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Research Article

Analysis of the epidemiological profile of obesity in Brazilian capitals

Análise do perfil epidemiológico de obesidade nas capitais brasileiras

Análisis del perfil epidemiológico de la obesidad en las capitales brasileñas

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Abstract

Introduction: Obesity is a clinical condition characterized by body fat excess with high prevalence in the world and in Brazil. This condition can cause serious health complications, especially when aligned with certain socioeconomic factors. **Objective:** To identify possible risk factors for obesity such as inadequate eating habits, sedentary lifestyle, and excessive screen use. **Methods:** This is an observational study of the ecological type. It is a population-based study. Data on individuals aged >18 years, interviewed by the Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey, were analyzed, conducted in Brazilian capitals and the Federal District between 2011–2021, publicly available. **Results:** We surveyed the prevalence of obesity in different age groups, sexes, levels of education, and eating habits. We observed an overall increase in the prevalence of obesity between 2011 and 2021, as well as a significant association between obesity and smoking habit, hypertension, diabetes, depressive episodes, and excessive screen use. **Conclusions:** We verified the factors most associated with the presence of obesity, being the highest incidence among young people, women, people who consume soft drinks, individuals with Systemic Arterial Hypertension and type 2 diabetes mellitus. The groups of people who do not exercise also presented a higher prevalence, but factors — such as body composition and exercise intensity — must be considered.

Keywords: Obesity; Risk factors; Data analysis; Prevalence.

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Resumo

Introdução: A obesidade é uma condição clínica caracterizada por um excesso de gordura corporal de grande prevalência no Brasil e no mundo. Tal condição pode causar complicações graves de saúde, especialmente quando alinhadas com determinados fatores socioeconômicos. **Objetivo:** Buscou-se identificar possíveis fatores de risco para a obesidade, como hábitos alimentares inadequados, sedentarismo e uso excessivo de telas. **Métodos:** Trata-se de um estudo observacional do tipo ecológico. A população de estudo foi composta por base populacional, e foram analisados dados referentes a indivíduos com idade >18 anos entrevistados pelo sistema de Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico (Vigitel), realizado nas capitais brasileiras e no Distrito Federal entre 2011 e 2021, sendo de acesso público. **Resultados:** O estudo levantou a prevalência da obesidade em diferentes faixas etárias, gêneros, escolaridades e hábitos alimentares. Observou-se um aumento geral da prevalência de obesidade entre 2011 e 2021, assim como uma associação significativa entre obesidade e tabagismo, hipertensão, diabetes, episódios depressivos e uso excessivo de telas. **Conclusões:** O estudo revelou os fatores mais associados à presença de obesidade, sendo a maior incidência entre jovens, mulheres, pessoas que consomem refrigerantes e pessoas com Hipertensão Arterial Sistêmica (HAS) e Diabetes Mellitus tipo II (DM2). Os grupos que não praticam atividades físicas também apresentaram uma maior prevalência, porém fatores como composição corporal e intensidade do exercício precisam ser considerados

Palavras-chave: Obesidade; Fatores de risco; Análise de dados; Prevalência.

Resumen

Introducción: La obesidad es una condición clínica caracterizada por un exceso de grasa corporal de alta prevalencia en el mundo y en Brasil. Tal condición puede causar serias complicaciones de salud, especialmente cuando se combina con ciertos factores socioeconómicos. **Objetivo:** Se buscó identificar posibles factores de riesgo para la obesidad, como malos hábitos alimenticios, sedentarismo y uso excesivo de pantallas. **Métodos:** Se trata de un estudio observacional de tipo ecológico. La población de estudio se compuso de datos de base poblacional, analizados, referentes a individuos de >18 años entrevistados por el sistema de Vigilancia de Factores de Riesgo y Protección para Enfermedades Crónicas por Indagación Telefónica (VIGITEL), realizado en las capitales brasileñas y en el Distrito Federal entre 2011–2021, siendo de acceso público. **Resultados:** El estudio relevó la prevalencia de obesidad en diferentes grupos de edad, género, educación y hábitos alimentarios. Hubo un aumento general en la prevalencia de la obesidad entre 2011 y 2021, así como una asociación significativa entre la obesidad y el tabaquismo, la hipertensión, la diabetes, los episodios depresivos y el uso excesivo de pantallas. **Conclusiones:** el estudio reveló los factores más asociados a la presencia de obesidad, siendo la mayor incidencia entre jóvenes, mujeres, personas que consumen refrescos, personas con Hipertensión Arterial Sistémica (HSA) y diabetes mellitus tipo II (DM2). Los grupos que no practicaban actividades físicas también mostraron una mayor prevalencia, pero hay que tener en cuenta factores como la composición corporal y la intensidad del ejercicio.

Palabras clave: Obesidad; Factores de riesgo; Análisis de datos, Prevalencia.

