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The prevalence of diabetes mellitus and its associated factors in the Brazilian adult population: evidence from a population-based survey

Prevalência de diabetes mellitus e fatores associados na população adulta brasileira: evidências de um inquérito de base populacional

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ABSTRACT: ***Objective:*** To estimate the prevalence of self-reported diabetes *mellitus* (DM) and its associated factors among the Brazilian adult population. ***Methods:*** The prevalence of DM was assessed in the Survey on Social Dimensions of Inequalities, a national survey with macro-regions representativeness carried out in 2008. Data were collected by a personal face-to-face interview with 12,423 individuals of both sexes, aged over 20 years. The χ^2 test at 5.0% was performed in order to identify associated factors, and logistic regression was used to estimate adjusted odds ratios. ***Results:*** The prevalence of DM in Brazil was 7.5%. After adjusting for potential confounders, diabetes remained associated with age (≥ 40 years), education (< 8 years of study), marital status (non-married), obesity, sedentary lifestyle, comorbidity with hypertension and hypercholesterolemia, as well as the demand for health services. ***Conclusion:*** Results indicate a high prevalence of DM and its associated preventable factors in Brazil. Thus, they highlight the need for a behavioral change as a strategy for prevention and control of diabetes and its complications.

Keywords: Diabetes mellitus. Diabetes mellitus, type 2. Self report. Health surveys. Prevalence. Logistic models.

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RESUMO: ***Objetivo:*** Estimar a prevalência de diabetes *mellitus* (DM) autorreferida e fatores associados na população adulta brasileira. ***Métodos:*** A prevalência de DM foi aferida na Pesquisa Dimensões Sociais das Desigualdades (PDSD), um *survey* nacional com representatividade para as macrorregiões, conduzido em 2008. Foram entrevistados 12.423 indivíduos de ambos os sexos, com idade igual ou superior a 20 anos. Para a identificação de fatores associados, foi realizado teste do χ^2 ao nível 5,0% e calculadas as razões de chance ajustadas por meio de regressão logística. ***Resultados:*** A prevalência de DM no Brasil foi de 7,5%. Após o ajuste para potenciais fatores de confusão, o diabetes permaneceu associado com a idade (≥ 40 anos), a escolaridade (< 8 anos de estudo), o estado conjugal (não casados), a obesidade, o sedentarismo, a comorbidade com hipertensão arterial e hipercolesterolemia, bem como com a procura por serviços de saúde. ***Conclusão:*** Resultados indicam elevada prevalência de DM e vários dos seus fatores associados (identificados como evitáveis) apontam a necessidade de mudanças comportamentais como estratégia para prevenção e controle do diabetes e suas complicações.

Palavras-chave: Diabetes mellitus. Diabetes mellitus tipo 2. Autorrelato. Inquéritos epidemiológicos. Prevalência. Modelos logísticos.

INTRODUCTION

Diabetes *mellitus* (DM) currently stands out as an important cause of morbidity and mortality. Global estimates indicate that 382 million people live with DM (8.3%), and this number could reach 592 million by 2035[1]. Approximately 50.0% of patients with diabetes are believed to be unaware of their condition[2]. With regard to mortality, it is estimated that 5.1 million people between the age of 20 and 79 years died of diabetes in 2013[3]. By 2030, DM may rise from ninth to seventh most important cause of death worldwide[4].

At the national level, the disease also represents a health problem of great magnitude. In 2013, Brazil earned fourth place among the countries with the largest number of diabetic people, counting 11.9 million cases among adult individuals (20–70 years of age)[3]. In addition, between 1996 and 2007, an increase of 2.0% in the mortality from this disease was observed[5].

The aging of the population, the increasing prevalence of obesity and of a sedentary lifestyle, and the processes of urbanization are considered the principal factors responsible for the increase in the incidence and prevalence of DM around the world[3,6]. This situation has generated high social and financial costs for the patient and for the healthcare system. Rosa et al.[7] estimated that DM accounted for 12.0% of the total hospitalizations not related to pregnancies and for up to 15.4% of hospital costs of the Brazilian Public Health System (SUS) in the period from 2008 to 2010.

