Original article

# Factors associated with glycemic control in a sample of individuals with Diabetes Mellitus taken from the Longitudinal Study of Adult Health, Brazil, 2008-2010*

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## Abstract

**Objective**: to investigate factors associated with glycemic control in individuals with diabetes *mellitus* (DM). **Methods**: this was a cross-sectional study, with participants in the Longitudinal Study of Adult Health with self-reported DM; binomial logistic regression was used. **Results**: 1,242 individuals were included; 54.2% had glycated hemoglobin ≥6.5%, showing inadequate glycemic control; factors associated with inadequate glycemic control were male sex (OR=1.39 – 95%CI 1.05;1.85), black skin color (OR=1.74 – 95%CI 1.22;2.48) or brown skin color (OR=1,57 – 95%CI 1.14;2.16), average occupation level (OR=1.63 – 95%CI 1.02;2.58), not having health insurance (OR=1.47 – 95%CI 1.09;1.96), use of insulin (OR=7.34 – 95%CI 3.56;15.15), increased waist-to-hip ratio (OR=1.87 – 95%CI 1.19;2.93), smoking (OR=1.73 – 95%CI 1.09;2.74), and poor or very poor self-rated health (OR=2.37 – 95%CI 1.17;4.83). **Conclusion**: the results reinforce the multicausal context in glycemic control, which was associated with sociodemographic factors, lifestyles and health conditions.

**Keywords**: Diabetes *Mellitus*; Glycated Hemoglobin A; Diabetes Complications; Hyperglycemia.

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## Introduction

Diabetes *mellitus* (DM) currently represents a global epidemic, a huge challenge for national health systems. Factors such as urbanization and industrialization, the global increase in life expectancy and lifestyles characterized by physical inactivity and eating habits that tend towards accumulation of body fat, have contributed to the advance of the DM epidemic worldwide.[1]

Brazil is the country with the fourth highest number of cases of the disease in adults in the world (14.3 million individuals); in 2015 alone there were 130,700 deaths caused by DM.[2] A household survey about DM occurrence conducted in Brazil in 2013 revealed that self-reported prevalence of the disease was 6.2%, with a higher proportion among women and people living in urban areas.[3]

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DM is a heterogeneous group of metabolic disorders the striking characteristic of which is hyperglicemia. In type 1 DM, the body fails to produce insulin and its treatment necessarily requires exogenous insulin. Type 2 DM, which accounts for more than 90% of cases, is related to defects in insulin action and secretion and regulation of hepatic glucose production. Its treatment implies a series of measures being taken in order to achieve dietary control which include combating obesity, promoting regular physical activity and use of single or combination oral antidiabetic medication.[1]

Glycated Hemoglobin A (hemoglobin A1c) stands out as a standardized test for assessing glycemic control.[1] There is ample evidence that good control of blood glucose and of other risk factors such as, for instance, obesity, physical inactivity and hypercaloric diet, prevent both acute and chronic complications of the disease. An evaluation study with individuals with decompensated DM identified that at the beginning of follow-up none of the patients had all parameters (glycemic control, blood pressure control and lipid control) within the recommended target limits.[4] Authors draw attention to the importance of changing lifestyle habits for weight control, diet and physical activity.[5] In this sense, understanding determining factors of DM control has shown itself to be fundamental: the earlier the intervention takes place, the better the clinical course of the disease and the lesser the probability of complications emerging.[1,5]

The objective of this study was to investigate factors associated with glycemic control in individuals with diabetes *mellitus* who took part in the Longitudinal Study of Adult Health (*ELSA-Brasil*).

## Methods

This is a cross-sectional study using baseline data from the Longitudinal Study of Adult Health (*ELSA-Brasil*). This information was collected between August 2008 and December 2010.[6]

The *ELSA-Brasil* cohort was comprised of 15,105 in-service or retired civil servants aged between 35 and 74 years old, from six public higher education institutions in the following Brazilian state capitals: São Paulo (São Paulo), Belo Horizonte (Minas Gerais), Salvador (Bahia), Porto Alegre (Rio Grande do Sul), Rio de Janeiro (Rio de Janeiro) and Vitória (Espírito Santo).[6]

*ELSA-Brasil* baseline data collection was done by teams that were trained and certified centrally and that conducted standardized interviews, clinical assessments and sample collections for performance of biochemical tests. Every three months the participants are contacted for them to undergo new procedures with the aim of accompanying their health and monitoring individual outcomes.[7]

This study included all individuals who took part in the *ELSA-Brasil* baseline who self-reported DM and were taking oral antidiabetic drug(s) or insulin. Those who did not have results for all the biochemical parameters studied and for the 'medication adherence' variable were excluded from the study.