INTRODUCTION

Obesity is a clinical condition that is characterized by body fat excess. This poses health risks and can lead to serious health complications such as type 2 diabetes mellitus (DM2), cardiovascular diseases, respiratory diseases, bone and joint problems, among others.[1] Such a condition occurs when caloric intake is higher than energy expenditure, resulting in an energy imbalance that leads to weight gain. The Body Mass Index (BMI) is often used to assess whether a person is overweight or obese. BMI is calculated by dividing a person's weight by its height squared. According to the World Health Organization (WHO), a BMI of 25 or more indicates overweight, while a BMI of 30 or more indicates obesity.[1]

It is worth stressing that obesity is a global public health issue, which has significant consequences for the quality of life and health of the affected people. In addition, obesity is a risk factor for many chronic diseases, including DM2, cardiovascular diseases and systemic arterial hypertension (SAH).[2] Taking this into consideration, it is worth mentioning a study published in 2021 whose authors showed greater propensity for obese women to develop cardiovascular diseases, while obese men are more likely to develop DM2.[3] Moreover, researchers of another study, published in 2019, evaluated the impact of obesity on mortality in a sample of more than 3.9 million people and, according to the results, obesity was associated with a significant increase in mortality from various causes, including specific causes such as cardiovascular

diseases and cancer.[4] Socioeconomic factors, such as low level of education, poverty, and poor access to healthy diets, also play an important role in the development of obesity.[5]

The incidence of obesity varies throughout the world, but, overall, high-income countries have more cases of obesity than low- and middle-income countries. Nonetheless, in many low- and middle-income countries the incidence of obesity is progressively increasing.[6]

Obesity is an increasingly prevalent health condition worldwide, with global obesity rates increasing by 69% since 1990, according to a 2021 study published in the scientific journal *The Lancet*. The study also highlights that the COVID-19 pandemic has considerably contributed to this growth globally, due to increased sedentary lifestyle and changes in dietary patterns.[7]

Authors of another study published in the same journal in 2014 analyzed the prevalence of obesity in children and adults worldwide between 1980 and 2013. The results showed a significant increase in obesity rates during this period, both among children and adults. These data demonstrate that obesity is a growing global epidemic and highlight the importance of effective interventions to prevent and treat obesity since childhood, on a global scale.[8]

Thanks to the evaluation of new interventions, such as the use of digital technologies to modify eating behaviors or physical activity, there are good prospects for the future. The most effective strategies include nutritional education, prescription of physical exercises, monitoring of weight and eating habits, and cognitive-behavioral therapy.[9] In more severe and refractory cases, the use of drugs, such as appetite suppressants and drugs that interfere with fat absorption,[10] may be an option in the treatment of obesity. Another option is bariatric surgery, also considered in more severe cases and when other interventions fail. This type of surgery reduces the size of the stomach and/or diverts the gastrointestinal tract, which reduces the food intake ability and changes the absorption of nutrients.[11]

As a method for evaluating the progression of obesity, Brazil has the Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey (*Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico* – Vigitel), which is a platform for the surveillance of risk and protective factors for Chronic Noncommunicable Diseases (CNCD) in the country, conducted annually by the Ministry of Health, by a telephone survey in the capitals and the Federal District. The research gathers information on the life and health habits of the Brazilian population, such as smoking habit, physical activity, eating habits, alcoholism, weight, height, hypertension, and diabetes. These data are used to monitor and evaluate the prevalence of these risk factors and to guide public health policies.[12]

Considering that obesity is a growing global issue and that there are gaps in knowledge of its causes, consequences, and the most effective preventive and therapeutic interventions, it is essential to estimate the prevalence of obesity and evaluate possible and relevant demographic, lifestyle, and comorbidity indicators. In this study, our objective was to analyze the epidemiological profile of obesity in Brazilian capitals between 2011 and 2021, based on Vigitel data, seeking to understand the prevalence and factors associated with this health condition and to estimate its prevalence throughout this period.

METHODS

This is an observational study of the ecological type. It is a population-base study, and data were analyzed regarding individuals aged >18 years interviewed by Vigitel,[13] conducted in Brazilian capitals and the Federal District between 2011 and 2021, publicly available.

The details of the sample plan, the sampling steps, and the application of weights are fully available in the Vigitel report.[13] The survey conducted by the platform is carried out annually, in all capitals and in the Federal District, via telephone calls to selected residences randomly. Interviewers collect information about life and health habits, such as smoking habit, physical activity, eating habits, alcohol consumption, weight, height, hypertension, and diabetes. All data were obtained from the analysis of Vigitel reports.[13]

For the time series, BMI >30 kg/m^2 was considered to define obesity, stratifying it by sex and considering the period from 2011 to 2021 in Brazilian capitals and the Federal District. For the analysis of factors associated with obesity, the year 2021 was considered, and the analyzed variables were sex, age (in complete years and categorized as 18–39, 40–59, 60–79, and >80 years) and level of education (kindergarten, early childhood, elementary school, middle school, high school, higher education, graduate school, and illiterate). In addition, the following variables were analyzed: vegetables intake, soft drinks consumption, alcohol consumption, physical activity, hypertension, screen use, smoking habit, diabetes mellitus, and depression.

