesquisas de Orçamentos Familiares* – POF), in 2002-2003 and 2008-2009[22]. More recently, weight and height measurements were taken in all adult residents selected to respond to the household interview in the National Health Survey (*Pesquisa Nacional de Saúde* – PNS), 2013, and in a subsample of participants in the PNS-2019[23]. The objectives of this study were to compare anthropometric indicators between 2013 and 2019 and to investigate the factors associated with obesity in Brazil, using measures of weight and height measured in the two editions of the PNS.

METHODS

STUDY DESIGN

In this study, the two editions of the PNS, held in 2013 and 2019, were used as sources of information. The PNS is a cross-sectional, national, household-based study carried out by the Ministry of Health in partnership with the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* – IBGE). The population surveyed corresponds to residents of permanent private households in Brazil, except for those located in the special census tracts. The field work of the two editions of the PNS was the responsibility of IBGE. In 2013, at the end of the field work, 69,994 households were occupied, and 64,348 household interviews were carried out. In 2019, 108,525 households were visited, and 94,114 interviews were conducted. Nonresponse rates were, respectively, 8.1 and 6.4%[23].

The PNS was approved by the National Research Ethics Commission (*Comissão Nacional de Ética em Pesquisa* – CONEP), in July 2013, under No. 328.159 for the 2013 edition and, in August 2019, under No. 3.529.376 for the 2019 edition.

SAMPLE

The PNS belongs to the Integrated System of Household Surveys (*Sistema Integrado de Pesquisas Domiciliares* – SIPD) of the IBGE and uses a sub-sample of the IBGE Master Sample. The PNS sampling plan was made by clusters in three stages of selection, with stratification of the primary sampling units (PSU). At all stages, the selection of sampling units was performed by simple random sampling[24].

In the PNS-2013, excluding all women who reported being pregnant at the time of the interview (n=800), 59,592 individuals were analyzed. In PNS-2019, a sub-sample of 7,060 people was selected to measure weight and height. Excluding individuals under 18 years of age and pregnant women (n=388), the analysis considered 6,672 individuals.

The sub-sample to measure anthropometric measurements was defined and proportionally allocated to the strata according to the PNS sample, maintaining a minimum number of two PSU per stratum. The primary units and households were selected by simple random sampling, and, in the selected households, the measurement was carried out on the resident selected to answer the individual questionnaire. Expansion factors were calculated analogously to the total sample, and calibration was performed considering the same age groups.

STUDY VARIABLES

In the present study, information from the individual questionnaire from the two editions of the PNS was used.

The assessment of nutritional status was performed using the body mass index (BMI), using the measured weight and height data from the two editions of the PNS. This indicator is obtained through the ratio between the weight and the square of an individual's height, and, according to the classification of the World Health Organization (WHO), proposed in 1995, values greater than or equal to 25 kg/m^2 indicate excess weight and values greater than or equal to 30 kg/m^2 characterize obesity[25].

The following demographic and socioeconomic indicators were considered: gender, age group (18 to 39 years, 40 to 59 years, and 60 years old and older), level of education (up to complete middle school or incomplete high school and more), living with a partner, type of area (urban or rural), per capita household income in terms of minimum wages (MW) (<1 MW, ≥1 and <2 MW, ≥2 MW) and race/skin color aggregated as white and not white (brown and black), excluding yellow and indigenous people due to their low representation in the PNS.

Regarding health conditions, the following indicators were elaborated: poor self-assessment of health (fair, bad or very bad) using the following question: "In general, how do you rate your health? Very good/good/fair/bad/very bad"; self-reported diagnosis of heart disease, hypertension, diabetes, and depression, using the questions from the chronic diseases module: "Has any doctor ever given you the diagnosis of _____?". For the diagnosis of at least one NCD, the following diseases were considered: hypertension, diabetes, heart disease, stroke, asthma or asthmatic bronchitis, arthritis or rheumatism, chronic spine problem, work-related musculoskeletal disorder, depression, other mental illness, lung cancer, and chronic kidney disease.

STATISTICAL ANALYSIS

In the data analysis, first, the proportional distributions (%) of demographic, socioeconomic, and health problems characteristics in the years 2013 and 2019 were compared, in addition to the mean weight, height, and the prevalence of overweight and obesity in the same period.

