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Self-reported diabetes and factors associated with it in the Brazilian adult population: National Health Survey, 2019

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Abstract *This study aims to analyze the prevalence of self-reported diabetes and its associated factors in the Brazilian adult population. It is a cross-sectional study using the 2019 National Health Survey. Prevalence and crude prevalence ratios (PRc) and adjusted prevalence ratios (PRa) of self-reported diabetes were estimated, with confidence intervals (95% CI), using Poisson regression. In the 82,349 adults, the prevalence of self-reported diabetes was 7.7%. Positively associated factors were: advanced age with greater association after 60 years (PRa 24.87; 95%CI 15.78-39.18); living in the Northeast (PRa 1.16; 95%CI 1.04-1.29), Southeast (PRa 1.27; 95% CI 1.14-1.43), South (PRa 1.18; 95%CI 1, 05-1.34), and Midwest (PRa 1.21; 95%CI 1.06-1.38); being a former smoker (PRa 1.17; 95%CI 1.09-1.27); self-assessment of regular health (PRa 2.41; 95%CI 2.21-2.64), bad/very bad (PRa 3.45; 95%CI 3.06-3.88); having heart disease (PRa 1.81; 95%CI 1.64-2.00), hypertension (PRa 2.84; 95%CI 2.60-3.69), high cholesterol (PRa 2.22; 95%CI 2.05-2.41), overweight (PRa 1.49; 95%CI 1.36-1.64), and obesity (PRa 2.25; 95%CI 2.05-2.47). It could be concluded that diabetes in Brazilian adults is associated with sociodemographic factors, aging, lifestyle, and morbidities. These results can guide public policies for the prevention and control of disease in Brazil.*

Key words *Diabetes mellitus, Risk factors, Health surveys, Brazil*

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Introduction

Diabetes mellitus (DM) has a complex and multifactorial etiology, involving genetic and environmental components. It results from alterations in the production of insulin by the pancreas and/or incapacity of the organ in performing its function in the organism[1]. DM evolves with micro and macrovascular complications[2], which result in repercussions in the target organs, such as the heart, blood vessels, eyes, kidneys, and brain[3,4].

Worldwide, approximately 422 million people suffer from DM, and 1.6 million annual deaths were directly attributed to DM between 1990 and 2019 (WHO, 2020). There has also been an increase in the number of deaths by DM between 1990 and 2019, going from 1,278,866 to 2,988,924, respectively. For the number of years lost due to incapacity (Disability Adjusted Life Years – DALYs), there was an increase from 28,586,671 in 1990 to 70,888,154 in 2019[5]. In Brazil, a similar scenario was observed. DM was responsible for 43,787 deaths in 1990 and 107,760 deaths in 2019 (7.64% of the total); it caused 1,730,460 DALYs in 1990 and 3,750,735 in 2019 (5.73% of the total)[5].

The profound regional inequalities contribute to the increase in the burden of DM, since countries with low and average income concentrate higher rates of morbimortality[4]. The socioeconomic and health inequalities are challenges in the DM context, since they hamper prevention, hinder access to care and treatment, and compromise the quality of life of people affected by the disease[5,6].

It is also important to highlight the growth in the prevalence of DM in the last two decades, due to population aging and obesity, and because of unhealthy lifestyles, such as sedentarism and unhealthy diets[4,7].

The literature illustrates factors associated with DM, sociodemographic characteristics[8,9], family history, obesity, arterial hypertension, dyslipidemia[9], insufficient physical activity, smoking, and alcohol consumption[8].

To prevent and control DM, it is essential to have measures in place that aim to produce behavioral changes, such as an increase in the consumption of natural foods (fruit, vegetables, and grains), a reduction in the consumption of ultra-processed foods, a reduction in the intake of sugary drinks and alcohol, an increase in physical activity, weight control, and quitting smoking[10,11].

Although the gold standard for DM population monitoring is estimated by laboratory data[12], health inquiries using self-reported measurements are also useful in the identification of DM prevalence, since they provide agility in terms of obtaining and publishing data, and have lower economic costs[12], contributing for better surveillance actions[13]. Considering the negative repercussions of DM on health, this study shows progress, as it identifies, in an unprecedented manner, the populational prevalence of self-reported DM and its associated factors, according to the 2019 National Health Survey (PNS, in Portuguese). It is important to mention that the penultimate edition of the PNS (2013) estimated the self-reported prevalence of DM in 6.2%[6]. Considering the population growth[1,3], it is important to know the current scenario of this condition within the country, in accordance with available data. Therefore, this study may contribute to the formulation of public policies and actions toward the control and prevention of DM[14].