As it is an ecological study, based on secondary public-domain data, without the identification of the participants, and using population aggregates as units of analysis, it was not necessary to submit and evaluate the project by the Research Ethics Committee (REC-UNISUL), according to the terms of CNS Resolution 510/2016, Article 1, Sole Paragraph, items II, III, and V.

Data tabulation was performed using the Microsoft Office Excel® software, and the data were analyzed using the SPSS® software version 20.0. Data were presented by absolute and percentage numbers, measures of central tendency and dispersion. The implementation of the time series of obesity was carried out through linear regression. For comparison with the obesity outcome, the χ^2 test was used. In the multivariate analysis by means of logistic regression, variables with $p<0.2$ were considered, using the backward method. A 95% confidence interval was used, with a 5% statistical significance level.

RESULTS

In this study, we sought to understand the prevalence of obesity in different age groups, sexes, levels of education, and eating habits. The sample consisted of 27,093 participants residents of the 26 Brazilian capitals and the Federal District. We observed that there was an overall increase in the prevalence of obesity between 2011 and 2021. In 2011, the average obesity in Brazilian capitals was 14.5%; in 2021, the average rose to 22.4%, as shown in Figure 1. Regarding the variation by city, some showed a higher increase in the prevalence of obesity in this period, such as Belo Horizonte, which went from 13.2% in 2011 to 24.8% in 2021. Conversely, other cities had a lower increase in the prevalence of obesity, such as Macapá, which ranged from 9.9% in 2011 to 14.8% in 2021. Still, none of the Brazilian capitals managed to reduce the prevalence of obesity in this 10-year period (Figure 1).

In Tables 1 and 2, we show bivariate and multivariate statistics, respectively. In the first analysis, all variables were associated with obesity. In the multivariate analysis, the variables were interrelated and those that were particularly relevant remained significant, as evidenced by the odds ratio (OR), 95% confidence interval (95%CI), and p-value.

By evaluating the results, we observed that obesity was significantly associated with age ($p<0.001$), with a higher prevalence in individuals aged 40 to 59 years and lower prevalence in those aged over 80 years; people aged 60 to 79 years and 80 years or over presented OR significantly different from the reference OR, indicating an association between age and obesity. Sex was also associated with obesity ($p=0.008$), with a higher prevalence in women: women presented an OR significantly different than 1.