Given the differences by gender in factors associated with obesity, the analysis was stratified by gender[18]. To investigate the variations in the prevalence of obesity between 2013 and 2019, according to demographic and socioeconomic factors and health problems, the prevalence of obesity by gender and the respective 95% confidence intervals were calculated. As the PNS sample is large enough to use the normal approximation for the binomial distribution and the sampling plan effects (SPA) of the two editions of the PNS are different, the independent samples' *t*-test was used to compare the prevalence of overweight and obesity and mean weight and height between 2013 and 2019[26]. To identify the sociodemographic factors and health problems associated with obesity, Poisson regression models with robust variance were used. Age-adjusted prevalence ratios (PR) and respective confidence intervals were used to test associations with obesity.

In the statistical analysis of the data, the sampling design of the two editions of the PNS was considered, taking into account the sampling weights and the conglomeration effect. The Software for Statistics and Data Science (StataCorp LP, CollegeStation, Texas, United States), version 14.0, survey module was used.

RESULTS

The total number of people aged 18 years old or older with weight and height measured in the PNS-2013 was 59,592, 47.6% males and 52.4% females. In the PNS-2019, this total was 6,672 individuals, 46.8% males and 53.2% females. As for sociodemographic variables, it is observed that in the period 2013–2019 there is an increase in the proportion of individuals aged 60 years old or older, with complete high school education and those who declared themselves non-white (Table 1).

Regarding the variables of self-rated health and the presence of NCDs in 2013 and 2019, significant differences were found among individuals who reported having high cholesterol, diagnosis of heart disease, hypertension, diabetes or at least one NCD. The proportion of people with an NCD increased from 45.2 to 51.7% and about a third had regular/poor evaluation of their own health, in the two years analyzed (Table 2).

As for the nutritional status of the studied population, the prevalence of obesity and overweight increased significantly in the total population between 2013 and 2019, from 20.8 to 25.9% and from 57.0 to 60.3%, respectively. The proportion of individuals with adequate weight decreased, from 40.5 to 36.6%. The average weight and height had significant increases in both genders (Table 2).

Table 3 shows the prevalence of obesity by gender for the categories of demographic and socioeconomic variables. Regarding the prevalence of obesity, there is an increase for

Table 1. Proportional distribution (%) of individuals aged 18 years old and older according to demographic and socioeconomic characteristics. Brazil, National Health Survey, 2013 and 2019.

		2013			2019		
		n	%	95%CI	n	%	95%CI
Gender	Male	28,357	47.6	46.8–48.4	3,125	46.8*	45.1–48.6
	Female	31,235	52.4	51.6–53.2	3,547	53.2*	51.4–54.9
Age range	18–39	28,128	47.2	46.4–48.0	2,875	43.1*	40.8–45.4
	40–59	20,593	34.6	33.9–35.2	2,355	35.3	32.3–38.4
	60 or +	10,870	18.2	17.7–18.8	1,442	21.6*	19.6–23.8
Education level	1	23,341	39.2	38.3–40.0	2,315	34.7*	32.8–36.6
	2	9,238	15.5	15.0–16.1	965	14.5	12.7–16.4
	3	27,012	45.3	44.4–46.2	3,392	50.8*	48.2–53.5
Color/race	White	28,339	47.6	46.7–48.4	2,815	42.2*	39.2–45.3
	Non-white	31,253	52.4	51.6–53.3	3,857	57.8*	54.7–60.8
Living with a partner	Yes	36,403	61.1	60.3–61.8	4,168	62.5	59.6–65.3
	No	23,189	38.9	38.2–39.7	2,504	37.5	34.7–40.4
Living área	Urban	51,367	86.2	85.7–86.7	5,767	86.4	85.2–87.6
	Rural	8,225	13.8	13.3–14.3	905	13.6	12.4–14.8
Per capita income	<1 MW	29,587	49.6	48.7–50.6	3,364	50.4	47.8–53.0
	≥1 and <2 MW	17,217	28.9	28.2–29.6	1,999	30.0	27.6–32.4
	>2 MW	12,788	21.5	20.6–22.4	1,310	19.6	17.4–22.0

Education level: 1. Incomplete Elementary/Middle school; 2. Complete Elementary/Middle school or incomplete High School; 3. Complete High School or more. *p<0.05 for the Student's *t*-test of independent samples.