Thus, taking into consideration the relevance of DB, in addition to the shortage of analytic population-based studies, with national representativeness, this study aimed at investigating the prevalence of self-reported DM and its associated factors in the Brazilian adult population, in the year 2008.

METHODS

This is a cross-sectional study carried out with data from the national survey on Social Dimensions of Inequalities Research (in Portuguese *Pesquisa Dimensões Sociais das Desigualdades* – PDSD), conducted in 2008, and coordinated by the *Instituto Universitário de Pesquisas do Rio de Janeiro* (IUPERJ) with the participation of researchers from other teaching and research academic institutions. The study was financed under the Millennium Institutes Program, by the National Council of Scientific and Technological Development (CNPq), and sought to interview heads of households and their spouses, both over 20 years of age, in addition to investigating themes such as life conditions, education, occupation, and health.

The population of the study was determined using a stratified multistage random sampling. The sample was composed of 1,374 census tracts (primary sampling units) and 8,048 permanent households (secondary sampling units) in common or nonspecific tracts, including favelas in urban and rural areas in all regions of Brazil. Since the main objective of the study was to analyze inequality in Brazil, a stratum of the sampling including the 10.0% richest of each census tract was created with the objective of guaranteeing greater access to respondents of this stratum and, thus, improving the precision of the inequality indicators. Approximately 20.0% of the primary households were replaced by other households, principally due to the refusal or impossibility of one of the spouses to accept being interviewed by the interviewer. This replenishment process sought to select new households within the same census tract (a neighboring household as close as possible) with the intention of preserving sociodemographic characteristics. In the end, 12,423 adult participants of both sexes were interviewed.[8]

The presence of DM was determined by means of the following question: "Has a doctor told you that you have diabetes?" This same question structure was used as a measure of the occurrence of other chronic diseases. Despite the fact that the analysis incorporated people with type 1 and type 2 diabetes, it is known by the literature, that type 2 represents more than 90.0% of all cases of DM,[3] which makes it the principal focus of this study.

In reference to the independent variables, they were divided into two large groups: sociodemographic variables (group 1), and behavioral and health condition variables (group 2).

In group 1, the variables for "sex" (male or female) and "age," in years, categorized by age range (20 – 39; 40 – 64; ≥ 65 years) were included. The level of "education" was classified into three categories, in accordance with the number of years completed of formal schooling (0 – 4 years; 5 – 7 years; ≥ 8 years). The variable "marital status" was classified into two categories: "married/union" and "others"—separated, widowed, or single. The participants were also grouped according to "region of origin." And, finally, "economic class" was defined according to "Brazil's Economic Classification Criteria—2008" and added to allow for an analysis in three categories (A/B, C, and D/E).

With regard to the behavioral and health condition variables, the individuals were classified according to the presence/absence of "obesity" (body mass index [BMI] ≥ 30), "sedentary lifestyle," and "smoking habit" (in the present and past). The "consumption of alcohol

in the past year" was categorized in accordance with the frequency of alcoholic ingestion declared by the interviewee (none; up to one time a week; ≥ 2 times per week). The presence/absence of "hypercholesterolemia" and "arterial hypertension" was also verified through prior self-reported medical diagnosis. The use of health services was evaluated by the variable "medical appointment in the last twelve months" (yes or no).

In order to verify the existence of association between the demographic, behavioral, and health variables and self-reported DM, Person's χ^2 test was used with a significance level of 5.0%. In a subsequent step, a multivariate logistic regression model was chosen to adapt to the need to control confounding variables and the use, as a response variable, of a binary event. The method of selection used was the stepwise backward. The variables that show statistical significance in the univariate analysis ($p \leq 0.05$) were included in the model and, after the interactions, the variables with $p > 0.05$ were eliminated. Finally, the logistic regression coefficients, the odds ratios and their 95% confidence intervals, as well as the probabilities for the outcome according to significant variables in the final model were determined. The proportion of correct classifications from the final model separately between the positives for diabetes and among those that did not refer to diabetes, as well as the proportion of total classification, were determined.