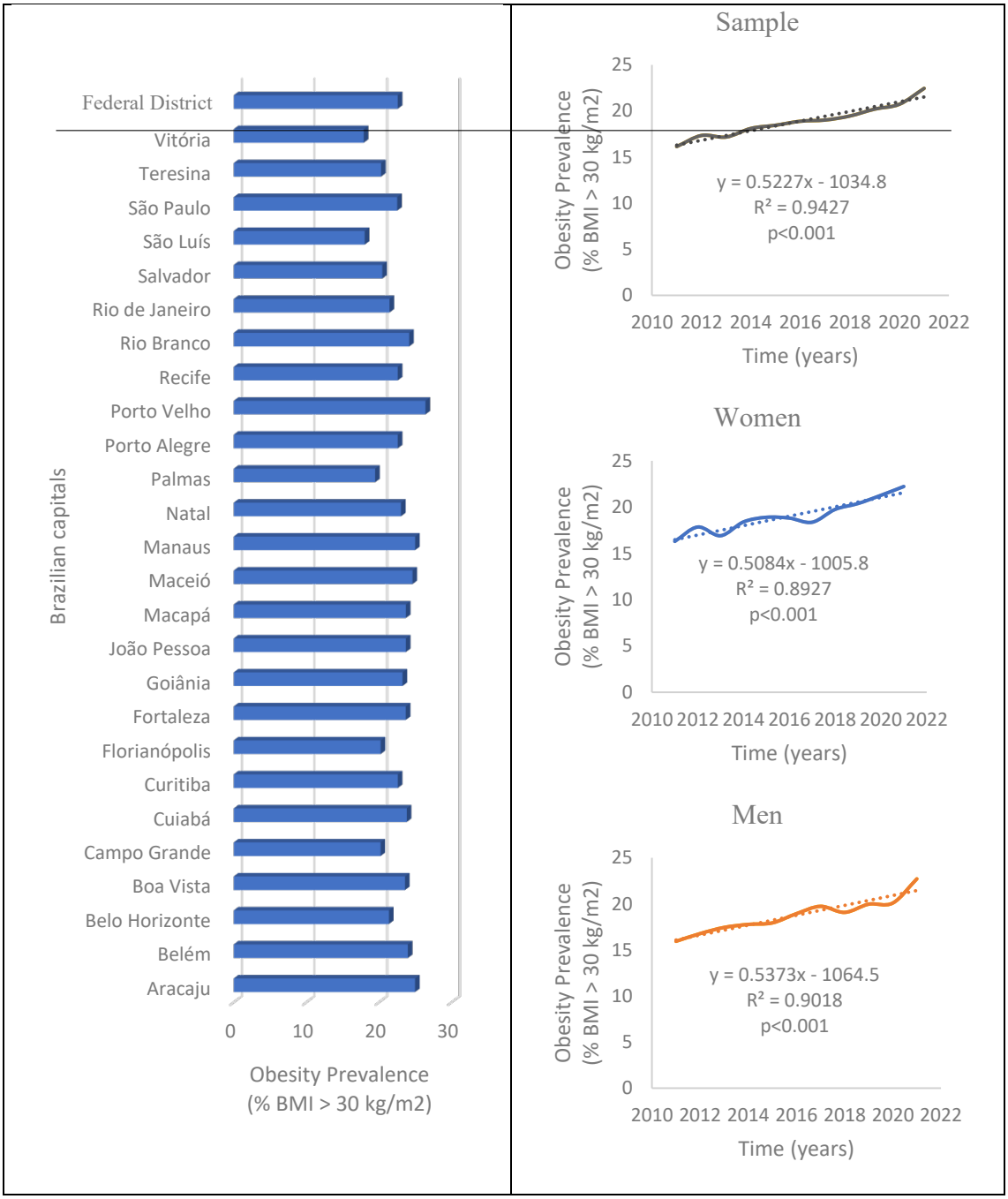

Figure 1. Prevalence of obesity in Brazilian capitals and the Federal District over the years.

Level of education was also associated with obesity (p=0.00), with a higher prevalence in individuals who attended only middle school or illiterate people, as shown in Tables 1 and 2.

Regarding physical activity, we verified that physical activity time was inversely associated with obesity (p<0.001), with a higher prevalence of obesity in individuals who reported not exercising or exercising for less than 150 minutes per week. In addition, the frequency of fruits and vegetables intake was inversely associated with obesity (p<0.001). Still regarding vegetables intake, all categories presented OR significantly different than 1, indicating an association between vegetables intake and obesity. The categories that presented lower OR were those that consumed vegetables the most (5–6 times a week and every day).

Table 1. Comparison of factors associated with obesity in Brazilian capitals and the Federal District in 2021 (Vigitel, 2021).

	Sample	Obesity		p-value
	n(%) column (2º%)	No n(%)	Yes n(%)	
Age (years)				
18 to 39	5,391 (22.1)	4,349 (80.7)	1,042 (19.3)	<0.001
40 to 59	7,602 (31.1)	5,699 (75.0)	1,903 (25.5)	
60 to 79	9,283 (38.0)	7,198 (77.5)	2,085 (22.5)	
80 or over	2,137 (8.8)	1,764 (82.5)	373 (17.5)	
Sex				
Men	8,876 (36.4)	6,995 (78.8)	1,881(21.2)	0.008
Women	15,537 (63.6)	12,015 (77.3)	3,522 (22.7)	
Level of education				
Kindergarten	3,326 (14.0)	2,624 (78.9)	702 (21.1)	0.001
Early childhood	1,565 (6.6)	1,229 (78.5)	336 (21.5)	
Elementary school	8,690 (36.5)	6,672 (78.8)	2,018 (23.2)	
Middle school	4,542 (19.1)	3,592 (79.1)	950 (20.9)	
High school	2,554 (10.7)	2,040 (79.9)	514 (20.1)	
Higher education	657 (2.8)	513 (78.1)	144 (21.9)	
Graduate/Master's Program	434 (1.8)	319 (73.5)	115 (26.5)	
Illiterate	2,030 (8.5)	1,563 (77.0)	467 (23.0)	
Frequency of vegetables intake (days per week)				
Eats vegetables 1–2	3,887 (15.9)	2,946 (75.8)	941 (24.2)	<0.001
Eats vegetables 3–4	6,399 (26.2)	4,985 (77.9)	1,414 (22.1)	
Eats vegetables 5–6	3,430 (14.0)	2,733 (79.7)	697 (20.3)	
Eats vegetables every day	9,623 (39.4)	7,554 (78.5)	2,069 (21.5)	
Rarely eats vegetables	663 (2.7)	497 (75.0)	166 (25.0)	
Never eats vegetables	411 (1.7)	295 (71.8)	116 (28.2)	
Frequency of fruits intake (days a week)				
Eats fruits 1–2	3,722 (15.2)	2,815 (75.6)	907 (24.4)	<0.001
Eats fruits 3–4	5,056 (20.7)	3,912 (77.4)	1,144 (22.6)	
Eats fruits 5–6	2,743 (11.2)	2,136 (77.9)	607 (22.1)	
Eats fruits every day	11,504 (47.1)	9,111 (79.2)	2,393 (20.8)	
Rarely eats fruits	1,067 (4.4)	796 (74.6)	271 (25.4)	
Never eats fruits	321 (1.3)	240 (74.8)	81 (25.2)	
Frequency of soft drinks consumption (days a week)				
Consumes soft drinks 1–2	6,971 (28.6)	5,246 (75.3)	1,725 (24.7)	<0.001
Consumes soft drinks 3–4	2,062 (8.4)	1,555 (75.4)	507 (24.6)	
Consumes soft drinks 5–6	703 (2.9)	543 (77.2)	160 (22.8)	
Consumes soft drinks every day	1,413 (5.8)	1,064 (75.3)	349 (24.7)	
Rarely consumes soft drinks	5,875 (24.1)	4,613 (78.5)	1,262 (21.5)	
Never consumes soft drinks	7,389 (30.3)	5,989 (81.1)	1,400 (18.9)	
Frequency of alcohol consumption (days a week)				
Consumes alcohol 1–2	4,401 (49.5)	3,397 (77.2)	1,004 (22.8)	0.039
Consumes alcohol 3–4	797 (9.0)	629 (78.9)	168 (21.1)	
Consumes alcohol 5–6	129 (1.5)	101 (78.3)	28 (21.7)	
Consumes alcohol every day	346 (3.9)	286 (82.7)	60 (17.3)	
Rarely consumes alcohol	1,416 (15.9)	1,138 (80.4)	278 (19.6)	
Never consumes alcohol	1,804 (20.3)	1,393 (77.2)	411 (22.8)	

