HbA1c and Blood Pressure Levels in Type 2 Diabetes: How Many Patients are on Target?

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Research

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Abstract

Background: Achieving HbA1c and blood pressure targets is an important strategy for preventing chronic vascular complications in diabetes. The aim of this paper was to determine the proportion of type 2 diabetes patients who meet the recommended HbA1c and arterial blood pressure targets and the determinants of failure to do so.

Methods: A cross-sectional study was conducted in an outpatient endocrine clinic at a university hospital. HbA1c was measured with a certified HPLC method, with a goal of 7%, except for patients with advanced chronic complications where 8% was the goal. Blood pressure was measured with a validated device after a 5-minute rest, and the overall expected target was 140/90 mmHg.

Results: A total of 602 type 2 diabetes patients were analyzed: 62% were female, 14% self-reported as black, the mean age was 63 ± 11 years, the mean diabetes duration was 17 ± 9 years, and the median (IQR) HbA1c was 8.0% (7.0-9.5%). Macrovascular disease was present in 198 (33%) patients, diabetic retinopathy in 283 (47%), peripheral neuropathy in 258 (43%) and diabetes kidney disease in 337 (56%). Regarding metabolic control, 403 (67%) patients were not at the adjusted target HbA1c level, and the main determinants of poor glycemic control were female gender, black skin color, younger age, and insulin use. Regarding blood pressure, 348 (58%) patients were not at the recommended targets, and a more advanced age was the main associated factor.

Conclusions: Since more than half of Brazilian type 2 diabetes outpatients do not meet the recommended HbA1c and blood pressure target values, there is a major call to overcome therapeutic inertia and treat to target each individual patient. Female, black and younger individuals seem to be associated with a worse glycemic profile.

Background

Diabetes mellitus (DM) is one of the most prevalent chronic diseases, with alarming rates in a number of countries. According to the International Diabetes Federation, in 2019 the global prevalence of DM was 463 million adults and estimated to reach 700 million by 2045, an increase of 51% (1). Brazil is the fifth leading country in diabetes cases, with a prevalence of 16.8 million adults (1). One of the first Brazilian multicenter studies to evaluate the prevalence of DM in adults was conducted between 1986 and 1988 (2). In a sample of approximately 22,000 individuals aged 30–69 years, the occurrence of type 2 diabetes was around 8%, similar to that of more developed countries (2). A further Brazilian study observed an increase in self-reported DM from 3.3% in 1998 to 5.3% in 2008 (3). The prevalence seems to be rising, as indicated in the baseline data of a Brazilian cohort of 15,000 civil servants aged 35–74 years (the ELSA study): the prevalence of type 2 diabetes between 2008–2010 was 19.7% (4).

Global mortality attributable to DM has been estimated at 5 million people aged between 20 and 99 years (5). Cardiovascular disease is the most common cause of death among diabetic patients, along with end-stage renal disease, this last comprising 20–40% of these patients (5,6). The most important

interventions for reducing the onset and/or progression of all diabetic chronic complications are the appropriate control of blood pressure and glucose levels, besides beneficial specific drug therapies, such as renin-angiotensin-aldosterone blockers, glucagon-like peptide 1 receptor agonists and sodium-glucose cotransporter 2 inhibitors (7).

Glycemic management is primarily assessed with the HbA1C test, which was the chosen parameter in clinical trials when studying the benefits of improved glycemic control. According to 2020 ADA guidelines, an HbA1c target of < 7% is a reasonable goal for most adults, while a more restrictive target of < 6.5% is indicated for patients at lower risk of hypoglycemia (8,9). On the other hand, a higher goal of 8% is reserved for patients with advanced diabetes complications, history of severe hypoglycemia, limited life expectancy or extensive comorbid conditions (8).

According to the Global Diabetes Plan, the three essential components of diabetes care are treatment and clinical monitoring to achieve glycemic and metabolic control, self-management education and support, and prevention and management of complications (10). Maintaining adequate glycemic and blood pressure control is the most effective treatment for the management and prevention of chronic complications.

The aim of this study was to investigate the proportion of type 2 diabetes patients who meet the target HbA1c and arterial blood pressure levels and to determine the factors associated with the failure to do so.

Methods

Patients

This cross-sectional study evaluated 602 type 2 diabetes patients consecutively examined at the outpatient endocrinology clinic of a university hospital (Hospital de Clínicas de Porto Alegre). Type 2 diabetes was defined as DM diagnosed after 30 years of age, with no prior ketoacidosis and no insulin used for the first 5 years after diagnosis. In doubtful cases, it was confirmed by negative anti-GAD antibodies and elevated C-peptide levels.