both genders, from 16.8 to 21.8% among men and from 24.4 to 29.5% among women. The sociodemographic characteristics that showed significant differences in the prevalence of obesity between 2013 and 2019 for males were: age group 40 to 59 years; white and non-white race/color; living with a partner; urban area or rural area; per capita household income greater than or equal to 1 and less than 2 MW. The greatest increases in the prevalence of obesity were found in the age group from 40 to 59 years old (9.1%) and in the per capita income group greater than 1 to 2 MW (8.3%). For females, significant differences were found for: age group 40 to 59 years; incomplete elementary school; not living with a partner; rural area; per capita household income of up to 1 MW. The greatest increases occurred in the age group from 40 to 59 years (7.8%), among those with incomplete elementary/middle education (8.7%), per capita income less than 1 MW (5.6%) and non-whites (6.0%).

Table 4 shows the results of the Poisson regression models with robust variance by gender, referring to the PR of obesity according to the categories of demographic and

Table 2. Proportional distribution (%) of individuals aged 18 years old and older according to indicators of health conditions and mean weight (kg) and height (cm). Brazil, National Health Survey, 2013 and 2019.

		2013			2019		
		n	%	95%CI	n	%	95%CI
Poor health self-assessment		19,248	32.3	31.6–33.0	2,236	33.5	31.0–36.1
High cholesterol		7,480	12.6	12.1–13.0	967	14.5*	13.2–15.9
Heart disease		2,488	4.2	3.9–4.5	341	5.1*	4.3–6.0
Hypertension		12,833	21.5	20.9–22.2	1,586	23.8*	22.0–25.6
Diabetes		3,741	6.3	5.9–6.6	548	8.2*	7.2–9.4
Any NCD		26,946	45.2	44.5–46.0	3,450	51.7*	49.6–53.8
Nutritional status	Obesity	12,399	20.8	20.2–21.4	1,728	25.9*	22.6–29.5
	Overweight	33,946	57.0	56.2–57.8	4,024	60.3*	58.2–62.4
	Eutrophy	24,162	40.5	39.8–41.3	2,443	36.6*	34.5–38.8
Mean weight (kg)	T	59,592	71.3	71.1–71.6	6,672	73.5*	72.1–74.9
	M	31,235	76.1	75.7–76.4	3,125	78.3*	77.3–79.3
	F	28,357	66.9	66.7–67.3	3,547	69.3*	67.1–71.5
Mean height (cm)	T	59,592	164.2	164.0–164.3	6,672	164.7*	164.4–165.1
	M	31,235	170.8	170.7–171.0	3,125	171.6*	171.2–172.1
	F	28,357	158.1	158.0–158.3	3,547	158.7*	158.2–159.2

Health self-assessment: Poor – Regular/Bad/Very bad. T: Total; M: Male; F: Female. *p<0.05 for the Student's *t*-test of independent samples.

socioeconomic variables, in 2013 and 2019. For both males and females, for the years 2013 and 2019, the PRs by age group were significantly >1 in the age groups 40–59 and 60 years old or older, although decreasing among aged people. After being adjusted for age group,

Table 3. Prevalence of obesity according to sociodemographic characteristics by gender among individuals aged 18 years old and older. Brazil, National Health Survey, 2013 and 2019.

	Male				Female			
	2013		2019		2013		2019	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI
T	16.8*	16.0–17.7	21.8*	18.7–25.2	24.4*	23.6–25.3	29.5*	25.3–34.2
Age range								
1	13.5	12.5–14.5	15.5	12.5–19.2	18.7	17.5–19.8	23.4	16.6–31.8
2	21.1*	19.6–22.7	30.2*	24.7–36.3	30.2*	28.7–31.8	38.0*	32.4–43.9
3	17.9	15.8–20.2	21.2	15.5–28.1	27.5	25.7–29.4	27.5	23.0–32.5
Education level								
1	15.0	13.9–16.3	17.8	14.2–22.1	28.8*	27.4–30.2	37.5*	32.8–42.5
2	15.4	13.4–17.6	28.5	15.2–47.2	24.3	22.3–26.5	24.9	19.3–31.5
3	19.0	17.7–20.4	22.4	19.2–26.1	20.9	19.8–22.1	25.5	19.9–32.1
Color/race								
W	19.2*	17.9–20.6	24.6*	20.7–29.0	25.0	23.8–26.2	29.1	24.2–34.5
NW	14.7*	13.7–15.8	19.8*	15.6–24.8	23.9*	22.9–25.0	29.9*	25.4–34.8
Living with a partner								
Y	19.4*	18.4–20.5	24.9*	21.0–29.1	26.5	25.4–27.6	32.0	26.1–38.7
N	12.1	11.0–13.3	14.3	11.0–18.5	21.6*	20.4–22.8	26.4*	22.6–30.6
Living área								
U	17.9*	16.9–18.9	23.1*	19.6–26.9	24.8	23.9–25.7	29.8	25.0–35.1
R	10.8*	9.4–12.3	14.1*	11.7–16.8	21.9*	20.0–24.0	27.7*	24.2–31.5
Per capita income								
1	13.1	12.1–14.2	16.3	12.6–20.7	24.5*	23.4–25.6	30.1*	25.7–34.8
2	18.0*	16.4–19.6	26.3*	21.7–31.4	26.2	24.6–27.9	27.0	21.1–33.9
3	22.9	21.0–25.0	23.4	18.0–29.9	21.9	20.3–23.6	25.7	18.5–34.6