Continue...

Table 1. Continuation.

	Sample	Obesity		p-value
	n(%) column (2°%)	No n(%)	Yes n(%)	
Exercise				
Exercises at least once a week	12,830 (94.8)	10,464 (81.6)	2,366 (18.4)	<0.001
Does not exercise any time in the week	702 (5.2)	529 (75.4)	173 (24.6)	
Exercise frequency (times a week)				
Exercises 1–2	3,188 (24.8)	2,522 (79.1)	666 (20.9)	
Exercises 3–4	4,922 (38.4)	3,999 (81.2)	923 (18.8)	<0.001
Exercises 5–6	3,334 (26.0)	2,767 (83.0)	567 (17.0)	
Exercises every day	1,386 (10.8)	1,176 (84.8)	210 (15.2)	
Frequency of screen use				
Use of tablet, PC, or TV: <1h/day	3,204 (20.3)	2,510 (78.3)	694 (21.7)	
Use of tablet, PC, or TV: 1–2h/day	5,492 (34.9)	4,324 (78.7)	1,168 (21.3)	
Use of tablet, PC, or TV: 2–3h/day	2,852 (18.1)	2,172 (76.2)	680 (23.8)	
Use of tablet, PC, or TV: 3–4h/day	1,695 (10.8)	1,327 (78.3)	368 (21.7)	0.006
Use of tablet, PC, or TV: 4–5h/day	866 (5.5)	684 (79.0)	182 (21.0)	
Use of tablet, PC, or TV: 6–7h/day	508 (3.2)	377 (74.2)	131 (25.8)	
Use of tablet, PC, or TV: >7h/day	1,137 (7.2)	851 (78.8)	286 (25.2)	
Smokers				
Smokes every day	1,351 (5.5)	1,134 (83.9)	217 (16.1)	
Smokes, but not every day	324 (1.3)	253 (78.1)	71 (21.9)	<0.001
Nonswmoker	22,738 (93.1)	17,623 (77.5)	5,115 (22.5)	
SAH				
Hypertensive	9,586 (39.3)	6,683 (69.7)	2,903 (30.3)	<0.001
Non-hypertensive	14,810 (60.7)	12,316 (83.2)	2,494 (16.8)	
DM2				
Type 2 diabetes	3,594 (14.7)	2,488 (69.2)	1,106 (38.8)	<0.001
Does not have diabetes	20,797 (85.3)	16,506 (79.4)	4,291 (20.6)	
Depressive episodes				
Has had depression	3,152 (12.9)	2,292 (72.7)	860 (27.3)	
Never had depression	21,231 (87.0)	16,701 (78.7)	4,530 (21.3)	<0.001
Does not recall having depression	30 (0.1)	17 (56.7)	13 (43.3)	
Physical activity				
Physically active	19,608 (80.3)	15,485 (79.0)	4,123 (21.0)	<0.001
Physically inactive	4,805 (19.7)	3,525 (73.4)	1,280 (26.6)	
Physical activity time				
Physical activity >150 min/week	13,172 (54.0)	9,094 (80.9)	2,147 (19.1)	<0.001
Physical activity <150 min/week	11,241 (46.0)	9,916 (75.3)	3,256 (24.7)	
Current depression				
Has depression	21,261 (87.1)	2,292 (72.7)	860 (,27.3)	<0.001
Does not have depression	3,152 (12.9)	16,718 (78.6)	4,543 (21.4)	

SAH: systemic arterial hypertension; DM: diabetes mellitus.

Table 2. Multivariate logistic regression of factors associated with obesity in Brazilian capitals and the Federal District in 2021 (Vigitel, 2021).