Hence, the current study aimed to analyze the prevalence of self-reported DM and the factors associated with it, among sociodemographic characteristics, lifestyles, and health conditions within the Brazilian adult population.

Methods

This is a cross-sectional study with data from the 2019 PNS, conducted between August 2019 and March 2020. The PNS is the broadest national inquiry concerning health in the country, conducted by the Brazilian Institute of Geography and Statistics (IBGE) in partnership with the Ministry of Health[14,15].

The PNS uses sampling by conglomerates in three selection stages: census sectors (primary units); homes (secondary units), and residents older than 15 years of age (tertiary units). In 2019, in the third selection stage, the residents were selected randomly among those who were 15 years of age and older, based on the list of residents obtained at the time of the interview[15].

To calculate the sample size, the average values and variances were taken into consideration, assuming a "no response" rate of 20%. In 2019, there were 108,525 homes in the sample, and data was collected from 94,114 of these[5]. In the current study, the analyses were done only among residents who were 18 years of age or older, including 82,349 individuals. The 2019 PNS adopted a complex sample design, and therefore weights of post-stratification sampling were adopted for selected homes and residents, aimed at

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correcting losses by "no response" and adjusting the totals for the Brazilian population. Further details about the methodology of the 2019 PNS can be found in specific publications[14,15].

In this study, to construct the variables, questions were used from the questionnaire modules of: identification; characteristics of the residents (C); characteristics of the education level of the residents (D); characteristics of work (E), health insurance coverage (I); perception of the state of health (N); lifestyles (P); and chronic diseases (Q)[14].

The outcome variable was the self-reported diagnosis of diabetes, evaluated by question Q30a: "Has a doctor ever told you that you have diabetes?" A diagnosis of diabetes was considered when the adults answered "yes", in addition to verifying, in the case of women, those who responded "no" to the question (Q30b) about gestational diabetes (Did this diabetes only occur during a period of your pregnancy?) The indicator was calculated by: numerator/denominator x 100 (numerator: man: Q30a = 1; woman: Q30a = 1 and Q30b = 2; denominator: number of people interviewed (C8 ≥ 18 years of age).

To support and verify the association, studies present in the literature were considered[8,18], which identified the complexity of the causation network of DM, which is associated with precarious socio-economic conditions: *sociodemographic characteristics (age, sex), unhealthy lifestyles, comorbidities, obesity,* among other factors [8,18]. Therefore, the variables used in this study were:

*Sociodemographic characteristics – s*ex: male and female; age group in years: 18 to 24, 25 to 39, 40 to 59, 60 and older; education: no education to complete elementary education, complete elementary education to incomplete high school, complete high school to incomplete higher education, and complete higher education; race/color: white, black, and others (which correspond to yellow and indigenous); family income (per capita in number of minimum wage salaries): up to one salary, 1 to 3 minimum salaries (MS), 3 to 5 MS, 5 or more MS; region of Brazil: North, Northeast, Southeast, South, and Midwest; has health insurance: yes or no.

*Lifestyle – s*moking: non-smoker, former smoker, and smoker; excessive consumption of alcoholic beverages: yes or no (we considered the consumption of five or more shots at a time)[14]. High consumption of salt: "*Considering homemade foods and industrialized foods, do you think that your salt consumption is…*", for those who responded "*high*" or "*very high*" to the question; "Consumption of foods that protect against noncommunicable diseases" (NCDs) or minimally processed, in the last 24 hours, considering whose who answered "yes" to a list of 12 foods, specifically (rice/pasta and others; potatoes/manioc/others, beans/lentils and others, beef/pork/poultry or fish; egg, lettuce/broccoli/watercress or spinach; pumpkin/carrots/sweet potatoes/okra; papaya/mango/melon or pequi; orange/banana/apple and pineapple; milk; peanut/cashews/Brazil nuts etc.; sufficient physical activity in free time: yes, no. We considered active, those who do 150 weekly minutes of moderate or light activities or 75 weekly minutes of intense, vigorous activity regardless of the number of days they are done per week[16].