The 'outcome' variable of this study was glycated hemoglobin (HbA1c). In its most recent guidelines, the Brazilian Diabetes Society defines HbA1c values greater than and/or equal to 6.5% as the criterion for diagnosing established DM.[1] In order to assess glycemic control, this study used laboratory data on glycated hemoglobin (HbA1c). Results were considered to be adequate when the value was less than 6.5%.[8]

The exposure variables were as follows:

a) socio-economic and demographic variables
   - age (in years: 35-44; 45-54; 55-64; 65 or over)
   - sex (male; female);

- race/skin color (white; black; brown; yellow/indigenous);
- marital status (married/living with someone; divorced or separated; single);
- schooling (incomplete elementary education; complete elementary education; complete high school education; higher education); and
- *per capita* income (in minimum wages: less than 4; from 4 to less than 8; from 8 to less than 12; from 12 to less than 16; 16 or more);

b) lifestyle habit variables
- physical activity (active; not active);
- alcohol consumption (never; former user; user); and
- tobacco smoking (never; smoker; former smoker);

c) dietary variables
- total daily diet calories (<2,000; 2,000<3,000; 3,000<4,000; ≥4,000);

d) nutritional variables, measured based on
- body mass index (BMI) – low weight (BMI <18,5kg/m$^2$)/normal weight (BMI <25kg/m$^2$); overweight (BMI <30kg/m$^2$); obesity (BMI ≥30kg/m$^2$) –;
- waist-to-hip ratio (ideal; changed); and
- abdominal circumference (ideal; changed);

e) psychosocial variables
- religious activity (no; yes); and
- self-rated health (very good; good; regular; poor/very poor);

f) general characteristics and health characteristic variables
- job category (expressed as level of schooling permitted for the job: support; high school [technical position]; higher/teacher);
- private health insurance (no; yes; no information);

g) DM medication variables (oral antidiabetic drugs; insulin; both); and

h) medication treatment adherence variables (low/medium adherence; high adherence).

With regard to the '*per capita* income' variable, the minimum wage in force in 2008 was BRL 415.00 (USD 257.44).

The 'self-rated health' variable was measured by asking the question "*In comparison to people of your age, how do you rate your general health status?*", with reply options categorized into strata: very good; good; regular; poor; very poor; no information (NS [didn't know]/NQR [didn't wish to answer]).

With regard to the 'alcohol consumption' variable, the 'user' category was recorded by asking the question "*Do you currently consume alcoholic beverages?*" with 'no' or 'yes' as reply options; the 'former user' category was determined by asking "*Have you ever consumed alcoholic beverages?*" with 'no' or 'yes' as reply options'; while the 'never' category was attributed to those individuals who informed that they had never used alcohol.

In order to define the 'diet calories' variable, total energy value was investigated by administering a previously validated Food Frequency Questionnaire (*QFA ELSA-Brasil*) containing 114 food items.[9] Following this, the nutritional composition and energy value of the food consumed were estimated. Total diet energy value was numerically categorized in calories (cal) for each individual.

The 'job category' variable was defined according to the level of schooling required for each civil service position: support; technical; or higher/teacher. The 'support' category covers the range of jobs for which complete elementary education is required.