	OR	95%CI		p-value
		Lower	Higher	
Age				
18 to 39	-			
40 to 59	1.139	1.041	1.247	0.004
60 to 79	0.733	0.665	0.809	<0.001
80 or over	0.488	0.423	0.564	<0.001
Sex				
Men	-			
Women	1.078	1.009	1.152	0.027
Frequency of vegetables intake (days per week)				
Eats vegetables 1–2	0.801	0.634	1.012	0.063
Eats vegetables 3–4	0.72	0.571	0.906	0.005
Eats vegetables 5–6	0.676	0.533	0.858	0.001
Eats vegetables every day	0.75	0.597	0.942	0.013
Rarely eats vegetables	0.848	0.637	1.129	0.259
Never eats vegetables	-			
Frequency of soft drinks consumption (days a week)				
Consumes soft drinks 1–2	1.479	1.36	1.608	<0.001
Consumes soft drinks 3–4	1.507	1.333	1.703	<0.001
Consumes soft drinks 5–6	1.37	1.129	1.662	0.001
Consumes soft drinks every day	1.463	1.077	1.682	<0.001
Rarely consumes soft drinks	1.175		1.283	<0.001
Never consumes soft drinks	-			
SAH				
Hypertensive	2.363	2.201	2.536	<0.001
Non-hypertensive	-			
DM2				
Type 2 diabetes	1.444	1.326	1.572	<0.001
Does not have diabetes	-			
Physical activity time				
Physical activity >150 min/week	-			
Physical activity <150 min/week	1.303	1.22	1.392	<0.001

OR: odds ratio; CI: confidence interval; SAH: systemic arterial hypertension; DM: diabetes mellitus.

Conversely, the frequency of soft drinks consumption was positively associated with obesity (p<0.001); all categories presented OR significantly different than 1, indicating an association between soft drinks consumption and obesity. The categories that presented the highest OR were those that consumed soft drinks the most (3–4 times a week, 5–6 times a week, and every day) (Tables 1 and 2).

As for the frequency of alcohol consumption, we observed a bordering association with obesity (p=0.039), with a higher prevalence of obesity in individuals who consumed alcohol more frequently.

However, it is worth emphasizing that this association was not as strong as the other variables analyzed, as shown in Tables 1 and 2.

According to the results, there was a significant association between screen use and obesity, with a gradual increase in the prevalence of obesity as the time of screen use increased. For instance, among those who used screens for less than 1 hour a day, the prevalence of obesity was 21.7%, while among those who used screens for more than 7 hours a day, the prevalence of obesity was 25.2%, with p=0.006 (Tables 1 and 2).

Furthermore, according to the results, there was a significant association between smoking habit and obesity, with a higher prevalence of obesity among daily smokers and occasional smokers compared to nonsmokers (p<0.001) (Tables 1 and 2).

Regarding SAH, there was a significant association between SAH and obesity (p<0.001), with a higher prevalence of obesity among hypertensive patients. Likewise, DM2 was also significantly associated with obesity, with a higher prevalence of obesity among individuals affected by type 2 diabetes (p<0.001). As for SAH and DM2, both categories showed OR significantly different than 1, indicating an association between these conditions and obesity, according to Tables 1 and 2.

In addition, there was a significant association between history of past depressive episodes and obesity, with a higher prevalence of obesity among those who reported having previously had depression (p<0.001) (Tables 1 and 2).

Regarding physical activity, there was a significant association between lack of physical activity and obesity, with a higher prevalence of obesity among physically inactive individuals (p<0.001). The category of physical activity >150 min/week presented OR significantly different than 1, indicating an association between greater physical activity time and lower odds of obesity. The category of physical activity <150 min/week showed no significant difference in relation to obesity, according to Tables 1 and 2.

Finally, according to the results, current depressive episode was also significantly associated with obesity, with a higher prevalence of obesity among those who reported having depression currently (p<0.001) (Tables 1 and 2).

DISCUSSION

In accordance with the main findings of the present study, age is associated with obesity, with a significant OR for the age groups from 40 to 59 years (OR=1.139), 60 to 79 years (OR=0.733), and 80 years or over (OR=0.488), compared to the age group of 18 to 39 years. Sex was also associated with obesity, with a significant OR for women (OR=1.078) compared to men. The frequency of vegetables intake was inversely associated with obesity, with a significant OR for all categories of vegetables intake, except “Eats vegetables 1–2 times a week.”

The frequency of soft drinks consumption was positively associated with obesity, with a significant OR for all categories of soft drinks consumption, except “Rarely consumes soft drinks.” The presence of SAH and DM2 was positively associated with obesity, with significant OR. Physical activity time was associated with obesity, with a significant OR for the “physical activity >150 min/week” category, compared to the “physical activity <150 min/week” category.

There was a predominance of women in our study. In 2011, the prevalence was 15.9% among men and 16.29% among women; in turn, in 2021, the prevalence of obesity rose to 21.2% among men and 22.7% among women, with a statistically significant difference (p=0.008). Such data may be correlated

with several worldwide scientific articles, according to which women predominated in the global obesity index, with a relative increase in the last 20 years.[14] There are possible reasons for the predominance of obesity among women and the increase in prevalence over the years, such as hormonal differences between men and women and sociocultural factors that led women to double burden, between domestic and employment tasks, leaving physical activity in the background.