The data were analyzed using the software Statistical Package for the Social Sciences (SPSS, Chicago, USA) version 17.0 for Windows. The PDSD was submitted to the Committee of Ethics in Research of the *Escola Nacional de Saúde Pública Sergio Arouca* and it was considered adequate for the human population (CEP nº 157/11). There are no conflicts of interest.

RESULTS

Table 1 shows that the prevalence of DM in the population studied was 7.5%. Among people with diabetes (n=935), there is a higher prevalence among women (8.2%), among those who are not married or in a union (10.3%) and among the residents of more developed regions, such as the South (8.9%) and the Southeast (8.2%). With regard to age, a greater occurrence of DM in individuals aged over 65 years (16.5%) was observed. Illiterate individuals or those with a low educational level demonstrated a prevalence of DM two times higher (10.2%) than those who had more than 8 years of schooling (5.1%). A significant association was not observed between economic class and self-reported diabetes.

In relation to the behavioral and health variables (Table 2), all of them demonstrated a significant association with the outcome, except smoking habit ($p = 0.062$). Obese individuals and those with a sedentary lifestyle were approximately two times more affected by DM when compared to those who did not show such characteristics. Prevalence ratio referring to alcohol consumption showed a significant association; however, it was an inverse association.

Considering health conditions, there was a higher prevalence of diabetes among those who also reported a previous diagnosis of hypercholesterolemia (22.0%) and arterial hypertension (17.0%). The demand for health services also demonstrated a significant association

Table 1. Sample distribution and prevalence of self-reported diabetes according to sociodemographic and economic variables in adults (≥ 20 years). Social Dimensions of Inequalities Research (PDSD), Brazil, 2008.

Socio-demographic Variables	Sample Total		Individuals with Diabetes		Confidence Interval 95%		p-value*
	n	% column	n	% line	Lower limit	Upper limit	
Sex							
Man	5,256	42.3	346	6.6	5.91	7.25	0.001
Woman	7,168	57.7	589	8.2	7.58	8.85	
Total	12,424	100.0	935	7.5	7.06	7.99	
Age (years)							
20 – 39	3,973	32.0	60	1.5	0.90	1.63	< 0.001
40 – 64	6,131	49.3	487	7.9	7.50	8.94	
≥ 65	2,318	18.7	387	16.7	15.26	18.39	
Number of years of schooling							
0 – 4	5,496	47.6	559	10.2	9.37	10.96	< 0.001
5 – 7	2,529	21.9	152	6.0	5.07	6.92	
≥ 8	3,518	30.5	178	5.1	4.34	5.79	
Marital status							
Married/union	8,823	71.0	565	6.4	5.89	6.91	< 0.001
Others	3,601	29.0	370	10.3	9.28	11.26	
Region							
North	596	4.8	33	5.5	3.53	7.26	0.002
Northeast	3,315	26.7	201	6.1	5.24	6.93	
Southeast	5,912	47.6	487	8.2	7.76	9.24	
South	1,990	16.0	178	8.9	7.99	10.65	
Central-east	611	4.9	37	6.1	3.85	7.71	
Economic class							
A/B	2390	19.2	159	6.7	5.57	7.67	0.127
C	5788	46.6	450	7.8	7.42	8.89	
D/E	4244	34.2	325	7.7	6.85	8.49	

*χ^2 test from Pearson (95%).

with DM. The prevalence of those who reported having had appointment with a doctor in the last year was 9.4% in relation to 2.3% of those that did not report such practice (Table 2).

All of the studied variables entered into the final model, except economic class and smoking habits, because they were not significant in the univariate analysis. After being adjusted by the multivariate model, DM remained associated with age (≥ 40 years), education (< 8 years of schooling), marital status (not married), the presence of obesity, and a sedentary lifestyle, with high levels of cholesterol, with a previous diagnosis of arterial hypertension, and with the demand for health services (Table 3). Sex, region

Table 2. Sample distribution and prevalence of self-reported diabetes according to behavioral and health variables in adults (≥ 20 years). Social Dimensions of Inequalities Research (PDSD), Brazil, 2008.

