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Poor glycaemic control in Brazilian patients with type 2 diabetes attending the public healthcare system: a cross-sectional study

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ABSTRACT

Objectives: To describe the clinical profile of Brazilian patients with type 2 diabetes attending the public healthcare system and identify factors associated with poor glycaemic control.

Design: Cross-sectional study.

Setting: 14 centres in five regions of Brazil, including primary care units and outpatient clinics of University Hospitals.

Participants: Patients with type 2 diabetes attending outpatient clinics of public healthcare system.

Main outcome measured: Glycated haemoglobin (HbA1c), centrally measured by high-performance liquid chromatography (National Glycohemoglobin Standardization Program certified).

Results: A total of 5750 patients aged 61±10 years, with 11±8 years of diabetes duration (66% women, 56% non-white, body mass index: 28.0±5.3 kg/m^2) were analysed. Mean HbA1c was 8.6±2.2%, and median HbA1c was 8.1% (6.9% to 9.9%). HbA1c <7% was observed in only 26% of patients. Mean HbA1c was higher ($p < 0.01$) in the North (9.0±2.6%) and Northeast (8.9±2.4%) than in the Midwest (8.1±2%), Southeast (8.4±2.1%) and South regions (8.3±1.9%). Using the cut-off value of HbA1c above the median, age (0.986 (0.983 to 0.989)), white ethnicity (0.931 (0.883 to 0.981)) and being from Midwest region (0.858 (0.745 to 0.989)) were protective factors, while diabetes duration (1.015 (1.012 to 1.018)), use of insulin (1.710 (1.624 to 1.802)) and living in the Northeast region (1.197 (1.085 to 1.321)) were associated with HbA1c >8%.

Conclusions: The majority of Brazilian patients with type 2 diabetes attending the public healthcare system had HbA1c levels above recommended targets. The recognition of Northeast residents and non-white patients as vulnerable populations should guide future policies and actions to prevent and control diabetes.

ARTICLE SUMMARY

Strengths and limitations of this study

- To the best of our knowledge, this is the largest surveillance study to assess glycaemic control in Brazil. We used a certified method to analyse glycated haemoglobin.
- However, (1) surveillance was based on self-reported answers, although medical records were consulted when available. (2) Only patients attended by the public health system were included and (3) lastly, due to its cross-sectional design, our study was able to identify associations between several factors and glycaemic control, but was unable to pinpoint risk factors.

INTRODUCTION

Brazil is among the 10 countries with the highest prevalence of diabetes mellitus (DM) in the world—about 7.6%.[1 2] Diabetes is the fifth underlying cause of death in Brazil, affecting 2.5% of the population.[3] Preliminary results obtained by our group[4] show that only 24% of Brazilian patients with diabetes had an HbA1c level below the recommended target (HbA1c <7%[5]), despite the availability of free medical care through the public healthcare system (Sistema Único de Saúde-SUS).[6] Medical assistance and specific drugs, including metformin, sulfonylureas and insulin, are provided free of charge across the country through primary care units and specific drugstores. Considering that poor diabetic control is associated with increased mortality in diabetic populations,[7] it is important to analyse the possible factors associated with the high levels of HbA1c in the population.

Therefore, the aim of this study was to describe the clinical profile of patients with type 2 diabetes receiving public healthcare in the five regions of Brazil and identify factors associated with poor glycaemic control.

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PATIENTS

A cross-sectional study was conducted between February 2006 and April 2011 at SUS outpatient clinics with 7201 patients with types 1 and 2 diabetes from the North (n=500; 7%), Northeast (n=2184; 30%), Midwest (n=461; 6%), Southeast (n=3382; 47%) and South (n=674; 9%) regions of Brazil. The number of patients in each region reflects the regional population density as reported in the 2000 national census.[8] A preliminary report describing the characteristics of this patient population, for all regions except the North, has been published.[4] Briefly, the current study was designed to obtain a representative sample of adult patients with type 2 diabetes living in urban areas of Brazil. A total of 14 centres, located in 12 cities belonging to the five regions of our country were included. The included cities were the largest in their respective region and nine of them ranked among the most populous municipalities in Brazil. We also considered that the data would be more reliable if they were collected from public healthcare centres that usually take care of at least 300 patients with diabetes/month. All patients provided written informed consent.