The 'medication adherence' variable was assessed by applying four-item Morisky Medication Adherence Scale (MMAS-4),[10] according to which 1 (one) point is given for each positive answer, while 0 (zero) is given for each negative answer. Adherence was classified in the following manner: high, when all 4 answers were negative; medium when 3 or 2 answers were negative; and low when only one answer was negative, or when all the answers were positive. People classified by MMAS-4 as having high adherence were considered to be adherent to medication, while those classified as having medium or low adherence were considered to be non-adherent.[11] Despite MMAS-4 having low sensitivity (43.6%) and reasonable specificity (81%),[12] this scale continues to be used in many studies.[10-12]

Waist circumference (WC) was categorized as ideal when it was less than 90cm for men and less than 80cm for women, in accordance with International Diabetes Federation recommendations.[13] Waist-to-hip ratio (WHR) was assessed according to the criteria of the Brazilian Association for the Study of Obesity and Metabolic Syndrome and was categorized as ideal when values were under 0.90 for men and under 0.85 for women.[14]

Assessment of physical activity was based on the

answers to the long version of the International Physical Activity Questionnaire (IPAQ). People who reported 150 minutes of moderate physical activity a week were considered to be sufficiently active.[15] The variables relating to treatment with medication consisted of the description of the profile of medication use, distributed into three categories: oral hypoglycemic agents; use of insulin; or both.

When analyzing the data, the comparison between categorical variables was done using Pearson's chi-square test. The multivariate analysis was done using binomial logistic regression, taking glycated hemoglobin $<6.5\%$ as the reference category, and included all variables associated with the result the p-value of which was $<0.100$ in the crude analysis. SPSS (Statistical Package for the Social Sciences) version 22 and BioEstat 5.3 were used for the statistical analyses, taking a 5% significance level.

The *ELSA-Brasil* Project was approved by the National Research Ethics Committee/National Health Council on August 4th 2006, (approval number 13,065), and by the Research Ethics Committees of the six institutions forming the consortium. This study was submitted to and approved by the *ELSA-Brasil* Scientific Committee.

## Results

The study included 1,242 individuals. DM prevalence in the population studied was 8.2%. Males were predominant (53.1%); 41.4% of the participants were in the 55-64 age range, 43.9% were of black race/skin color, 78.4% had high school and higher education, 61.2% reported *per capita* income below four minimum wages – 25.3% had income between four and up to eight minimum wages (Table 1).

There was a predominance of physically inactive people (96.6%), people who had never smoked (50.6%) and people who consumed alcoholic beverages (56.2%). Of the 697 individuals who self-reported alcohol use, 10.2% were classified as excessive drinkers (Table 1).

The majority (60.2%) had low/medium adherence to medication and 54.2% of individuals with DM had inadequate glycemic control (Table 1).

With regard to the categories of drugs used by individuals with DM, 86.5% only used oral antidiabetics, 7.8% used oral antidiabetics and insulin jointly, and 5.7% only used insulin as a form of treatment (Table 1). According to the medication classes of the oral antidiabetics and respective active ingredients, of the 1,174 individuals with DM taking oral antidiabetics, the majority used biguanide (57.2%), followed by those who used biguanide and sulfonylurea combinations (24.2%); only 8.9% used sulfonylurea on its own; other combination treatments accounted for 9.5%. Of the total sample, 0.2% were not able to state the name of the medication they were taking. No information was available on the *ELSA-Brasil* Project database about the number of medications used by each individual with diabetes.

In Table 2, it can be seen that together overweight and obesity account for 82.8% of the sample, changed waist circumference and changed WHR each account for more than 90%, and almost 40% had abdominal obesity. 45.8% of the sample self-rated their health as good and 63.4% had health insurance.

In the crude analysis (Tables 3 and 4), there was a higher proportion of adequate glycemic control (HbA1c $<6.5\%$) in females, people of white race/skin color, people with higher education, those who only used oral antidiabetics, those who had religious activities and health insurance, those who had never smoked, those with good self-rated health and a daily diet consumption of 2,000 to 3,000 calories. Poorer medication adherence and lower *per capita* income were found in those with poorer glycemic control (HbA1c $\geq 6.5\%$).

In the multivariate analysis (Table 5), the following variables were associated with inadequate glycemic control: male sex (OR=1.39 – 95%CI 1.05;1.85); black race/skin color (OR=1.74 – 95%CI 1.22;2.48) or brown race/skin color (OR=1.57 – 95%CI 1.14;2.16); use of insulin on its own (OR=7.34 – 95%CI 3.56;15.15) or in combination with oral antidiabetics (OR=7.58 – 95%CI 3.96;14.52); changed waist-to-hip ratio (WHR) (OR=1.87 – 95%CI 1.19;2.93); occupation compatible with high school education (technical position) (OR=1.63 – 95%CI 1.02;2.58), compared to those with higher education; poor or very poor self-rated health (OR=2.37 – 95%CI 1.17;4.83); not having private health insurance (OR=1.47 – 95%CI 1.09;1.96); and being a smoker (OR=1.73 – 95%CI 1.09;2.74).