Regarding the age group, we observed that the group from 40 to 59 years was the most prevalent, with 25.5% of the sample; and it was lower among people aged 80 years or over, with only 17.5% of the sample being obese. Authors of an American systematic review, covering the period from 1999 to 2018, corroborate this finding, reporting the highest prevalence of obesity in the age group from 40 to 59 years, with a rate of 42.8%; and lower prevalence among people aged 60 years or over, with a rate of 38.5%. In addition, the researchers observed a statistically significant difference in the prevalence of obesity among age groups, with $p<0.001$.[14] Among the plausible explanations for such occurrence are changes in metabolism over time, which affect energy balance and body weight.

As for level of education, the prevalence of obesity was higher among students attending graduate and master's programs (26.5%), followed by those who are illiterate (23%). There is a statistically significant difference in the prevalence of obesity among levels of education, with $p<0.001$. The Brazilian article titled "Prevalence of obesity and associated factors in the Brazilian population: a study of data from the 2013 National Health Survey," published in 2020, is in line with the results obtained in the present study, as the authors demonstrated that individuals with lower level of education had higher obesity rates compared to those with higher levels of education. The prevalence of obesity found was 24.7% among those who did not complete middle school, 20.4% among those who completed middle school, and 14.3% among those with complete higher education. The difference between these groups was statistically significant.[15] Among the possible explanations for these divergences, one hypothesis is limited nutritional knowledge, low availability and high cost of healthy foods, and higher levels of education being related to more sedentary types of work.

In terms of eating habits, the prevalence of obesity was lower among people who eat vegetables every day (21.5%) and higher among people who never eat vegetables (28.2%). The prevalence of obesity was also lower among people who eat fruits every day (20.8%) and higher among those who never eat fruits (25.2%). Corroborating these data, we highlight a study[14] whose authors investigated the relationship between dietary patterns and obesity in adults living in the city of Rio de Janeiro. According to the results, the participants who consumed more fruits and vegetables presented lower body mass index and lower prevalence of obesity, compared to those who consumed more foods rich in fat and sugar. There was a 13% reduction in obesity in men who consumed fruits and vegetables and a 14% reduction in women who also consumed this food group. The association between fruit and vegetables intake and obesity was statistically significant, with a value of $p<0.001$.[16] Among the probable justifications for the association of obesity with low consumption of fruits and vegetables is the fact that these foods have low calorie density, thus producing satiety more easily and in smaller portions.

In our study, we verified that the prevalence of obesity was higher among people who consume soft drinks 1–2 days a week (24.7%) and lower among those who never consume it (18.9%). This datum was similar to that obtained in the study "Association between soft drink consumption and overweight/obesity among adolescents in Brazil." The authors evaluated the association between the consumption of soft drinks and overweight/obesity in Brazilian adolescents and found results similar to our data. As per the results, the consumption of soft drinks was significantly associated with overweight/obesity ($p<0.001$), and adolescents who consume soft drinks daily have a 52% higher risk of overweight/obesity, compared to

those who do not consume it.[17] Among the explanations for this association are the high sugar content, with no significant nutritional value, the low feeling of satiety, and the impact on metabolic regulation, as it can lead to insulin resistance.

In the present study, we observed a statistically significant difference in the prevalence of obesity in all groups of eating habits, with values of $p<0.001$, except alcohol consumption, where the difference was marginally significant ($p=0.039$). Alcohol consumption in the sample was common, with 49.5% of individuals drinking alcohol once to twice a week. A systematic review that can be correlated with this datum is "Alcohol consumption and obesity: a review," whose authors reviewed the existing literature on alcohol consumption and obesity and found mixed results. In some studies, they observed that moderate alcohol consumption may be associated with lower obesity rates, while in other researches they verified a positive association between alcohol consumption and obesity. However, most studies did not find a significant relationship between alcohol consumption and obesity. In this sense, the authors of the article concluded that more research is necessary to determine this relationship.[18] The caloric value of alcohol is a possible explanation, which provides about seven calories per gram. Therefore, excessive alcohol consumption can lead to an increase in total caloric intake, which can contribute to weight gain and obesity. Conversely, moderate alcohol consumption, in controlled quantities, may not lead to a significant increase in caloric intake and, therefore, not necessarily be associated with obesity. Another possible hypothesis is the metabolism, as alcohol is metabolized primarily by the liver and alcohol metabolism can influence, hinder, or assist the metabolism of other nutrients.

Exercising was common in the sample, with 94.8% of individuals exercising at least once a week. In this regard, we observed that exercising at least once a week was associated with a lower prevalence of obesity, with a higher prevalence of obesity in individuals who reported not exercising or who exercised for less than 150 minutes a week. The presented data can be compared with a cross-sectional study carried out in Southern Brazil, in which 29.6% of the investigated population presented insufficient level of physical activity, given that this was closely linked to obesity. Conversely, having access to public spaces for physical activity and reporting positive self-rated health were factors associated with a higher prevalence of sufficient physical activity.[19] Among the benefits of physical activity to reduce obesity is increased energy expenditure, which creates a calorie deficit, thus reducing body fat and obesity.