In the present study, we reported the results for 5750 patients with type 2 diabetes for whom HbA1c values were available. Type 2 diabetes was defined as diabetes diagnosed after 30 years of age without insulin use in the first 5 years after the diagnosis. Patients were from the North (n=312; 5%), Northeast (n=1906, 33%), Midwest (n=348, 6%), Southeast (n=2642, 46%) and South (n=542, 9%) regions.

Assessment of clinical characteristics

Information on clinical variables (age, gender, ethnicity, DM duration, body weight, height, physical activity and medications in use,) was obtained by a standardised questionnaire. Ethnicity was self-reported as white or non-white (black, mixed or other—including Asian and Native Brazilians). Marital status was categorised as living with or without a partner, and employment status as working or not currently employed. Educational status was classified as at least 8 years or less than 8 years of formal education. DM treatment was classified as none, diet alone, oral agents, oral agents plus insulin and insulin alone. Frequency of self-blood glucose monitoring (SBGM) and hypoglycaemic episodes in the previous year were recorded. Body mass index (BMI) was calculated (weight/height^2; kg/m^2). Data were collected in 14 cities representing the five regions of Brazil: South (Porto Alegre, Curitiba), Southeast (São Paulo, Cotia, Campinas, Belo Horizonte, Rio de Janeiro), Midwest (Brasilia, Taguatinga), Northeast (Fortaleza, Recife, Salvador), North (Belém, Manaus).

HbA1c measurements

HbA1c was measured in a central laboratory by an ion-exchange high-performance liquid chromatography method (reference range 4.7–6%) certified by the National Glycohemoglobin Standardization Program and calibrated to the Diabetes Control and Complications Trial standard.

Statistical analyses

The five regions were compared in terms of clinical variables and HbA1c results by one-way analysis of variance (with Bonferroni post hoc test) and χ^2 tests. The characteristics of patients were evaluated according to glucose control (median HBA1c), region of origin and self-reported ethnic background. Prevalence ratio (PR) and 95% CI were obtained by Poisson regression analyses to determine the association of different factors with HbA1c >8% (dependent variable). Adjustment was made taking into account independent variables selected based on their significance on univariate analyses and/or biological relevance (age, diabetes duration, ethnicity, living with partner, working status, insulin use, SBGM and geographic region).

Variables were expressed as mean±SD, number of cases (%) and median (25–75 IQ intervals). HbA1c was also described as median. Statistical analyses were carried out using SSPS V.18.0. p Values less than 0.05 (two tailed) were considered significant.

RESULTS

A total of 5750 patients with type 2 diabetes were included and the main characteristics were: age of 61 ±10 years, diabetes duration of 11±8 years and BMI 28.0 ±5.3 kg/m^2. Most patients were women (66%), non-white (56%) and lived with a partner (59%). One-third (33%) had completed 8 years of formal education, 20% were employed and 37% were not physically active. Regarding treatment, 1% did not follow any kind of treatment for diabetes, 6% were on diet alone, 57% were taking oral agents, 22% used oral agents and insulin and 13% insulin alone. Mean HbA1c was 8.6±2.2% and median was 8.1% (IQR 6.9–9.9%). HbA1c <7% was found in only 26% of the patients.

Since the majority of the included patients had a poor glycaemic control we decided to compare the characteristic of patients grouped according to median HbA1c (8%). Table 1 describes clinical characteristics and PR (CI 95%) of patients with HbA1c ≥8% and <8%. In unadjusted model, patients with HbA1c ≥8% were younger, non-whites, with longer DM duration, more sedentary, mainly from North and Northeast regions and treated more frequently with insulin than patients with HbA1c <8%. After adjustment, DM duration (1.015 (1.012 to 1.018)), insulin use (1.710 (1.624 to 1.802)) and being from Northeast region (1.197 (1.085 to 1.321)) was associated with HbA1c ≥8%. On the other hand, age (0.986 (0.983 to 0.989)), white ethnicity (0.931 (0.883 to 0.981)) and living in the Midwest region (using the South region as reference; (0.858 (0.745 to 0.989))) were protective factors. In order to further explore the variables associated with HbA1c ≥8% we performed stratified analysis according to geographic region, ethnicity and insulin use. An online

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Table 1 Prevalence of patients' characteristics according to HbA1c ≥8%