## Discussion

Diabetes *mellitus* prevalence in the population studied was 8.2%. The study showed that factors associated with greater odds of inadequate glycemic control included socio-economic and demographic variables (male sex; black or brown race/skin color), lifestyle (tobacco

**Table 1 – Characterization of the socio-economic, demographic, income and lifestyle and health habits of individuals with diabetes *mellitus* taking part in the baseline of the Longitudinal Study of Adult Health, Brazil, 2008-2010**

| Variable | Categorization | n | % |
|---|---|---|---|
| **Sex** | Male | 659 | 53.1 |
| | Female | 583 | 46.9 |
| **Age range (in years)** | 35-44 | 80 | 6.4 |
| | 45-54 | 354 | 28.5 |
| | 55-64 | 514 | 41.4 |
| | ≥65 | 294 | 23.7 |
| **Race/skin color** | Black | 545 | 43.9 |
| | Brown | 273 | 22.0 |
| | White | 343 | 27.6 |
| | Yellow/indigenous | 61 | 4.9 |
| | No information | 20 | 1.6 |
| **Schooling** | Incomplete elementary | 143 | 11.5 |
| | Complete elementary | 125 | 10.1 |
| | Complete high school | 464 | 37.3 |
| | Higher education | 510 | 41.1 |
| **Marital status** | Married or living with someone | 808 | 65.1 |
| | Divorced. separated or widowed | 308 | 24.8 |
| | Single | 125 | 10.0 |
| | No information | 1 | 0.1 |
| **Per capita income (in minimum wages)** | <4 | 760 | 61.2 |
| | 4 to <8 | 315 | 25.3 |
| | 8 to <12 | 120 | 9.7 |
| | 12 to <16 | 11 | 0.9 |
| | ≥16 | 31 | 2.5 |
| | No information | 5 | 0.4 |
| **Physical activity** | Active | 42 | 3.4 |
| | Not active | 1,200 | 96.6 |
| **Smoking habit** | Never | 629 | 50.6 |
| | Former smoker | 480 | 38.6 |
| | Smoker | 132 | 10.7 |
| | No information | 1 | 0.1 |
| **Alcohol consumption** | Never | 176 | 14.1 |
| | Former user | 369 | 29.7 |
| | User | 697 | 56.2 |
| **Medication adherence** | Low/medium adherence | 748 | 60.2 |
| | High adherence | 494 | 39.8 |
| **Medication type** | Oral antidiabetic | 1,074 | 86.5 |
| | Insulin | 71 | 5.7 |
| | Both | 97 | 7.8 |
| **Glycemic control** | Glycated hemoglobin≥6.5% | 673 | 54.2 |
| | Glycated hemoglobin<6.5% | 569 | 45.8 |
| **Total** | | **1,242** | **100.0** |

smoking; increased waist-to-hip ratio), health status (use of insulin; poor self-rated health), as well as job category compatible with high school education (technical position) and not having health insurance.

Among the socio-economic and demographic variables, the male sex was associated with poorer glucose level results. Another national study with people with self-reported DM also indicated difference between the sexes, with higher prevalence among females (7.0% – 95%CI 6.5;7.5), this fact is put down to women using health services more, especially during pregnancy, as well as women's greater awareness of taking care of their own health.[3]

Notwithstanding the literature pointing to more

**Table 2 – Characterization of nutritional, dietary, psychosocial and functional variables of individuals with diabetes *mellitus* taking part in the baseline of the Longitudinal Study of Adult Health, Brazil, 2008-2010**