Age range: 1: 18–39; 2: 40–59; 3: 60+. Education level: 1: Incomplete Elementary/Middle School; 2: Complete Middle School/ Incomplete High School; 3: Complete High School or more. Color/race: W: White; NW: Non-White. Living with a partner: Y: Yes; N: No. Living area: U: Urban; R: Rural. Per capita income: 1. <1 MW; 2. ≥1 and <2 MW; 3. ≥2 MW.
*p<0.05 for the Student's *t*-test of independent samples.

for males, in 2013 and 2019, the PRs were significantly greater than 1 for living with a partner, living in an urban area, and having a per capita income ≥1 and <2 MW, and significantly lower than 1 for the lowest level of education (incomplete elementary school). For females,

Table 4. Obesity prevalence ratios according to sociodemographic characteristics by gender among individuals aged 18 years old and older. Brazil, National Health Survey, 2013 and 2019.

	Male				Female			
	2013		2019		2013		2019	
	PR	95%CI	PR	95%CI	PR	95%CI	PR	95%CI
Age range								
1	1.00	–-	1.00	–	1.00	–	1.00	–
2	1.56*	1.42–1.73	1.94*	1.46–2.59	1.62*	1.50–1.75	1.62*	1.23–2.14
3	1.33*	1.15–1.53	1.36	0.96–1.94	1.47*	1.34–1.62	1.18	0.78–1.77
	PR**	**95%CI**	**PR****	**95%CI**	**PR****	**95%CI**	**PR****	**95%CI**
Education level								
1	0.69*	0.61–0.77	0.65*	0.49–0.86	1.23*	1.14–1.33	1.45*	1.18–1.79
2	0.81*	0.69–0.94	1.23	0.70–2.17	1.15*	1.04–1.28	0.97	0.70–1.35
3	1.00	–	1.00	–	1.00	–	1.00	–
Color/race								
W	1.28*	1.16–1.41	1.20	0.91–1.57	1.02	0.95–1.08	0.96	0.83–1.11
N	1.00	–	1.00	–	1.00	–	1.00	–
Living with a partner								
1	1.53*	1.38–1.70	1.62*	1.19–2.21	1.27*	1.18–1.36	1.25*	1.02–1.52
2	1.00	–	1.00	–	1.00	–	1.00	–
Living area								
U	1.69*	1.45–1.95	1.65*	1.31–2.09	1.13*	1.03–1.24	1.07	0.86–1.34
R	1.00	–	1.00	–	1.00	–	1.00	–
Per capita income								
1	1.00	–	1.00	–	1.00	–	1.00	–
2	1.36*	1.20–1.53	1.61*	1.24–2.08	1.04	0.96–1.12	0.85	0.66–1.10
3	1.72*	1.53–1.93	1.38	0.96–2.00	0.85*	0.78–0.93	0.81	0.61–1.08

Age range: 1: 18–39; 2: 40–59; 3: 60 or +. Education level: 1–Incomplete Elementary/Middle School; 2–Complete Middle School or incomplete High School; 3–Complete High School or more. Color/race: W: White; N: Non-White. Living with a partner: 1–Yes; 2–No. Living area: U: Urban; R: Rural. Per capita income: 1. <1 MW; 2. ≥1 and <2 MW; 3. ≥2 MW. *p<0.05. **PR: prevalence ratio adjusted by age range.

both in 2013 and 2019, PRs significantly >1 were found for living with a partner and low education, indicating that, unlike men, the higher the level of education, the lower the prevalence of obesity. In 2013 alone, the PR was significantly >1 for living in an urban area and significantly <1 for per capita income ≥ 2 MW.