Health conditions and nutritional conditions – self-evaluation of one's health conditions: good/very good, regular, and bad/very bad; self-reported diagnosis of hypertension: yes, no; self-reported diagnosis of high cholesterol: yes, no; nutritional condition: eutrophic, classified by body mass index (BMI) < 25 kg/m^2, overweight (BMI between 25 and 29 kg/m^2), and obese (BMI ≥ 30kg/m^2)[17]. The BMI was calculated based on the report of height and weight.

In the descriptive analysis, the prevalence was estimated and was presented in prevalence (%) and 95% confidence intervals (95%CI). Adopted as an association measure was the prevalence ratio (PR) obtained by models of Poisson regression with robust variance. The crude PR (PRc) and adjusted PR (PRa) were estimated by age, education, and sex, and their respective CI were 95%. Associated factors were defined as the variables with values of $p \leq 0.05$ for the adjusted analyses. The data analysis and statistical software (Stata), version 16, was used, applying the "*survey*" module, which considers the post-stratification weights.

The 2019 PNS was approved by the National Committee of Research Ethics from the Ministry of Health, decision number 3,529,376 (2019). Participation in the survey was voluntary, and confidentiality of information was guaranteed. The 2019 PNS data bank and the modules of the questionnaires are available for access and public use at: https://www.pns.icict.fiocruz.br/.

Results

The prevalence of the self-reported diagnosis of diabetes was 7.7% (95% CI: 7.4-8.0), which was higher for females (8.4%; 95% CI: 8.0-8.8), for

those who were 60 and older (20.2%; 95% CI: 19.3-21.1), and those with a low-level education (12.9%; 95%CI: 12.3%-13.5) (Table 1).

Table 2 shows the prevalence of self-reported diabetes according to lifestyle and health conditions. It can be seen that the prevalence of diabetes is higher for former smokers (11.3%; 95%CI: 10.6-12.0), for those who responded no to excessive alcoholic beverage consumption (8.5%; 95%CI: 8.2-8.9%), those who do not have a high intake of salt (8.0%; 95%CI: 7.7-8.3), those who do not practice physical activities in their free time (8.7%; 95%CI: 8.3-9.1), and those who considered their health as regular (14.2%; 95%CI: 13.5-14.9), bad, or very bad (23.8%; 95%CI: 21.8-25.8). People with heart disease (22.5%; 95%CI: 20.5-24.5), hypertension (20.6%; 95%CI: 19.7-21.5), high cholesterol (20.8%; 95%CI: 19.5%-22.0), overweight (8.3%; 95%CI; 7.8-8.8), and obesity (12.6%; 95%CI: 11.7-13.4) showed a higher prevalence of diabetes.

In the adjusted analyses, it was verified that the higher prevalence of self-reported diabetes is associated with the female sex (PRa = 1.22; 95%CI: 1.13-1.32), increase age (25 to 39 years of age): PRa = 2.21; 95%CI: 1.36-3.61; 40 to 59 years of age: PRa = 10.54; 95% CI: 6.68-16.61; 60 or older: PRa = 24.87; 95%CI: 15.78-39.18), residing in the Northeast region (PRa = 1.16; 95%CI: 1.04-1.29), Southeast (PRa = 1.27; 95%CI: 1.14-1.43), South (PRa = 1.18; 95%CI: 1.05-1.34), and Midwest (PRa = 1.21; 95%CI: 1.06-1.38), former smokers (PRa = 1.17; 95%CI: 1.09-1.27), those who self-reported their health conditions as regular (PRa = 2.41; 95%CI: 2.21-2.64), bad or very bad (PRa = 3.45; 95%CI: 3.06-3.88), having heart disease (PRa = 1.81; 95%CI: 1.64-2.00), hypertension (PRa = 2.84; 95%CI: 2.60-3.69), high cholesterol (PRa = 2.22; 95%CI: 2.05-241), overweight (PRa = 1.49; 95%CI: 1.36-1.64), and obesity (PRa = 2.25; 95%CI: 2.05-2.47). By contrast, the lowest prevalence of diabetes is associated with having an average level education (PRa = 0.77; 95%CI: 0.70-0.86) and complete higher education (PRa = 0.58; 95%CI: 0.51-0.66), higher income (5 or more minimum wage salaries: PRa = 0.67; 95%CI: 0.58-0.78), excessive consumption of alcoholic beverages (PRa = 0.76; 95%CI: 0.66-0.88), and the practice of physical activities in one's free time (PRa = 0.85; 95%CI: 0.77;0.93) (Table 3).