Behavioral and Health Condition Variables	Sample Total		Individuals with Diabetes		Confidence Interval 95%		p-value*
	n	% column	n	% line	Lower Limit	Upper Limit	
Obesity							
No	10,027	80.7	625	6.2	5.74	6.69	< 0.001
Yes	2,396	19.3	310	12.9	11.59	14.28	
Sedentary lifestyle							
No	8,641	70.2	516	6.0	5.47	6.47	< 0.001
Yes	3,665	29.8	409	11.2	10.14	12.18	
Smokes or has already smoked							
No	6,926	55.7	494	7.1	6.52	7.73	0.062
Yes	5,498	44.3	441	8.0	7.30	8.74	
Consumption of alcohol in the past year							
None	7,576	61.0	673	8.9	8.24	9.53	< 0.001
Up to one time a week	3,669	29.5	199	5.4	4.71	6.18	
≥ 2 times per week	1,178	9.5	62	5.3	3.92	6.47	
Hypercholesterolemia							
No	10,654	85.8	545	5.1	4.68	5.52	< 0.001
Yes	1,768	14.2	389	22.0	20.11	24.00	
Arterial hypertension							
No	8,907	71.7	339	3.8	3.41	4.21	< 0.001
Yes	3,516	28.3	596	17.0	15.65	18.14	
Doctor's appointment in the last 12 months							
No	3,284	26.4	74	2.3	1.77	2.80	< 0.001
Yes	9,138	73.6	860	9.4	8.79	9.99	

*χ^2 test from Pearson (95%).

of origin, and alcohol consumption were not associated with the occurrence of DM in this population.

According to what is demonstrated in Table 3, the odds of having DM showed to be four times higher among older people when compared to younger people ($p < 0.001$).

Table 3. Crude odds ratios and results of the final multivariate logistic regression model (stepwise) for the occurrence of diabetes mellitus. Social Dimensions of Inequalities Research (PDSD), Brazil, 2008.

Regression Model: Stepwise Logistics	Diabetes *mellitus*				
	Odds ratio crude	Odds ratio adjusted	Confidence Interval 95%		p-value
			Lower limit	Upper limit	
Age (years)					
20 – 39*	1.00	1.00	-	-	< 0.001
40 – 64	5.62	2.65	1.99	3.53	
≥ 65	13.06	4.00	2.93	5.46	
Number of years of education					
0 – 4	2.12	1.28	1.05	1.55	0.012
5 – 7	1.20	1.12	0.88	1.41	0.358
≥ 8*	1.00	1.00	-	-	-
Marital status					
Married/union*	1.00	1.00	-	-	0.020
Others	1.67	1.20	1.03	1.40	
Obesity (IMC > 30)					
No*	1.00	1.00	-	-	< 0.001
Yes	2.24	1.58	1.35	1.86	
Sedentary lifestyle					
No*	1.00	1.00	-	-	< 0.001
Yes	1.98	1.41	1.21	1.64	
Hypercholesterolemia					
No*	1.00	1.00	-	-	< 0.001
Yes	5.23	2.59	2.21	3.03	
Arterial hypertension					
No*	1.00	1.00	-	-	< 0.001
Yes	5.16	2.20	1.88	2.60	
Consult in the past twelve months					
No*	1.00	1.00	-	-	< 0.001
Yes	4.51	2.51	1.93	3.27	

Note: Adjustment (Proportion of Classification); Positives: 76.6%; Negatives: 70.5%; Total: 71.0%; *Reference category.

After analysing the whole scenario, an age gradient in the chances of occurrence of DM was observed (Figure 1A). Another alteration was also observed with respect to education, but inversely (Figure 1B). The difference was significant only when compared to the extreme categories (Table 3). Those with a low-level of education showed almost 30.0% more chances of having DM than those who had completed eight years or more of schooling (Table 3). Married individuals reduced the chance of having DM by 20% when compared with the other category (Table 3 and Figure 1C).