	HbA1c <8% N=2791	HbA1c ≥8% N=2959	PR (95% CI)	p Value	Adjusted PR (95% CI)*	p Value
Age (years)	62±11	60±10	0.991 (0.989 to 0.993)	0.000	0.986 (0.983 to 0.989)	0.000
Diabetes duration (years)	9±8	12±8	1.018 (1.015 to 1.021)	0.000	1.015 (1.012 to 1.018)	0.000
BMI (kg/m^2)	28.0±5.1	28. 0±5.4	0.999 (0.994 to 1.004)	0.640	–	–
Females	1824 (65)	1972 (67)	0.972 (0.922 to 1.026)	0.304	–	–
White	1339 (48)	1199 (40)	0.862 (0.818 to 0.907)	0.000	0.931 (0.883 to 0.981)	0.007
Living with a partner	1613 (58)	1762 (59)	1.035 (0.983 to 1.089)	0.189	1.006 (0.959 to 1.057)	0.796
≥8 years of formal education	933 (41)	967 (48)	0.987 (0.932 to 1.044)	0.646	–	–
Active worker	527 (19)	609 (21)	0.949 (0.893 to 1.009)	0.094	1.053 (0.989 to 1.212)	0.109
Ever participate in a diabetes education program†	318 (11)	387 (13)	0.929 (0.865 to 0.999)	0.047	–	–
Diabetes treatment				0.000	–	–
None	48 (2)	23 (1)	0.522 (0.346 to 0.786)			
Diet only	285 (10)	58 (2)	1.302 (0.928 to 1.827)			
Oral agents	1905 (69)	1390 (47)	2.300 (1.641 to 3.224)			
Oral agents and insulin	318 (11)	930 (32)	2.176 (1.551 to 3.055)			
Insulin alone	228 (8)	545 (18)				
Insulin use	546 (20)	1475 (50)	1.834 (1.749 to 1.924)	0.000	1.710 (1.624 to 1.802)	0.000
SBGM	1838 (66)	2158 (73)	1.186 (1.118 to 1.1258)	0.000	1.061 (1.001 to 1.1.23)	0.045
Geographic region				0.000		0.000
North	135 (5)	177 (6)	1.225 (1.073 to 1.399)		1.137 (0.996 to 1.298)	
Northeast	814 (29)	1092 (50)	1.212 (1.212 to 1.365)		1.197 (1.085 to 1.321)	
Midwest	194 (7)	154 (5)	0.956 (0.842 to 1.109)		0.858 (0.745 to 0.989)	
Southeast	1357 (49)	1285 (43)	1.050 (0.951 to 1.159)		0.959 (0.871 to 1.056)	
South	291 (10)	251 (8)				

*Poisson regression adjusted for: age, diabetes duration, ethnicity, living with partner, working status, insulin use, SBGM and geographic region.
†Data not available for North region (not included in the adjusted analysis).
BMI, body mass index; PR, prevalence ratio; SBGM, self-blood glucose monitoring.

supplementary table shows unadjusted and adjusted analyses applying the same multivariate model using a cut-off of HbA1c <7%. The differences between the groups of patients with HbA1c <7% and ≥7% did not differ substantially from the results using the cut-off of HbA1c <8%.

The characteristics of the patients stratified by region are described in table 2. Mean HbA1c was higher (p<0.01) in the North (9.0±2.6%) and Northeast (8.9 ±2.4%) than in the Midwest (8.1±2%), Southeast (8.4 ±2.1%) and South (8.3±1.9%) regions. Moreover, the five regions differed in all other evaluated characteristics. Patients living in the Northeast had the highest prevalence of non-whites, the lowest BMI and the highest frequency of employed individuals.

Characteristics of patients according to self-reported ethnicity (white and non-white) are described in table 3. Non-white patients had higher HbA1c values, lower BMI and more years of formal education than white patients. They were also younger, more often female and single.

Of the 5750 patients in this study, 35% (2021 patients) used insulin. Of these, 33% (n=658) used insulin once daily, 58% (n=1154) twice daily and 9% (n=189) three times a day or more. Eighty-one per cent (n=1630) of the insulin users performed SBGM, but only 421 (26%) did it on a daily basis. Patients who performed more frequently SBGM had lower values of HbA1c (at least once daily: 9.3±2.1%) than those who did not measure capillary glucose (9.7±2.3%; p=0.008).