Table 1. Prevalence of diabetes according to sociodemographic characteristics. National Health Survey, Brazil, 2019.

Variables	Self-reported diabetes	
	%	95%CI
Sociodemographic characteristics		
Total	7.7	7.4-8.0
Sex		
Male	6.9	6.5-7.4
Female	8.4	8.0-8.8
Age group (years)		
18 to 24	0.7	0.4-1.1
25 to 39	1.6	1.3-1.8
40 to 59	7.9	7.4-8.5
60 and older	20.2	19.3-21.1
Education		
No education to incomplete elementary	12.9	12.3-13.5
Complete elementary to incomplete high school	6.3	5.5-7.0
Complete high school to incomplete higher education	4.6	4.2-5.0
Complete higher education	4.7	4.1-5.5
Race/color		
White	8.0	7.6-8.5
Black	7.3	6.9-7.7
Light-skinned black	7.8	7.0-8.7
Others (yellow/indigenous)	10.8	7.5-14.2
Health insurance		
No	7.7	7.3-8.0
Yes	7.9	7.3-8.5
Income in number of minimum wage salaries		
Up to 1	7.2	6.8-7.7
1 to 3	8.3	7.8-8.8
3 to 5	9.1	7.8-10.3
5 or more	6.9	5.9-7.9
Region of Brazil		
North	5.5	4.9-6.0
Northeast	7.2	6.8-7.6
Southeast	8.5	7.9-9.1
South	7.9	7.2-8.6
Midwest	7.2	6.4-7.9

95%CI: confidence interval 95%.

Source: Authors.

Discussion

This study identified a prevalence of self-reported diabetes of 7.7% in individuals 18 years of age and older (one in every 13 Brazilians), which rep-

Table 2. Prevalence of diabetes according to lifestyle and health conditions. National Health Survey, Brazil, 2019.

Variables	Self-reported diabetes	
	%	95%CI
Lifestyle		
Smoking		
Non-smoker	6.4	6.1-6.8
Former smoker	11.3	10.6-12.0
Smoker	6.4	5.6-7.2
Consumption of healthy foods		
No	7.5	7.2-7.8
Yes	8.4	7.8-9.1
Excessive consumption of alcoholic beverages		
No	8.5	8.2-8.9
Yes	3.8	3.3-4.3
Excessive consumption of salt		
No	8.0	7.7-8.3
Yes	5.7	4.9-6.6
Physical activity in free time		
No	8.7	8.3-9.1
Yes	5.4	4.9-5.9
Health conditions		
Evaluation of health conditions		
Good/very good	3.8	3.5-4.1
Regular	14.2	13.5-14.9
Bad/very Bad	23.8	21.8-25.8
Heart disease		
No	6.9	6.6-7.2
Yes	22.5	20.5-24.5
Hypertension		
No	3.7	3.4-3.9
Yes	20.6	19.7-21.5
High cholesterol		
No	5.9	5.6-6.2
Yes	20.8	19.5-22.0
Nutritional conditions		
Eutrophic	4.9	4.6-5.3
Overweight	8.3	7.8-8.8
Obesity	12.6	11.7-13.4

95%CI: confidence interval 95%.

Source: Authors.

resents a population group of 12.3 million people with diabetes[14]. DM is positively associated with females, increase in age, with the prevalence being 10-fold higher after 40 years of age and approximately 25-fold higher for individuals 60 years of age and older. Living in the Northeast, Southeast, South, and Midwest regions, being a former smoker, reporting a worse health situation, and having such comorbidities as hypertension, heart disease, cholesterol, overweight, and obesity were all factors more frequently associated with the self-reported diabetes. The negatively associated factors included having a higher-level education and income, practicing physical activities in one's free time, and excessive alcohol intake.