With respect to the behavioral and health variables, hypercholesterolemia and arterial hypertension were those most associated with the outcome when compared with the other variables (Figure 2). Individuals with a previous diagnosis of one of these conditions had more than double the chance of presenting a diagnosis of DM than

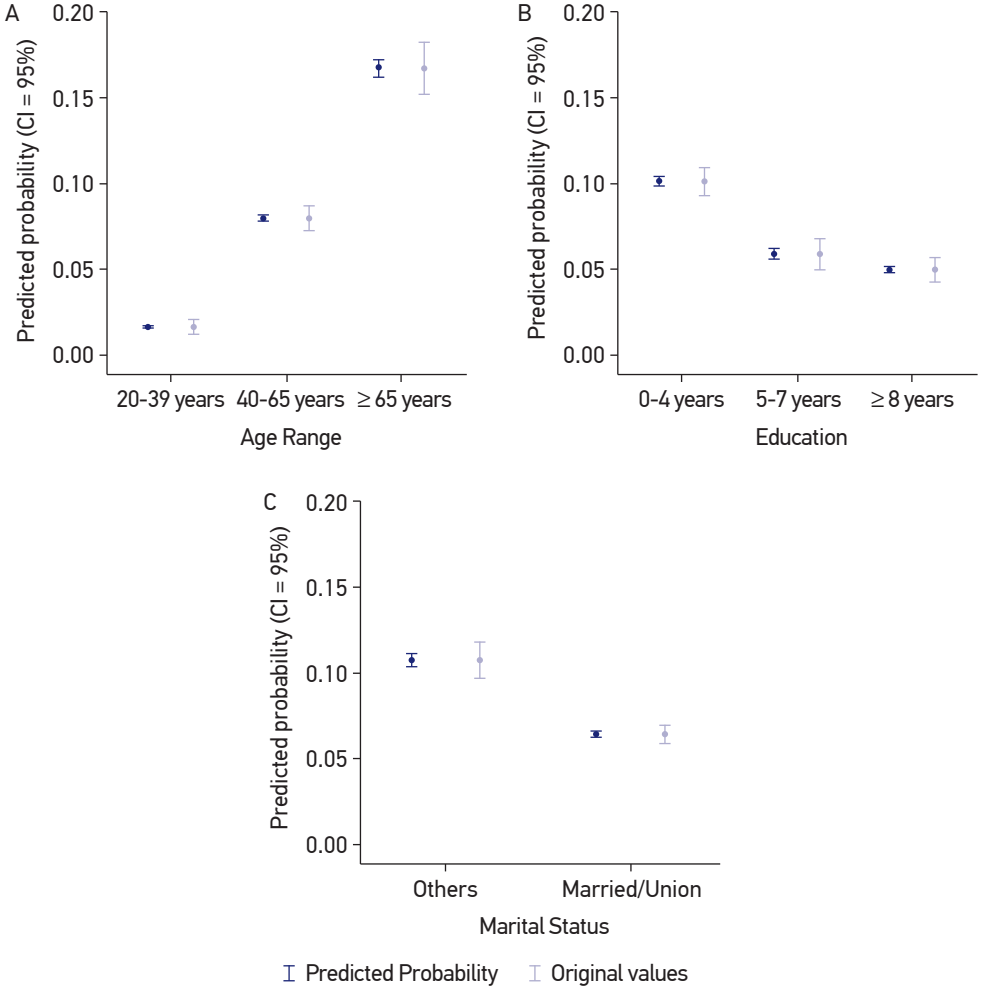

Figure 1. Predicted probability and observed probability of occurrence of diabetes mellitus according to sociodemographic variables. Social Dimensions of Inequalities Research (PDSD), Brazil, 2008.

individuals without these diseases (Table 3). There was also an increase of 58.0% in the chance of occurrence of DM for obese people and 41.0% for those with a sedentary lifestyle (Table 3).