| Variable | Categorization | n | % |
|---|---|---|---|
| Body mass index (BMI) | Low/normal weight | 214 | 17.2 |
| | Overweight | 518 | 41.7 |
| | Obesity | 510 | 41.1 |
| Waist circumference (WC) | Ideal | 122 | 9.8 |
| | Changed | 1,119 | 90.1 |
| | No information | 1 | 0.1 |
| Waist-to-hip ratio (WHR) | Ideal | 117 | 9.4 |
| | Changed | 1,124 | 90.5 |
| | No information | 1 | 0.1 |
| Abdominal obesity | No | 315 | 25.4 |
| | Yes | 484 | 39.0 |
| | No information | 443 | 35.6 |
| Total daily diet calories | <2,000 | 265 | 21.3 |
| | 2,000<3,000 | 567 | 45.7 |
| | 3,000<4,000 | 255 | 20.5 |
| | ≥4,000 | 154 | 12.4 |
| | No information | 1 | 0.1 |
| Self-rated health (SRH) | Very good | 108 | 8.7 |
| | Good | 569 | 45.8 |
| | Regular | 483 | 38.9 |
| | Poor/very poor | 80 | 6.4 |
| | No information | 2 | 0.2 |
| Private health insurance | No | 454 | 36.5 |
| | Yes | 787 | 63.4 |
| | No information | 1 | 0.1 |
| Occupational history | Working | 754 | 60.7 |
| | Retired | 487 | 39.2 |
| | No information | 1 | 0.1 |
| Job category | Support | 404 | 32.5 |
| | Technical | 452 | 36.4 |
| | Higher/teacher | 386 | 31.1 |
| Religious activity | No | 354 | 28.5 |
| | Yes | 888 | 71.5 |
| **Total** | | **1,242** | **100.0** |

cases of the disease among women, in this study in particular, men had greater desglycemic discontrol. This relationship between the sexes can be attributed to a series of behavioral and cultural factors regarding men's health, for many of whom illness may be seen as a sign of weakness, leading them to avoid medical consultations and taking care of their health.[16] Male fear of discovering they have a serious disease must also be taken into consideration, this being yet another reason for explaining men's absence in health services, hindering the establishment of prevention habits among them.[17]

In this study, an individual being of black or brown race/skin color increased the odds of poor glycemic control. Similarly, another study identified ethnic differences in the appearance of DM, with the disease being two times more frequent in people belonging to the Black ethnic group.[18] Despite these studies having the same findings with regard to black/brown race/skin color in relation to the appearance and control of the disease, these disparities do not appear to be so well-established: for some authors they are due to difficulties in overcoming iniquities, such as differences in formal education, communication and access to health services, reiterating the existence of ethnic and social disparity in the progression of DM, apart from the need for a discussion about the identification of barriers possibly related to poorer control of the disease by individuals of black or brown race/skin color.[19]

Individuals whose job category was compatible with high school education (technical position) had greater

**Table 3 – Socio-economic, demographic, medication type and adherence variables of individuals with diabetes *mellitus*, according to glycemic control, taking part in the baseline of the Longitudinal Study of Adult Health, Brazil, 2008-2010**

| Variable | Categorization | Inadequate glycemic control (HbA1c ≥6.5%) | | p-value[a] |
|---|---|---|---|---|
| | | n | % | |
| Sex | Male | 377 | 57.2 | 0.023 |
| | Female | 296 | 50.8 | |
| Age range (in years) | 35-44 | 46 | 57.5 | 0.080 |
| | 45-54 | 210 | 59.3 | |
| | 55-64 | 270 | 52.5 | |
| | ≥65 | 147 | 50.0 | |
| Race/skin color | Black | 244 | 44.8 | <0.001 |
| | Brown | 177 | 64.8 | |
| | White | 209 | 60.9 | |
| | Yellow/indigenous | 35 | 57.4 | |
| Schooling | Incomplete elementary | 101 | 70.6 | <0.001 |
| | Complete elementary | 89 | 71.2 | |
| | Complete high school | 274 | 59.1 | |
| | Higher education | 209 | 40.9 | |
| Per capita income (in minimum wages) | <4 | 470 | 61.8 | <0.001 |
| | 4 a <8 | 138 | 43.8 | |
| | 8 a <12 | 48 | 40.0 | |
| | 12 a <16 | 6 | 54.5 | |
| | ≥16 | 9 | 29.0 | |
| Marital status | Married/living with someone | 437 | 54.0 | 0.587 |
| | Divorced or separated | 172 | 55.8 | |
| | Single | 63 | 50.4 | |
| Type of medication | Oral antidiabetic | 528 | 49.2 | <0.001 |
| | Insulin | 61 | 85.9 | |
| | Both | 85 | 87.6 | |
| Medication adherence | Low/medium | 426 | 56.9 | 0.016 |
| | High | 247 | 50.0 | |

a) p-value: calculated using Pearson's chi-square test.