In the present study, we found that screen use was common in the sample, with 34.9% of individuals using screens for one to two hours a day. Frequent screen use is associated with higher prevalence of obesity and physical inactivity. Vicente-Rodriguez et al. showed that, among Spanish adolescents, overweight and obesity were associated with the time spent watching TV and playing video games, especially during the weekend; and the risk of overweight increased by 15.8% ($p<0.05$) per additional hour watching TV.[20] Among the reasons that can help explain this association are inadequate eating habits, as people tend to opt for processed foods, rich in fats and sugars, when they are distracted by the use of screens.

SAH was common in the sample of the present study, with 39.3% of individuals being hypertensive. The pathology was associated with higher prevalence of obesity, physical inactivity, DM2, and depressive episodes. This result is in line with the Brazilian literature on the topic, such as Feijão et al., who associated hypertension with overweight, with a prevalence of 22.58 and 51.26% respectively, demonstrating a strong association between body mass and blood pressure, regardless of sex, age, family income, level of education, and occupation.[21] As a hypothesis for this, excess body weight places an additional load on blood vessels, which leads to an increase in blood pressure. In addition, obesity is associated with a greater activation of the Renin-Angiotensin-Aldosterone System, which regulates blood pressure.

Regarding DM2, the result in the sample was less common, with 14.7% of individuals being diabetic. DM2 was associated with higher prevalence of obesity, physical inactivity, hypertension, and depressive episodes. DM2 was significantly associated with obesity ($p<0.001$). The association between DM2 and obesity is well-established in the scientific literature, the latter being a risk factor for the development of the former, because the presence of excess adipose tissue leads to insulin resistance and the impairment of insulin secretion by pancreatic beta cells.[15]

Ultimately, we observed that depressive episodes were common in the sample, with 12.9% of individuals having presented at least one depressive episode, and 27.3% of the population that had already had depression being obese. Furthermore, there was an association between depressive episodes and higher prevalence of obesity, physical inactivity, SAH, and DM2. Authors of a systematic review conducted in Brazil found a strong association between the presence of depression and obesity, verifying 34% of the sample with depressive and obese symptoms, [22] data that corroborate our results. As possible explanations for this, changes in dietary patterns, such as emotional eating, compulsive eating, or lack of appetite, are observed. These behaviors can lead to weight gain and obesity.

Finally, we highlight some limitations related to the methods adopted in the surveys considered, which could result in possible information, selection, and sampling biases in the comparisons carried out. It should be noted that there could be selection bias, because the data could not represent the entire population due to the need for landline number coverage in Vigitel data. Moreover, there was the sampling bias, as users of the platform might not be representative. In addition, it was necessary to consider the possibility of information bias due to the form of collection of Vigitel data via telephone calls, which generated difficulty in accurate measurement, as the data were based on self-reports.

CONCLUSION

All in all, we demonstrated that age and sex are associated with obesity, with younger groups presenting a higher probability of being obese and women, a slightly higher probability than men. Frequent consumption of vegetables was associated with a lower probability of obesity, whereas the consumption of soft drinks showed a positive association with obesity. The presence of systemic arterial hypertension and type 2 diabetes was also related to a higher probability of obesity. The relationship between physical activity and obesity was complex, with those who exercise more than 150 minutes per week presenting a lower probability of obesity, although other factors — such as body composition and intensity of physical activity — must be considered. With these results, we highlight the importance of preventive strategies and interventions to combat obesity.

Based on the results of multivariate logistic regression, some factors associated with obesity in Brazilian capitals in 2021 could be identified. Therefore, age, sex, frequency of vegetables intake, frequency of soft drinks consumption, presence of SAH and DM2, and time of physical activity were variables significantly associated with obesity.

Based on the obtained results, we verified an overall increase in the prevalence of obesity between 2011 and 2021; thus, it is possible to make an analysis on the trend for the next 10 years. This increase trend may suggest that the prevalence of obesity will continue to grow in the coming years, if effective prevention and control measures are not implemented. However, it is worth emphasizing that the future of obesity prevalence will depend on several variables, including changes in public policies, access to healthy

foods, promotion of physical activities, public awareness, and changes in the lifestyle of the population. Besides, new factors and trends may arise in the coming years, which may influence the results.

CONFLICT OF INTERESTS

Nothing to declare.

AUTHORS' CONTRIBUTIONS

ECF: Project administration, Formal analysis, Conceptualization, Writing – original draft, Writing – review & editing, Investigation, Methodology, Resources, Software, Visualization. VMF: Data curation, Writing – review & editing, Visualization. KSK: Formal analysis, Conceptualization, Data curation, Writing – review & editing, Supervision, Validation, Visualization.

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