DISCUSSION

The prevalence of DM found in the adult Brazilian population in 2008 was 7.5% (95%CI 7.02 – 7.95). The occurrence of DM was associated with modifiable and unchangeable factors, with age (≥ 40 years), obesity, a sedentary lifestyle, and the presence of other health conditions being the ones to stand out.

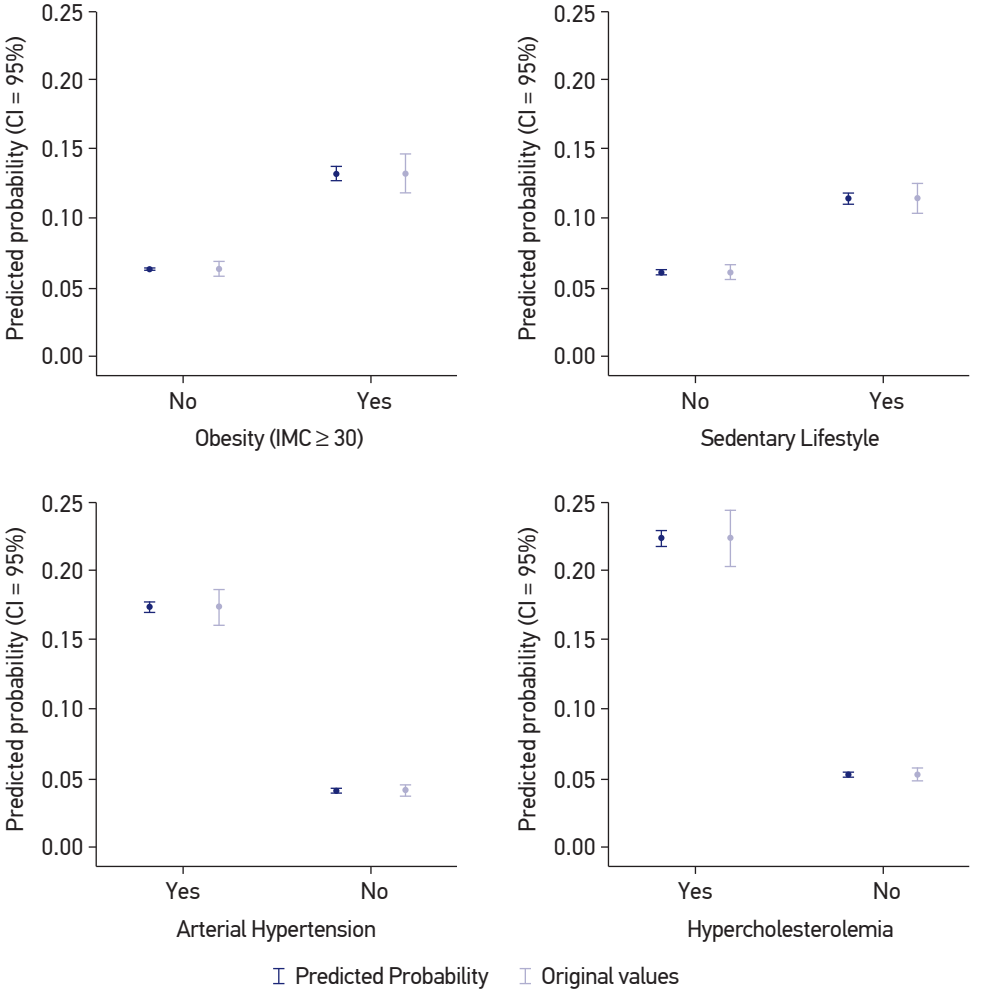

Figure 2. Predicted probability and observed probability of occurrence of diabetes mellitus according to behavioral and health variables. Social Dimensions of Inequalities Research (PDSD), Brazil, 2008.

In the country, a more specialized study, using biochemical markers to estimate the prevalence of diabetes was carried out in 1988 in nine Brazilian capital cities, when a prevalence of 7.6% in adults aged between 30 and 69 years was obtained. More recent studies, in different geographic contexts, show that the prevalence of diabetes varies between 6 and 15% in the Brazilian adult population[10-12].