odds of having inadequate glycemic control, when compared to those with higher education. This association between fewer years of study and more likelihood of having DM has also been found in other studies.[20,21] Following comparison between the job categories studied, the majority of individuals with higher education were teachers and researchers who, due to the nature of the institutions involved, have advantages in relation to the other job categories (technical and support), as well as greater working time flexibility, more than 30 days holiday a year and workload adaptable to other environments, so that these factors may be considered to be a factor contributing to the differences found in the process of people taking care of their health and controlling chronic diseases, as is the case of DM. The finding with regard to desglycemic discontrol in individuals with less schooling reinforces the importance of education in the process of having knowledge of the disease and attitudes towards health status. Identifying how people live, work and age demonstrates the importance of social determinants, both in the process of becoming ill and also in taking care of their health.[22]

In parallel to these considerations is the unquestionable importance of income between different job categories. Professionals with higher education have more attractive pay, more advantageous career progression and, consequently, better access to health services, including having health insurance and using first-line medication with fewer side effects. This is how these issues are understood as social determinants of health.[22]

The result of this study showed that not having private health insurance was also associated with inadequate glycemic control. A study that compared use of health services by people with diabetes who had private health

**Table 4 – Nutritional. occupational, psychosocial, lifestyle and dietary habit characteristics of individuals with diabetes *mellitus*, according to glycemic control, taking part in the baseline of the Longitudinal Study of Adult Health, Brazil, 2008-2010**

| Variable | Categorization | Inadequate glycemic control (HbA1c >6.5%) | | p-value[a] |
|---|---|---|---|---|
| | | n | % | |
| Body mass index (BMI) | Low/normal weight | 117 | 54.7 | 0.661 |
| | Overweight | 273 | 52.7 | |
| | Obesity | 283 | 55.5 | |
| Waist circumference (WC) | Ideal | 65 | 53.3 | 0.839 |
| | Changed | 607 | 54.2 | |
| Waist-to-hip ratio (WHR) | Ideal | 50 | 42.7 | 0.009 |
| | Changed | 622 | 55.3 | |
| Religious activity | No | 176 | 49.7 | 0.046 |
| | Yes | 497 | 55.9 | |
| Job category | Support | 273 | 67.6 | <0.001 |
| | Technical | 260 | 57.5 | |
| | Higher/teacher | 140 | 36.3 | |
| Private health insurance | No | 300 | 66.1 | <0.001 |
| | Yes | 373 | 47.4 | |
| Occupational history | Working | 417 | 55.3 | 0.310 |
| | Retired | 255 | 52.4 | |
| Self-rated health (SRH) | Very good | 44 | 40.7 | <0.001 |
| | Good | 278 | 48.8 | |
| | Regular | 292 | 60.4 | |
| | Poor/very poor | 58 | 72.5 | |
| Physical activity | Active | 25 | 59.5 | 0.480 |
| | Not active | 648 | 54.0 | |
| Smoking habit | Never | 320 | 50.9 | 0.001 |
| | Former smoker | 262 | 54.6 | |
| | Smoker | 90 | 68.2 | |
| Alcohol consumption | Never | 102 | 57.9 | 0.039 |
| | Former user | 214 | 58.0 | |
| | User | 355 | 50.9 | |
| Total daily diet calories | <2,000 | 138 | 52.1 | <0.001 |
| | 2,000<3,000 | 281 | 49.5 | |
| | 3,000<4,000 | 148 | 58.0 | |
| | ≥4,000 | 105 | 68.2 | |

a) p- value: calculated using Pearson's chi-square test.

insurance and those who relied on Public Health facilities found that access (defined as lack of difficulty in getting medical appointments) was greater among those with health insurance than among those who used public services covered by the Family Health Strategy or traditional primary health care centers.[23] This fact suggests the existence of important differences between access by those who have private health insurance and those who depend on public services, not just with regard to the possibility of first contact with a specialist doctor but also, and above all, with regard to the frequency and ease with which those with private health insurance can access health services. This may be a determining factor of adequate glycemic control.