Table 5 shows the crude and adjusted PRs by age group, according to gender, for health status indicators, in the years 2013 and 2019. For males, in 2013, significant gross PRs were found for all health problems considered and significant adjusted PR, except for heart disease. In 2019, the crude and adjusted PRs were significant for high cholesterol, arterial hypertension, and at least one NCD. For females, in 2013, significant crude and adjusted PRs were found for all indicators of health conditions. In 2019, the significant crude and adjusted PR corresponded to poor self-assessment, high blood pressure, diabetes, and having at least one NCD.

Table 5. Obesity prevalence ratios according to health problems by gender among individuals aged 18 years old and older. Brazil, National Health Survey, 2013 and 2019.

	Male				Female			
	2013		2019		2013		2019	
	PR	PR**	PR	PR**	PR	PR**	PR	PR**
Poor health self-assessment	1.20*	1.15*	1.01	0.88	1.28*	1.29*	1.35*	1.50*
95%CI	1.12–1.27	1.04–1.28	0.78–1.19	0.71–1.10	1.23–1.33	1.19–1.39	1.21–1.46	1.25–1.80
High cholesterol	2.04*	1.93*	1.47*	1.36*	1.48*	1.34*	1.16	1.08
95%CI	1.80–2.30	1.70–2.19	1.12–1.94	1.02–1.82	1.38–1.60	1.24–1.45	0.90–1.49	0.80–1.47
Heart disease	1.24*	1.08	1.26	1.12	1.39*	1.23*	1.19	1.14
95%CI	1.01–1.52	0.88–1.34	0.81–1.96	0.71–1.77	1.23–1.58	1.08–1.40	0.83–1.71	0.81–1.61
Hypertension	2.35*	2.38*	2.20*	2.16*	2.03*	1.98*	1.72*	1.84*
95%CI	2.13–2.59	2.13–2.66	1.76–2.75	1.66–2.81	1.91–2.16	1.84–2.13	1.44–2.05	1.45–2.33
Diabetes	2.06*	1.86*	1.38	1.24	1.75*	1.54*	1.58*	1.51*
95%CI	1.76–2.42	1.58–2.20	0.90–2.13	0.80–1.91	1.61–1.91	1.40–1.69	1.25–2.00	1.12–2.03
Any NCD	1.71*	1.65*	1.58*	1.48*	1.68*	1.57*	1.50*	1.50*
95%CI	1.55–1.89	1.48–1.83	1.21–2.04	1.12–1.96	1.56–1.80	1.46–1.69	1.15–1.97	1.19–1.89

PR: prevalence ratio estimated by bivariate Poisson regression between obesity and each variable. **PR: prevalence ratio adjusted by age range. *p<0.05.

DISCUSSION

The results of this study show a significant increase in mean height, mean weight, and the prevalence of obesity in the Brazilian population, between 2013 and 2019, for both men and women. The greatest increases in the prevalence of obesity were found among men and women aged 40 to 59 years. However, the trends of increasing prevalence of obesity according to socioeconomic status (SES) were different by gender: while, among men, obesity increased in the median income range (≥1 and <2 MW), among women, the highest increases occurred in those with low education and lower income.

Mean weight increased by 2.2 kg and influenced the increase in the prevalence of overweight and obesity between 2013 and 2019[27]. The significant increase in height, on the other hand, can probably be attributed to improvements in socioeconomic and health conditions and the decrease in malnutrition in children over the years[28]. Studies have shown that human height has been increasing all over the world for a century and a half, and although the final height has reached a plateau in developed countries, such as those in northern Europe, developing countries continue to show a trend of increasing height[28,29].

Brazilian researches have shown temporal trends of accentuated growth in the prevalence of overweight and obesity in Brazil[18,30-32]. The results of the present study indicate not only the continuation of the upward trend in obesity in both genders, but also an acceleration in the rate of growth. Comparing PNS data from 2013 to 2019, the annual growth rates in the prevalence of obesity were 3.2% for females and 6.4% for males, while between 1975 and 2013, annual growth rates were 2.9 and 4.5%, respectively[22]. A study by Silva *et al.* (2021) using data from Vigitel and self-reported anthropometric measures also showed increases in the prevalence of obesity in Brazil, from 11.8% in 2006 to 20.3% in 2019, and in the prevalence of overweight, from 42.6 to 55.4%, respectively[33]. A recent article showed a growth in morbid obesity in the set of Brazilian capitals, warning of the urgency of adopting measures to stop the progressive increase in obesity[34].