Methods

Data on age, skin color, diabetes duration, and current medications were recorded. DM treatment was classified as diet alone or diet plus oral agents, or both in combination with insulin. The patients' weight and height were measured while shoeless and wearing light clothing, and body mass index (BMI) was calculated based on these measurements (weight/height^2 ; kg/m^2). Blood pressure was measured after a 5-minute rest using a validated Omron device.

Laboratory evaluation

HbA1c was measured with certified high-performance liquid chromatography, glucose was measured with the hexokinase method, and total cholesterol, HDL and triglycerides were measured with enzymatic

colorimetric methods. LDL was calculated with the Friedewald equation. Serum creatinine was measured with the compensated Jaffe method, and the glomerular filtration rate (GFR) was estimated with the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) Eq. (11). Urinary albumin excretion (UAE) was measured twice in a random sample using immunoturbidimetry.

Assessment of diabetic chronic complications

Diabetes kidney disease (DKD) was defined as a low estimated GFR ($< 60 \text{ mL/min/1.73 m}^2$) and/or UAE $> 14 \text{ mg/L}$ (6,12). Diabetic retinopathy was evaluated by direct fundoscopy. Peripheral neuropathy was defined as a lack of sensitivity in at least one point in the 10 g-monofilament test or as the presence of symptoms. Peripheral arterial disease was defined as lack of a palpable lower-limb pulse. Cardiovascular disease was determined through angina symptoms, ischemia by myocardial scintigraphy, prior myocardial infarction or prior coronary revascularization surgery. Cerebrovascular disease was determined through prior report or sequelae upon physical examination.

Therapeutic targets

The HbA1c target was defined according to international guidelines as $< 7\%$, whereas for patients with advanced kidney disease (defined herein as $\text{GFR} < 60 \text{ mL/min/1.73 m}^2$) and ischemic heart disease the target was set at $< 8\%$ (8,13). For blood pressure, the targets were $< 130 \text{ mmHg}$ of systolic and $< 80 \text{ mmHg}$ of diastolic blood pressure for patients with high cardiovascular risk (defined as existing atherosclerotic cardiovascular disease and/or DKD) and $< 140/90$ for the remaining patients (5,14).

Statistical analyses

The results were expressed as mean $\pm$ SD, cases (%) or median (interquartile range). In univariate analyses, continuous variables were analyzed with a t-test and dichotomous variables were analyzed with the chi-square test. The prevalence ratio (PR) and 95% CI were obtained by Poisson regression with robust variance to determine the association of different factors with uncontrolled HbA1c and blood pressure (dependent variables). Statistical analyses were carried out in SPSS V.18.0. P-values < 0.05 were considered statistically significant.

Results

A total of 602 type 2 diabetes patients were analyzed: 374 (62%) were female, the mean age was 63 ± 11 years, the mean DM duration was 17 ± 9 years and the median (IQR) HbA1c level was 8.0% ($7.0\text{--}9.5\%$); 56 (9.3%) were smokers, 84 (14%) self-reported their skin color as black and 540 (91%) had arterial hypertension.

Regarding diabetes complications, 197 (33%) had macrovascular disease, while microvascular complications included 334 (56%) patients with diabetes kidney disease, 258 (43%) with peripheral neuropathy and 283 (47%) with diabetic retinopathy (Fig. 1).

Regarding glycemic control, 403 (67%) patients were not at the target HbA1c level after individualizing goals (as defined in the methods section). This group was younger with longer disease duration and included more women, blacks and insulin users. The uncontrolled group also had higher serum cholesterol and triglyceride levels and less macrovascular disease than the well-controlled group (Table 1). Poisson multivariable regression with robust variance confirmed advanced age, female gender, black skin color and insulin use as independent factors associated with uncontrolled HbA1c (Table 2).

To understand why women were more likely to have higher HbA1c levels than men, we stratified the results by gender (Table 3). Age remained significantly lower and insulin use higher in uncontrolled patients in both genders. However, having black skin color and a longer duration of the disease was more prevalent only among off target women, while total cholesterol was higher only in men.

Table 4 shows the clinical and laboratory characteristics of type 2 diabetes patients according to blood pressure target. A total of 348 (58%) patients, even after adjusting for specific scenarios, were not at the recommended goals. The uncontrolled group had a higher age, but HbA1c, lipid profile and insulin use did not differ between the groups. Regarding the number of anti-hypertensive agents, 46% of the patients needed at least 3 medications to reach the target ($p < 0.001$). The uncontrolled blood pressure group had a higher proportion of macrovascular disease and DKD. In the multivariable analysis, higher age and the use of three or more anti-hypertensive medications remained significantly related to higher blood pressure (Table 2).