The higher prevalence of self-reported diabetes among women was also identified in the 2013 PNS[18] and in the laboratory edition of the PNS between 2014-2015[12]. However, these results were not found in the Brazilian Longitudintal Study of Adult Health (ELSA-Brasil, in Portuguese), in which the higher prevalence rates were among men[19]. There is an implication related to the sexual hormones in the protection or in the risk factors for the development and progression of DM. Women are less likely to develop DM in comparison to men, possibly because the sexual hormones protect against the development of the condition, although diabetic comorbidities, such as cardiovascular diseases (CVD) and terminal kidney disease tend to affect women more often[20]. However, the loss of hormonal protection that women pass through after menopause may contribute to DM. Another possible justification for the findings in this study is in terms the search for medical services and having greater access to medical diagnoses among women, something that has already been described by data from the National Household Sample Survey (PNAD, in Portuguese)[21] and the inquiries conducted through the Noncommunicable Disease Risk Factor Surveillance (Vigitel, in Portuguese)[22].

The increase in age is associated with the increase in frequency of type 2 DM, especially among the elderly. Approximately one fifth of that population had the disease, due to the physiopathological mechanisms of aging, physical inactivity, poor nutrition, increase in obesity, and greater access to diagnoses[23]. However, the study indicated that the young population, between 25 and 29 years of age, already showed a high prevalence, demonstrating that the disease has been appearing earlier. The 2013 PNS indicated a high prevalence of glycated hemoglobin abnormalities (A1c), which are indicative of diabetes (18.5% according to the criteria set forth by the American Diabetes Association and 7.5% according to the WHO criteria[24]), which has been explained by the increase in obesity among young people and their unhealthy lifestyles.

Table 3. Crude and adjusted prevalence ratio and 95% confidence intervals for self-reported diagnosis of diabetes according to sociodemographic characteristics, lifestyle, and health conditions. National Health Survey, Brazil, 2019.

Variables	PRc	95%CI	PRa	95%CI
Sociodemographic characteristics				
Sex				
Male	1		1	
Female	1.22	1.13-1.32	1.22	1.13-1.32
Age group (years)				
18 to 24	1		1	
25 to 39	2.15	1.32-3.51	2.21	1.36-3.61
40 to 59	10.95	6.94-17.28	10.54	6.68-16.61
60 and older	27.84	17.68-43.85	24.87	15.78-39.18
Education				
No education to incomplete elementary	1		1	
Complete elementaryto incomplete high school	0.49	0.43-0.55	0.89	0.79-1.01
Complete high school to incomplete higher education	0.36	0.32-0.39	0.77	0.70-0.86
Complete higher education	0.36	0.32-0.41	0.58	0.51-0.66
Race/color				
White	1		1	
Black	0.90	0.83-0.98	1.08	1.00-1.17
Brown	0.97	0.86-1.10	1.12	1.00-1.26
Others (yellow/indigenous)	1.35	0.98-1.84	1.34	1.00-1.80
Health insurance				
No	1		1	
Yes	1.03	0.94-1.12	0.95	0.87-1.03
Income in number of minimum wage salaries				
Up to 1	1		1	
1 to 3	1.15	1.06-1.25	0.93	0.86-1.01
3 to 5	1.25	1.08-1.45	0.95	0.83-1.09
5 or more	0.95	0.81-1.11	0.67	0.58-0.78
Region of Brazil				
North	1		1	
Northeast	1.31	1.18-1.47	1.16	1.04-1.29
Southeast	1.56	1.39-1.75	1.27	1.14-1.43
South	1.45	1.27-1.64	1.18	1.05-1.34
Midwest	1.31	1.14-1.51	1.21	1.06-1.38

it continues

In relation to the sociodemographic data, we highlight the protector effect of higher education and income. Studies with data from the 2013 PNS[18] and from other countries[25,26] have also found a higher prevalence of DM among people with a low-level education. Those results proved that higher education and income contribute to better access to information, better health care, and better understanding of the disease and its risks, as well as the adoption of healthy nutrition habits and physical activity[16,25]. It can be inferred that people with a higher income have greater access to health services, to the acquisition of top-quality medication with less collateral effects, and to health insurance[27]. However, in this study, the access to health insurance did not show a difference in prevalence, indicating that the Brazilian Unified Health System (SUS, in Portuguese) has been efficient in providing access to services and diagnosis of DM in the country[28]. In relation to race/color, there were no significant differences in the adjusted analysis, similarly to the study

Table 3. Crude and adjusted prevalence ratio and 95% confidence intervals for self-reported diagnosis of diabetes according to sociodemographic characteristics, lifestyle, and health conditions. National Health Survey, Brazil, 2019.