Even though biochemical tests are the most recommended for the diagnosis of DM, various studies use self-reporting information, especially those with a large comprehensiveness, such as the case of PDSD. Recently, results from the Risk Factors Surveillance System and Protection for Chronic Diseases Telephone Survey (acronym in Portuguese – VIGITEL) showed that Brazilian capitals have a prevalence of DM of 6.3%[13] for individuals who are aged 18 years or older, which is similar to the result found for Brazil in the National Health Research in 2013, with 6.2% (95%CI 5.9 – 6.6)[14] for this same age group. With regard to the National Household Sampling Survey (acronym in Portuguese – PNAD) from 2008, the prevalence found for the adult population (aged ≥ 18 years) was 4.3%[15]. This same study highlighted the rate of growth in the country over a period of ten years. However, it is worth highlighting that comparisons between Brazilian surveys should not be done directly. They should take into consideration, the year of the study, methodological aspects such as age group investigated, the type of question used to indicate the presence of the disease, and aspects inherent in the process of sampling and conducting interviews. VIGITEL, for example, uses telephone interviews in their investigations, in addition to including only the Brazilian capital cities in the survey[13]. In the case of PNAD, the fact that one household member can respond for all members of the family is important to highlight, because it may further reduce the frequency of the reported disease[15]. With regard to PDSD, its sampling process included an over representation of the richest individuals, who, hypothetically, have more access to an early diagnosis, which could have contributed to the increase in the prevalence of the reported disease in this stratum[8].

With regard to the association with sociodemographic variables, age was the one that showed the highest effect over the chances of having DM. Similarly to other studies, the diagnosis of the disease becomes more common among individuals at an elderly age[13,14,16,17]. In the Bambuí Project – Population-Based Cohort Study on the Health of the Elderly, in which clinical tests were performed for the diagnosis of the disease, elderly individuals showed a prevalence approximately six times higher (14.6%) when compared to adult individuals aged between 18 and 59 years.[18] In fact, much has been discussed about the impact of changes in the demographic structure and the increase in longevity in the profile of chronic noncommunicable diseases, especially diabetes. The demographic transition observed in the last few decades has been indicated as one of the principal causes for the increase in the incidence and prevalence of DM in Brazil and in the world. [6]

A low level of education was also associated with a higher prevalence of DM. Such association had already been verified previously, in Brazil and other countries[13,19,20]. The prevalence of diabetes found in a Brazilian region marked by low income and low levels of education

demonstrated to be much higher than among adults in other regions[12]. Education level demonstrated to be an important socioeconomic indicator, as it is considered a proxy of the social position of an individual. Such characteristic imply differentiated risks in getting sick and in death, since they are related to access and use of health services, as well as influences familial decisions concerning food, care for their body, and disease prevention[21-23].

Even though economic class was not significant in the univariate analysis, a higher prevalence in the C and D/E classes was observed. Freitas and Garcia (2012)[15] explain that in cross-sectional population studies, to face a bias of prevalence or survival is possible, since individuals with a worse socioeconomic level experience a lower survival rate. Because of this, such individuals can be underrepresented. Additionally, since education and income are connected to access to health services, it is most probable to encounter people with a previous diagnosis of diabetes in a strata of higher income[24]. As stated by these authors, the estimated social disparities between the social strata presented may be smaller than the true ones.

With regard to marital status, this also remained associated with the diagnosis of DM, even after controlling for the remaining variables. Some studies published previously in Brazil do not verify the association between these two aspects[10,25]. However, in a study of elderly people in the city of São Paulo, the prevalence of diabetics was 60% higher among widows when compared with married people. This significance remained in the final model, even when it was adjusted for age[26]. In addition to potentially being associated with the smallest chance of occurrence of DM, the presence of one partner is an important condition for diabetic individuals to manage the disease, since they motivate the patients to receive treatment, to control unhealthy habits, and to adopt favorable lifestyles[27].