The variables related to the disease, treatment and self-perception of health increased substantially the odds of increased glycated hemoglobin. According to this study, use of insulin was also related to increase in glucose and this result has also been found by other researchers.[4] This relationship may possibly be related to changes in the daily routine of patients with diabetes. These changes are often stressful, caused by daily use of insulin, the need to adjust daily habits, particularly with regard to meal times, as well as storing and transporting

**Table 5 – Factors associated with glycemic control in individuals with diabetes *mellitus* taking part in the baseline of the Longitudinal Study of Adult Health, Brazil, 2008-2010**

| Variable | Categorization | Adjusted analysis | p-value[c] |
|---|---|---|---|
| | | Adjusted (95%CI)[b] | |
| Sex | Female | – | – |
| | Male | 1.39 (1.05;1.85) | 0.021 |
| Age range (in years) | 35-44 | – | – |
| | 45-54 | 1.05 (0.60;1.81) | 0.856 |
| | 55-64 | 0.90 (0.52;1.54) | 0.700 |
| | ≥65 | 0.98 (0.54;1.76) | 0.954 |
| Schooling | Incomplete elementary | 1.03 (0.55;1.96) | 0.905 |
| | Complete elementary | 1.38 (0.74;2.57) | 0.300 |
| | Complete high school | 0.95 (0.62;1.46) | 0.832 |
| | Higher education | – | – |
| *Per capita* income (in minimum wages) | <4 | 1.55 (0.59;4.06) | 0.370 |
| | 4 to <8 | 1.25 (0.48;3.23) | 0.633 |
| | 8 to <12 | 1.562 (0.58;4.18) | 0.375 |
| | 12 to <16 | 3.02 (0.59;15.43) | 0.184 |
| | ≥16 | – | – |
| Religious activity | Yes | – | – |
| | No | 0.87 (0.64;1.18) | 0.379 |
| Race/skin color | White | – | – |
| | Black | 1.74 (1.22;2.48) | 0.002 |
| | Brown | 1.57 (1.14;2.16) | 0.006 |
| | Yellow/indigenous | 1.65 (0.91;2.99) | 0.098 |
| Job category | Support | 1.67 (0.94;2.96) | 0.078 |
| | Technical | 1.63 (1.02;2.58) | 0.039 |
| | Higher/teacher | – | – |
| Health insurance | Yes | – | – |
| | No | 1.47 (1.09;1.96) | 0.010 |
| Type of medication | Oral antidiabetic | – | – |
| | Insulin | 7.34 (3.56;15.15) | <0.001 |
| | Both | 7.58 (3.96;14.52) | <0.001 |
| Waist-to-hip ratio (WHR) | Ideal | – | – |
| | Changed | 1.87 (1.19;2.93) | 0.007 |
| Smoking habit | Never | – | – |
| | Former smoker | 0.97 (0.73;1.28) | 0.817 |
| | Smoker | 1.73 (1.09;2.74) | 0.019 |
| Self-rated health (SRH) | Very good | – | – |
| | Good | 1.29 (0.80;2.09) | 0.290 |
| | Regular | 1.53 (0.93;2.52) | 0.092 |
| | Poor/very poor | 2.37 (1.17;4.83) | 0.017 |
| Total daily diet calories | <2,000 | – | – |
| | 2,000<3,000 | 0.89 (0.64;1.25) | 0.530 |
| | 3,000<4,000 | 1.17 (0.78;1.73) | 0.433 |
| | ≥4,000 | 1.53 (0.95;2.45) | 0.075 |

**Table 5 – Factors associated with glycemic control in individuals with diabetes *mellitus* taking part in the baseline of the Longitudinal Study of Adult Health, Brazil, 2008-2010**

| Variable | Categorization | Adjusted analysis | p-value[c] |
|---|---|---|---|
| | | Adjusted (95%CI)[b] | |
| Alcohol consumption | Never | – | – |
| | Former user | 0.92 (0.60;1.40) | 0.709 |
| | User | 0.97 (0.64;1.46) | 0.894 |
| Medication adherence | Low/medium adherence | 1.20 (0.92;1.56) | 0.166 |
| | High adherence | – | – |

a) OR: odds ratio.

b) 95%CI: 95% confidence interval.