Variables	PRc	95%CI	PRa	95%CI
Lifestyles				
Smoking				
Non-smoker	1		1	
Former smoker	1.75	1.62-1.90	1.17	1.09-1.27
Smoker	0.99	0.86-1.14	0.87	0.76-1.01
Consumption of healthy foods				
No	1		1	
Yes	1.13	1.03-1.23	0.93	0.86-1.02
Excessive consumption of alcoholic beverages				
No	1		1	
Yes	0.44	0.38-0.51	0.76	0.66-0.88
Excessive consumption of salt				
No	1		1	
Yes	0.71	0.61-0.83	1.02	0.88-1.18
Physical activity in free time				
No	1		1	
Yes	0.62	0.56-0.69	0.85	0.77-0.93
Health conditions				
Evaluation of health conditions				
Good/Very Good	1		1	
Regular	3.74	3.44-4.08	2.41	2.21-2.64
Bad/Very Bad	6.26	5.59-7.01	3.45	3.06-3.88
Heart disease				
No	1		1	
Yes	3.26	2.95-3.61	1.81	1.64-2.00
Hypertension				
No	1		1	
Yes	5.59	5.17-6.04	2.84	2.60-3.69
High cholesterol				
No	1			
Yes	3.5	3.23-3.79	2.22	2.05-2.41
Nutritional conditions				
Eutrophic	1		1	
Overweight	1.69	1.54-1.85	1.49	1.36-1.64
Obesity	2.55	2.31-2.81	2.25	2.05-2.47

PRc: crude prevalence ratio. PRa: adjusted prevalence ratio. PRa adjusted be age, sex, and education.

Source: Authors.

conducted with data from Vigitel, which found no associations between DM and race/color[29].

The North region of Brazil showed the lowest prevalence of DM in comparison to the other regions. Those results are similar to those found in a national study with laboratory data from the PNS[24]. Since it refers to self-reported DM, although the information from the PNS show improvements in access to and use of health services, regional differences were still observed[15,18,24]. Even though the final model was adjusted by age, the adjustment may have been insufficient to correct it, taking into consideration that the North region has the youngest population, with a lower prevalence of DM[14].

Considering the lifestyles, smoking is an important risk factor for cardiovascular disease, and it is associated with the aggravation of DM. Quitting smoking is the priority measure for secondary prevention[11,30]. The current study identified

an association between DM and former smokers, which could be explained by measures referring to the protocols which recommend giving up smoking when faced with the diagnosis of the disease, primarily due to the systemic vascular effects caused by tobacco[11,30]. Moreover, another possible justification for the findings is related to the weight gain associated with quitting smoking, already identified in national[18] and international[31] literature, which also increases the risk of developing DM[11,30]. In overweight people, it also is common to identify metabolic alterations that result in DM[11].

The protective effect of excessive alcohol consumption found in the adjusted analyses, estimated for half of the population with DM, also suggests possible changes in lifestyle, such as a reduction in alcohol consumption. The present study highlights that alcohol consumption is not recommended for people with diabetes; therefore, guideline concerning DM lead health professionals to discourage the use of alcohol to facilitate the glycemic control of those patients[32] as well as to achieve more favorable[1] outcomes, thus constituting a reverse causality effect. Moreover, that variable refers to abusive consumption or binging, which tends to be more common among young individuals[33], and the prevalence of DM in that age group is lower.

The prevalence of protective foods investigated here was higher among individuals with DM, but the association between the consumption of healthy foods and diabetes disappeared when adjusted by age, education, and sex, which was also identified in a previous study[18]. The self-reported consumption of salt was lower among patients with DM, but it showed no significance after the adjustment for the selected variables. It should be emphasized that the consumption of 400 grams of fruit, vegetables, and salad; the encouragement of such foods as minimally processed grains; beans; and the reduction of fat consumption and salt are part of the guidelines recommended by health professionals to individuals with DM, and such changes in habits may explain the findings of this study, of a cross-sectional cohort[1,32].