Table 1
Clinical and laboratory characteristics of type 2 diabetes patients according to
HbA1c values.

	HbA1c target		P-value
	Achieved	Not achieved	
	N = 199	N = 403	
Age (years)	65 ± 10	62 ± 11	< 0.001
Female	100 (51)	273 (68)	< 0.001
White	182 (92)	336 (83)	0.01
Smokers	18 (9)	38 (9.5)	0.97
BMI (kg/m ²)	30 ± 6	31 ± 5	0.068
Diabetes duration (years)	16 ± 10	18 ± 9	0.013
Insulin use	101 (51)	314 (78)	< 0.001
SBP (mmHg)	136 ± 20	135 ± 20	0.708
DBP (mmHg)	79 ± 11	78 ± 12	0.720
HbA1c (%)	6.7 (6.1–7.4)	8.9 (8.0–10.0)	by design
Fasting plasma glucose (mg/dL)	123 ± 43	177 ± 79	< 0.001
Total cholesterol (mg/dL)	163 ± 44	173 ± 43	0.006
Triglycerides (mg/dL)	134 (97–190)	151 (99–224)	0.033
Diabetes kidney disease	110 (55)	226 (56)	0.814
Diabetic retinopathy	91 (46)	192 (48)	0.750
Peripheral neuropathy	86 (43)	173 (43)	0.979
Macrovascular disease	98 (49)	100 (25)	< 0.001

Data presented as mean ± SD, median (interquartile range) or number of cases (%).

P value was calculated by X² or independent samples t-test.

BMI: body mass index; SBP: systolic blood pressure, DBP: diastolic blood pressure.

Table 2
Poisson regression with robust variance with target HbA1c and target blood pressure as dependent variables.

Target HbA1c				
	PR	95%CI		P-value
		Lower	Upper	
Skin color (black)	1.156	1.009	1.324	0.036
Age	0.989	0.984	0.995	< 0.001
Insulin use	1.491	1.268	1.753	< 0.001
Gender (female)	1.210	1.066	1.375	0.003
Triglycerides	1.000	1.000	1.000	0.943
Total Cholesterol	1.001	1.000	1.003	0.086
BMI	0.998	0.987	1.008	0.664
Diabetes duration (years)	1.008	1.002	1.015	0.13
Target Blood Pressure				
	PR	95%CI		P
		Lower	Upper	
Skin color (black)	1.147	0.951	1.383	0.152
Age	1.013	1.005	1.020	0.001
Gender (female)	0.960	0.829	1.111	0.581
Medications (3 or more)	1.217	1.047	1.414	0.011
BMI	1.011	0.999	1.024	0.075

PR: Prevalence ratio, BMI: body mass index, Medications: use of three or more anti-hypertensive medications.

Table 3

Clinical and laboratory characteristics of type 2 diabetes patients according to gender and stratified by achieving or not HbA1c target values.

	Men		P-value	Women		P-value
	Achieved (N = 98)	Not Achieved (N = 130)		Achieved (N = 101)	Not Achieved (N = 273)	
Age (years)	66 ± 10	62 ± 11	0.009	65 ± 10	62 ± 10	0.008
White	90 (92)	112 (86)	0.260	92 (91)	224 (82)	0.047
Smokers	11 (11)	14 (11)	0.999	7 (7)	25 (9)	0.783
BMI (kg/m ²)	29 ± 4	30 ± 5	0.209	31 ± 6	32 ± 5	0.653
Diabetes duration (years)	17.4 ± 10.6	16.7 ± 9	0.811	15 ± 9	18.2 ± 9.3	0.002
Insulin use	54 (55)	101 (78)	< 0.001	48 (48)	213 (78)	< 0.001
SBP (mmHg)	134 ± 18	133 ± 19	0.559	138 ± 21	137 ± 21	0.630
DBP (mmHg)	78 ± 10	78 ± 11	0.941	80 ± 12	79 ± 12	0.492
HbA1c (%)	6.7 (6.1– 7.3)	8.9 (7.8– 9.8)	by design	6.7 (6.3– 7.4)	9 (8-10.3)	by design
Fasting plasma glucose (mg/dL)	120 ± 43	176 ± 70	< 0.001	127 ± 42	177 ± 83	< 0.001
Total Cholesterol (mg/dL)	149 ± 36	163 ± 45	0.013	176 ± 47	177 ± 41	0.827
Triglycerides (mg/dL)	120 (82– 174)	136 (90– 241)	0.073	145 (110– 196)	153 (104– 214)	0.558

Data presented as mean ± SD, median (IQR) or number of cases (%).