c) The multivariate analysis was performed using binomial logistic regression and included all variables associated with the result with p-value <0.100 in the bivariate analysis.

medication at controlled temperatures, use of syringes to administer it and adequate disposal of waste and sharps. A study that investigates variables and their relationship with stress in people with DM found that emotional load and stress, either in relation to the treatment regime or interpersonal relationships, were associated with being on insulin therapy, reinforcing even more the negative emotional load deriving from use of insulin treatment to control this disease.[24]

Alongside exclusive use of insulin, treatment with a combination of insulin and oral antidiabetics also contributed to inadequate glycemic control by individuals with DM analyzed in this study. The need for complex treatment regimes, combining insulin with oral antidiabetics, is a necessary practice in the routine of people with diabetes who are unable to achieve glycemic control targets by other means. A study conducted to verify the role of polymedication in individuals with type 2 DM or hypertension taking part in a treatment group at a Family Health Strategy health centre in a municipality in Southern Brazil found that patients on polymedication had higher glucose levels compared to those who only took one type of medication.[25] In this sense, the need for complex regimes is a big challenge for people with DM, given the need for specialized knowledge in order to handle them, which may be prejudicial to metabolic self-control.

As in this study, poorer self-rated health was found among diabetic Korean adults with glycemic discontrol.[26] For a person with diabetes, increased glycated hemoglobin can represent poorer health status and, because of their knowledge of their metabolic process, result in their health being self-rated as poor. One of the factors which may also contribute to negative perception of health status by an individual with DM may be related to being diagnosed as having the disease, since this discovery necessarily implies a series of lifestyle changes – and, from the point of view of the diagnosed individual, a reduction in their quality of life.[27]

Being a smoker contributed to poorer glycemic control, as was also found by a study conducted in Saudi Arabia: smokers were more prone to having higher HbA1c than non-smokers.[28] In addition to being associated with metabolic discontrol, tobacco smoking has been shown to be a risk factor for the development of DM. A study conducted in Japan with workers from twelve industrial companies also found, even after adjusting the variables, type 2 DM incidence among current and former smokers, and risk of DM increased as cigarette consumption increased among smokers.[29] According to these conclusions, a person who has DM and also smokes demonstrates that they have not adapted to the disease, in view of their maintaining a lifestyle not in keeping with their clinical status, and that they may also present other conditions and behaviors unfavorable to glycemic control.

Changed waist-to-hip ratio (WHR) was also associated with inadequate glycemic control. This finding differs from other studies, other than when referring solely to incidence of type 2 DM cases.[30] Changed WHR may also be a reflection of changed nutritional parameters among the majority of participants, especially those that had inadequate glycemic control. Together, those who were overweight and obese accounted for 82.8%; and almost 40% of these had abdominal obesity and over 90% changed waist circumference measurements. Moreover, 56.2% regularly consumed alcoholic beverages, 96.6% were physically inactive, and more than a third reported having a diet with more than 3,000 calories a day. These changes were also found in metabolic terms: 54.2% had HbA1c values >6.5%, providing evidence of metabolic discontrol.

A limitation of this study lies in its cross-sectional design, which does not allow investigation of the

relationship of temporality with most of the variables. However, as it was an exploratory study, it was capable of raising hypotheses to be answered by cohort studies and, at the same time, providing information to health services in support of the health promotion of people with diabetes *mellitus*.

The results presented reinforce the multicausal context and its power to act as a barrier or facilitator of glycemic control, considering the complexity of the interaction of social determinants of health in this process, while focusing on several dimensions such as, for instance, diet quality, quantity and frequency, physical activity type, regularity and duration, absence of obesity, control of alcohol consumption, as well as taking medication correctly, assuming that it has been prescribed correctly.

In conclusion, there is a need to implement care lines for people with diabetes by strengthening the chronic conditions care model and including it in the care network for people with chronic diseases.

## Authors' contributions

Moraes HAB took part in the concept and planning of the study, data interpretation and drafting the manuscript. Mengue SS and Molina MCB took part in critically reviewing the contents of the manuscript. Cade NV took part in the concept and planning of the study, data interpretation and drafting the final version of the manuscript. All the authors have approved the final version of the manuscript and are responsible for all aspects thereof, including the guarantee of its accuracy and integrity.

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