The regular practice of physical activities is important for the treatment and reduction of diabetes, since it may contribute to the reduction of the use of hypoglicemics[32], and it improves the metabolic control in relation to the absorption of glucose by body tissues[34]. Sedentary lifestyles are associated with a higher insulin resistance[1,11,35]. The advice for the regular practice of physical activities is part of the recommendations given by health professionals to patients; however, the association found in this study was that patients with DM are likely to practice less physical activities[29,32]. Since the majority of the DM patients are elderly individuals, the recommended physical activity level is not always reached by this population[29], and it continues to be important medical advice for patients at the time of the diagnosis of DM.

Concerning health conditions, the study indicated a strong association between having DM and the evaluation of one's own health being regular or bad/very bad, with a dose response gradient. The findings are in conformity with the literature[16,38,37]. This indicator is a predictor of severe outcomes, including mortality[6,38], and constitutes a qualitative evaluation of the state of health. The perception, in general, relates to the worsening of health, besides objective questions, such as the more frequent use of health services, changes in lifestyles, limitations in daily physical activity, and worse quality of life[36,38], indicating the burden of DM on the life of those individuals.

The present study also illustrated an association between being overweight or obese and having DM, which is well described in the literature[1,11,27-41]. The increase in obesity in the Brazilian population may worsen this scenario. Obesity results in the infiltration of fat in the liver, changing the metabolism and resulting in insulin resistance. The excess of fats and glucose in the circulation increases the secretion of insulin by the pancreas, leading to the exhaustion of the beta cells (β)[11,40]. Other health associated conditions included hypertension, heart disease, and high cholesterol, also related to the nutritional state of the individual, indicating the syndemic of factors common to the occurrence of chronic diseases[42]. The literature indicates that low levels of high density lipoprotein cholesterol (HDL-C) and high levels of triglycerides may be associated with DM[41,43], as well as hypertension and cardiovascular diseases, due to micro and macrovascular lesions[11,40]. Furthermore, these conditions are common in diabetic people due to metabolic alterations[1], and such comorbidities are responsible for a high morbimortality among those patients[44,45], since they increase cardiovascular risk[1].

Among the limitations of this study are those which are inherent to cross-sectional study designs, determined by simultaneous measurements of risk factors or protection factors and the outcomes, which limit inferences about the directionality of some of the associations in the causality model. It is important to note the bias

of reverse causality, or the changes in the lifestyle determined by the disease and by the advice from health professionals. The use of self-reported morbidity data depends on the access to health services for the diagnosis; therefore, individuals who use the service more often have a greater opportunity of receiving a diagnosis of diabetes.

Regardless of the limitations of cross-sectional studies, the results of the PNS presented in this study allowed us to establish a set of factors associated with diabetes, thus contributing to subsidize public policies for health promotion and for the evidence-based prevention of diseases. After the adjustments by age, education, and sex, it was found that diabetes was associated with older age, lower education, income, poor health conditions, and lifestyles, indicating a pattern of risk factors also common to other NCDs in the Brazilian adult population. The close association between diabetes and self-assessment of poor health shows the implications of the disease in the lives of Brazilian adults and the elderly. It is also important to mention the increase in obesity and life expectancy, which may worsen such a situation.

The information in the PNS is representative of the Brazilian population and is therefore useful to support the reformulation of public surveillance policies and of health care by SUS, aligned with the Plan for Strategic Actions to Curb NCDs in Brazil, with the Global Plan for curbing NCDs from 2013[46], and with the objectives of sustainable development[47], thereby establishing national and global commitments.

Furthermore, the COVID-19 pandemic worsened NCDs, since it determined worse lifestyles and less access to health services[48,49], which may well make the control and prevention of DM in Brazil even more difficult. Hence, we emphasize the importance of monitoring the disease, as well as health promotion programs and interventions, in favor of more healthy nutrition, more physical activity, restrictions to tobacco and alcohol consumption, obesity controls, and long-term care in terms of primary health care.

Collaborations

All of the authors contributed to the planning, conception, and alignment of the study; collection, analysis, and interpretation of data; writing and critical revision of the article; approved the final version to be published; agreed to be responsible for all the aspects of the work, ensuring that all the questions related to the accuracy and integrity of any part of the work were investigated as necessary and were duly resolved.

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