CONCLUSIONS

In this study, most patients with type 2 diabetes attending the public healthcare system in Brazil had HbA1c levels above the recommended target, that is, above 7%. Being non-white and from the northeast, as well as the longer diabetes duration, and insulin use were factors associated with poor metabolic control, whereas age and being from the Midwest were associated with HbA1c <8% (median HbA1c level for this population). To the best of our knowledge, this is the largest surveillance study to assess glycaemic control in Brazil using a certified method to measure HbA1c. We also may consider that the present study included a representative sample of patients with type 2 diabetes living in the urban areas and attending the public healthcare system in Brazil.

In the current survey we chose to use the cut-off value of HbA1c 8% to compare patients with different glycaemic control. The recommended target for HbA1c is below 7%, but it has been recently recommended to individualise the goal of HbA1c.[5] Since only 26% of our patients achieved this target, we adopted a more representative cut-off value (median HbA1c value of our study

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Table 2 Characteristics of patients with type 2 diabetes according to the five geographic regions of Brazil

	North	Northeast	Midwest	Southeast	South	p Value
N	312	1906	348	2642	542	—
HbA1c (%)	9.0±2.6	8.9±2.4	8.1±2.0	8.4±2.1	8.3±1.9	<0.01*
Age (years)	58±10	61±11	60±11	61±10	62±10	<0.01†,‡
Diabetes duration (years)	10±8	10±8	11±8	11±9	11±9	0.029
BMI (kg/m^2)	29.0±5.5	27.2±5.0	27.7±5.2	28.2±5.3	29.1±5.3	<0.01‡,§,¶
Females	193 (62)	1317 (69)	245 (70)	1726 (65)	315 (58)	<0.01**
White	71 (23)	560 (29)	131 (38)	1311 (50)	465 (86)	<0.01**
Living with a partner	199 (64)	1099 (58)	185 (53)	1537 (58)	355 (66)	<0.01††
≥8 years of formal education	140 (45)	521 (27)	106 (30)	1011 (38)	122 (27)	<0.01‡‡
Active worker	112 (36)	341 (18)	65 (19)	482 (18)	136 (25)	<0.01§§
Sedentary	134 (43)	670 (35)	147 (43)	1005 (38)	168 (31)	<0.01¶¶
Diabetes treatment						
None	2 (1)	18 (1)	7 (2)	38 (1)	6 (1)	<0.01**
Diet only	14 (5)	145 (8)	31 (9)	138 (5)	15 (3)	
Oral agents	172 (59)	1172 (62)	180 (52)	1426 (54)	345 (64)	
Oral agents and insulin	67 (23)	332 (17)	64 (18)	660 (25)	125 (23)	
Insulin alone	37 (12)	239 (12)	66 (19)	380 (15)	51 (9)	

Data are mean±SD or number of patients with the characteristic (%).
*North and Northeast versus Midwest, Southeast and South.
†North versus Northeast, Southeast and South.
‡Midwest and Southeast versus South.
§North versus Northeast and Center-West.
¶Northeast versus Southeast and South.
**Linear-by-linear association.
††Higher in North and South; lower in Midwest.
‡‡Higher in North; lower in Northeast and South.
§§Higher in North and South; lower in Northeast and Southeast.
¶¶Higher in North and Midwest; lower in Northeast and South.
BMI, body mass index.

Table 3 Demographic and clinical characteristics of patients with type 2 diabetes according to ethnicity

	White N=2538	Non-white N=3208	p Value
HbA1c (%)	8.3±2.1	8.8±2.3	<0.01
Age (years)	62±10	60±10	<0.01
Diabetes duration (years)	11±9	11±8	0.06
BMI (kg/m^2)	28.2±5.2	27.8±5.3	0.003
Females—n (%)	1615 (64)	2178 (68)	<0.01
Living with a partner—n (%)	1568 (62)	1805 (56)	<0.01
At least 8 years of formal education—n (%)	803 (38)	1094 (41)	0.011
Active worker—n (%)	520 (21)	616 (19)	0.227
Sedentary—n (%)	904 (36)	1220 (38)	0.072
Diabetes treatment—n (%)			0.007
None	37 (2)	34 (1)	
Diet only	151 (6)	192 (6)	
Oral agents	1498 (59)	1794 (56)	
Oral agents and insulin	533 (21)	714 (22)	
Insulin alone	314 (12)	459 (15)	
Geographic region—n (%)			<0.01
North	71 (23)	241 (77)	
Northeast	560 (29)	1344 (71)	
Midwest	131 (38)	217 (62)	
Southeast	1311 (50)	1329 (50)	
South	465 (86)	77 (14)	

Data are mean±SD, number of patients with the characteristic.
BMI, body mass index; HbA1c, glycated haemoglobin.