Among the current existing strategies for the control of DM, those aimed at modifiable risk factors such as being overweight and physical inactivity stand out. Findings from diverse studies registered the statistically significant relationship between being overweight and a sedentary lifestyle and the incidence or the prevalence of diabetes, because that is the relation measured by the effects of resistance to insulin[13,18,28]. The nutritional transition observed in the last decades has, as such, placed a large part of the population in risk for the development of DM. In Brazil, in 2008[29], 58.3% of the burden of diabetes among women and 45.4% among men was attributed to obesity—higher numbers than those found for 2002/2003[30].

Similarly to being overweight, a sedentary lifestyle has been associated with the occurrence of diabetes, independently of nutritional condition[18]. The regular practice of physical activities can prevent and control the disease since it acts to diminish or maintain corporal weight, diminish the resistance to insulin and contribute to improve glycemic control, which, in turn, reduces the risk of complications associated with this disease[31,32]. Despite such a causal relationship being amply reported in the literature, a study performed in Brazil, with the intention of evaluating population knowledge about the associations of four behavioral risk factors with some morbidities, it was shown that approximately half of the interviewees were not aware of the existing association between a sedentary lifestyle and diabetes[33].

Commonly, diabetes seems to be associated with other conditions, such as arterial hypertension and dyslipidemia, which corroborates the findings of this study. In the city of Campos, Rio de Janeiro, it was observed that individuals with hypertension or dislipedimia showed three times more of a chance of having DM when compared to the population unexposed to these factors[11]. In the elderly, having hypertension duplicated the chance of occurrence of diabetes[34]. Such associations are consequent of the resistance to insulin and are worrisome, because they considerably increase the risk of cardiovascular complications[15,35].

As DM is a chronic disease, patients with this disease need medical follow-up throughout their entire lives. This coupled with the increased susceptibility of diabetic patients to the development of other health problems and complications probably favors a larger doctor's appointments report from this group[10]. Regardless of the variable referring to the search for a doctor's appointment, the effect may be due to the bias inherent in cross-sectional studies in which simultaneous assessments of risk/protection factors and outcomes limit inferences about a causal relationship between variables.

An important limitation of the results refers to the diagnostic of self-reported DM. Although it is related to the occurrence of the disease, the proportion of individuals who are unaware of their disease may lead to an underestimation of the cases of diabetes found in the study population. Estimates indicate that, worldwide, 25–50% of individuals are unaware of having the disease[3]. The accuracy of the reported morbidity varies depending on the disease, its severity, sociodemographic and economic characteristics; however, despite the limitations, a diverse set of authors agree that the use of this methodology is growing worldwide owing to its practicality and low cost, as it is an important tool in health planning[13,36,37]. The self-reported hypertension and hypercholesterolemia in this study may also be underestimated.

In Brazil, studies with national representativeness that investigate the prevalence of DM are limited. Because of this, the results of this study deserve to stand out, because in addition to originating in a population-based study, they have national representativeness. Due to the comprehensiveness of PDSD, dealing with a significant number of cases of diabetes was possible, and a wide range of variables could be associated with the occurrence of this disorder, confirming previous findings.

CONCLUSION

It is concluded that DM is a relevant health problem, which is associated with socioeconomic and demographic factors and other health conditions. Among the factors identified, some are susceptible to intervention, highlighting the need for more incisive and effective public policies, focused specially on the modification of living habits.

The control of risk factors associated with diabetes, through health promotion measures, may contribute to the reduction of the incidence of the disease and its chronic

complications, as well as to the reduction of costs generated for the health system. The Strategic Action Plan for Tackling Chronic Noncommunicable Diseases (NCDs) in Brazil, 2011–2022,[38] which defines and prioritizes the actions and investments needed to prepare the country to tackle and stop NCDs, highlights the need for actions aimed at promoting healthy living habits. Also, in this context, the National Food and Nutrition Safety Plan, the elaboration of the Food Guide for the Brazilian Population, the Health Gym Program, the Health in the School Program, as well as the free access to pharmacological treatment of DM are important strategies in Brazil for the prevention of this disease and for tackling the current situation.

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