Reflecting this scenario, the Global Burden of Disease (GBD) estimates for 2017 indicated that high BMI was responsible for 13% of all deaths in Brazil, with the most prevalent causes of death from cardiovascular disease and diabetes[13]. The findings of this study show the aging of the Brazilian population between 2013 and 2019, together with the increase in the prevalence of chronic diseases. They also indicate higher prevalence of obesity among individuals with a perception of health as fair/poor, self-reported diagnosis of arterial hypertension, diabetes and at least one NCD, corroborating findings from other nationa[l7,18] and international[6,8] studies. However, after adjusting for age group, not all health problems were significantly associated with obesity, such as heart disease. Despite the gradual increase in the prevalence of obesity with age, there is a decrease among the elderly, who are the ones who most frequently present chronic health problems.

Like other national studies, our findings showed the highest prevalence of obesity in the median age groups[35,36]. Particularly among women, weight gain is common in menopause[37]. Healthy diets combined with physical activity have shown beneficial effects in preventing menopause-related obesity[38].

Living with a partner was another factor associated with a higher prevalence of obesity for both genders. In an article that considered waist circumference as an outcome, it was equally evident that men and women living with a partner had higher means of this anthropometric indicator[39]. A study in China showed that individuals gain weight after marriage or stable union[40]. One of the explanatory hypotheses is that people who do not have a partner invest more efforts in monitoring their weight to remain attractive[41].

Regarding socioeconomic level, the highest prevalence of obesity was found among men with a better level of education and higher per capita household income. Conversely, obesity was more prevalent among low-educated and low-income women. These findings are in line with those found in a study based on information from Vigitel[42] and should be taken into account when planning strategies to modify the eating habits of Brazilians from different social strata[43].

As for the urban/rural situation, the highest prevalence of obesity is found among people living in urban areas, especially among men. However, it is interesting to note that important increases occurred among residents of rural sectors between 2013 and 2019, indicating that the nutritional transition has reached the rural population, corroborating previous findings[44].

Brazil has made commitments with the United Nations to halt the growth of obesity among adults, with a reduction in the consumption of sugary drinks, an increase in the consumption of fruits and vegetables, a reduction in the consumption of ultra-processed foods and the increase in the practice of physical activity. To achieve these goals, the country urgently needs changes in food policies. Strategies that have been adopted include requesting the addition of micronutrients to processed foods, taxing sugary drinks, stuffed cookies and other ultra-processed foods, placing warning labels on harmful health effects and restricting unhealthy food advertising[20,45].

Strategies that have not yet been implemented, but that have been suggested, concern increasing knowledge about the benefits of healthy eating[46] and expanding the availability of healthy foods at subsidized costs in poor areas[43]. Regarding leisure-time physical activity, in addition to encouraging regular practice, it is necessary to continue the construction and maintenance initiatives of public spaces as favorable and safe environments, ensuring accessibility to all population groups[47].

Among the limitations of this work is the difference in the sample size of people with anthropometric measurements. In PNS-2019, the sub-sample of people was relatively small, which may have affected the results of the statistical inference. In addition, the PNS is a cross-sectional study, and the temporality bias should not be disregarded in the analyses of association with obesity. Furthermore, possible problems in measuring weight and height may have occurred due to the inadequacy of the characteristics of the households for measuring.

This study identified that the prevalence of obesity increased significantly in Brazil between 2013 and 2019. The greatest increases occurred among men aged 40–59 years and in the median income group, and among women with low education and non-whites. Educational level was directly associated with obesity for males, and inversely associated with females. Obesity has been shown to be associated with several health problems for

both genders. Therefore, given the increase in obesity in the country, observed with the data measured from the two editions of the PNS, the importance of implementing intersectoral policies to encourage the promotion of healthier lifestyles for Brazilians, reducing the consumption of ultra-processed foods, is emphasized, encouraging healthy eating, encouraging the practice of leisure physical activity, taking into account economic, social, cultural, and environmental aspects.

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