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population). Nevertheless, we also performed an analysis using the cut-off of HbA1c <7% and the results did not change.

Diabetes control varies in different countries. In the USA, mean HbA1c among middle-aged adults was approximately 7.3%.[9] Patients with type 2 diabetes using oral agents to treat diabetes in seven European countries had similar glycaemic control (mean HbA1c 7.2%).[10] However, in the EURIKA,[11] a study performed in 12 European countries, only 36.7% of patients with type 2 diabetes achieved the goal of HbA1c <6.5%. In the present study, mean HbA1c (8.6±2.2%) was much higher than that observed in these countries, and only 26% of our patients had HbA1c below the 7% goal.

In our study, a broad range of HbA1c levels were also observed across Brazilian regions. The poor glycaemic control observed in the Northeast than the other regions might be explained by a diverse ethnic and economic background. Numerous studies show ethnic disparities in HbA1c values; a meta-analysis has reported that African-Americans had absolute HbA1c values 0.65% higher than non-Hispanic whites.[12] According to the Brazilian Geography and Statistics Institute, 23.6% of the population in the North and 28.9% in Northeast are white, versus 41.7% in the Midwest, 56.7% in the Southeast and 78.5% in the South.[13] In our study, the difference in HbA1c between whites and non-whites was about 0.5%. Regarding the role of economic status, *per capita* income is almost twice as high in the South than in the Northeast.[14] In this sense, a European surveillance of socioeconomic predictors of mortality has demonstrated an association between low income[15] and higher mortality in men with type 2 diabetes.

Free, universal healthcare has been available to all Brazilian citizens since 1988,[6] including free access to many drugs. Metformin, sulfonylureas and insulin are distributed in primary care units and drugstores around the country. However, other medications used to treat diabetes are not covered. Also, SBGM devices are not freely supplied. Therefore, although our Public Health System may represent an advance in healthcare, it has not been enough to reach glycaemic control targets in diabetes care. Other measures are highly necessary, and should include a structured diabetes education programme,[16] public policies to improve adherence to diet and exercise, and free access to SBGM, at least to all patients on insulin.[5]

The present study has limitations. First, surveillance was based on self-reported answers, although medical records were consulted when available. Second, only patients attending the public healthcare system were evaluated and it is known that almost one-fourth of the Brazilian population rely on private healthcare.[17] Finally, due to its cross-sectional design, our study was able to identify associations between several factors and glycaemic control, but was unable to pinpoint risk factors. It is also important to remember that reverse causality is always possible in cross-sectional studies, and poor glycaemic control in patients using insulin cannot be attributed to insulin prescription per se. As insulin is generally prescribed to patients with more severe diabetes, the health status of these patients may also account for their poor glycaemic control. We may consider that only patients with diabetes living in urban areas could represent a potential limitation. However we can speculate that patients from the rural areas of our country, who attend primary care units less equipped and with less trained healthcare personnel, may have even poorer diabetes control.

In conclusion, Brazilian patients with type 2 diabetes attending the public healthcare system have poor glycaemic control as demonstrated by HbA1c values far above the recommended target. New strategies are necessary to improve glycaemic control in this population. Furthermore, the increased vulnerability of Northeast residents and non-white patients to poor metabolic control should be taken into account when designing strategies to control diabetes.

Contributors LVV and CBL were responsible for the logistics of data and blood sample collections in the North and Northeast, analyses of data and writing the manuscript, CKK analysed data, ATNZ worked as a research assistant, DLJ collected the data and blood samples in the North, JF collected the data and blood samples in the Northeast, ABV and ARC were responsible for the data and blood sample collections in the Southeast and Midwest, MJA and JLG were responsible for the data collection in the South, idealising and reviewing the manuscript.

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Competing interests None.

Patient consent Obtained.

Ethics approval The protocol was approved by the Ethics Committee at Hospital de Clínicas de Porto Alegre and at each participating centre/clinic.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

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