P-value was calculated by X² or an independent sample t-test. BMI: body mass index; SBP: systolic blood pressure, DBP: diastolic blood pressure

Table 4
Clinical and laboratory characteristics of type 2 diabetes patients according to blood pressure values.

	Blood pressure target		P-value
	Achieved	Not Achieved	
	N = 254	N = 348	
Age	61 ± 11	64 ± 10	< 0.001
Female	157 (62)	215 (62)	0.999
White	221 (87)	296 (85)	0.644
Smokers	25 (10)	30 (8.8)	0.803
BMI (kg/m ²)	30 ± 6	31 ± 5	0.123
Diabetes diagnosis (years)	17 ± 10	17 ± 9	0.529
Insulin use	165 (65)	251 (72)	0.084
SBP (mmHg)	119 ± 10	148 ± 16	by design
DBP (mmHg)	73 ± 9	83 ± 11	by design
HbA1c (%)	7.9 (7-9.1)	8.2 (7-9.7)	0.069
Fasting plasma glucose (mg/dL)	137 (102–183)	144 (112–196)	0.054
Total Cholesterol (mg/dL)	170 ± 41	172 ± 74	0.724
Triglycerides (mg/dL)	142 (98–212)	144 (99–203)	0.582
Diabetes kidney disease	104 (41)	233 (67)	< 0.001
Retinopathy	112 (44)	171 (49)	0.345
Neuropathy	99 (39)	160 (46)	0.185
Macrovascular	62 (25)	136 (39)	< 0.001

Data presented as mean ± SD, median (IQR) or number of cases (%).

P-value was calculated by X² or an independent sample t-test. BMI: body mass index; SBP: systolic blood pressure, DBP: diastolic blood pressure.

Discussion

In the present study, 67% of the type 2 diabetes outpatients were above internationally recommended personalized HbA1c levels and 58% were above target blood pressure levels. In contrast, in National Health and Nutrition Examination Survey (NHANES) cross-sectional data from 2013 to 2016, only 36% of adults with diabetes did not meet individualized A1C target levels, with a mean HbA1C of 7.5%, and just 30% did not achieve recommended blood pressure control (15). Nevertheless, similar to our findings, a meta-analysis of observational studies including North-America, Europe and Asia populations, demonstrates that 64% of type 2 patients did not meet HbA1c goals (16). Alike our findings, this meta-analysis describes that lower age, a higher proportion of females and non-Caucasians were all associated with a higher failure rate of achieving glycemic control.

While only 35% of diabetes-related health expenditure is spent in low- and middle-income countries, 87% of diabetes-related deaths occur there (1). Improved glycemic control in diabetes is associated with a lower risk of diabetes complications and reduced all-cause and cardiovascular mortality (17). In patients with type 2 diabetes, an HbA1c level outside the target range was found to be the strongest predictor of stroke and acute myocardial infarction, the main cause of death in this population (18). Nevertheless, the HbA1c target should be individualized according to a number of factors, such as age, diabetes duration, comorbid conditions, life expectancy, risk of hypoglycemia, and patient adherence/preference. According to international consensus, an HbA1c level < 7% is recommended for non-pregnant adults, while 7.0–8.0% is suggested for patients with co-morbidities or advanced age (8,9,13,19). HbA1c targets of 7.5–8% were suggested in the most recent International Diabetes Federation clinical practice recommendations (1). Stricter HbA1c goals, such as 6.5%, are suggested for selected patients if they can be attained without significant hypoglycemia or other adverse effects (19). In our study, a less stringent HbA1c target of up to 8% was considered for patients with stage III DKD and ischemic heart disease (10). It has not been consistently shown that intensive glycemic control to HbA1c levels < 7% reduces clinical microvascular and macrovascular events or death (20). Moreover, lowering HbA1c requires more anti-hyperglycemic medications at higher doses, which can lead to more adverse events (21,22). Thus, personalizing glycemic goals in DM patients should include consideration of the benefits and hazards of pharmacotherapy.

In our cohort, patients not in the HbA1c target range were mostly women, younger and black and were more frequently insulin users. In NHANES sample, younger age (18–44 years), female sex, and nonwhite adults with diabetes, presented worse glycemic control over the study period (15). Manicardi et al. (23) observed that women were 33% more likely to have higher HbA1c levels than men in a sample of type 1 diabetes patients (23). A study of type 2 diabetes patients found similar results, with women reaching HbA1c targets less often than men (24). It does not seem that our findings can be explained by differences in treatment or BMI between genders, since they were not significantly different. The access to the health service does not seem to be responsible either, since our sample is composed mostly of women and global diabetes-related health expenditure seems to be slightly higher in women than in men (1). Instead, these results could be related to a sex difference in carbohydrate metabolism during exercise, since women oxidize more lipids and less carbohydrates as a metabolic substrate than men (25). In addition, prior research has demonstrated sex differences in drug response regarding pharmacodynamic

and pharmacokinetic factors (26). Although it is tempting to speculate that lifestyle elements, such as the amount and type of physical activity could also be involved, we did not collect such data.

Younger age has also been associated with worse glycemic control in diabetes in other studies (27–31). Individuals developing type 2 diabetes at an earlier age seem to represent a different phenotype that requires more aggressive interventions to achieve glycemic control (29). Rozenfeld et al. found older adult patients with type 2 diabetes to have improved adherence to antidiabetic medications (30). A 10% increase in adherence to oral antidiabetic medications was associated with a 0.1% decrease in HbA1c, when controlled for baseline HbA1c and therapy regimen (30).

Another clinical characteristic that affected glycemic control included the use of insulin. Patients with type 2 diabetes who require insulin, alone or in combination with oral antidiabetic medications, consistently have higher HbA1c values than those taking no medication or oral medications only (16,28,32). Furthermore, sustained poor glycemic control was observed in patients with diabetes taking more medication of any kind (31). Insulin use could represent disease severity to some extent (27).

Regarding skin color, a sub-analysis of the Action to Control Cardiovascular Risk in Diabetes (ACCORD) trial showed that patients who failed to reach the HbA1c target were more likely to be black and on insulin therapy, which agreed with our results (33). It is important to point out that some studies suggest that black subjects have higher HbA1c levels than whites, which could not be related to glycemic control itself, but rather to differences in HbA1c glycation patterns. Although our black patients presented higher HbA1c, their fasting plasma glucose levels were similar. A meta-analysis that included non-diabetic subjects found that HbA1c levels were around 4.7% higher in blacks than whites (34). These results are similar to those of previous studies in diabetic patients, which indicated a 0.65% higher HbA1c level in African Americans than in non-Hispanic whites (35). Such ethnic disparities could be explained by genetic and/or environmental factors. One study has claimed that socioeconomic factors are the main cause of this disparity (36). However, other studies have reported that genetic variants may be responsible for increasing or reducing the enzyme activity in HbA1c metabolism, which consequently affects HbA1c levels, possibly with distinct patterns in different races (37). Although we did not collect data on socioeconomic status in our cohort, this was probably not the major explanation for the discrepancy, since only black women had higher HbA1c.

Regarding blood pressure goals, 58% of the patients in our cohort did not meet the target levels, despite adjustment for cardiovascular risk status. These patients were older and had a higher prevalence of ischemic heart disease, stroke and DKD, which could reflect the difficulty of achieving the stricter goals required for these specific groups or that they indeed had a previous past of worse blood pressure control. In a 2014 cross-sectional analysis of patients in a Belgium hospital, Camara et al. (38) found that approximately 68% of type 2 diabetes patients had SBP levels > 130 mmHg (38). In our study, BP control was defined according to recent ADA and ESC/AHA/ACC guidelines, with desirable BP values < 140/90 mmHg, except for patients with high cardiovascular risk and DKD, when < 130/80 mmHg was recommended (39,40). Although optimal BP targets are still under discussion, it has been demonstrated

that lowering BP levels in hypertensive type 2 diabetes patients is definitely beneficial (18,41). A meta-analysis found a significantly lower risk of mortality, cardiovascular events, coronary heart disease, and heart failure in DM patients whose baseline SBP was ≥ 140 mmHg and then reduced 10 mmHg with treatment (41). Additionally, lowering a baseline SBP ≥ 130 mmHg by 10 mmHg was associated with a lower risk of stroke, albuminuria and retinopathy (36). In patients with DKD, the recommended goals of SBP < 130 mmHg and DBP < 80 mmHg helped prevent macrovascular and microvascular outcomes (42,43). Accordingly, we defined our BP cut-off points based on these findings, requiring stricter values for patients with DKD.

In our cohort, the patients who did not achieve the BP control goals were older. This finding could be explained by certain theories. First, the definition of hypertension in the general population is the same for any age category. However, several important studies have claimed that SBP and, mainly, DBP goals should not be the same for people over 75 years of age (44,45). In this subset of patients, SBP and DBP targets of < 150 mmHg and < 90 mmHg, respectively, are recommended. According to the Brazilian Cardiology Society, it would be safer to keep the SBP goal around < 150 mmHg rather than 140 mmHg in older adults to avoid the consequences of hypotension (39,40,46). However, since the benefits of more restricted targets are undeniable, even for older people, we did not make distinctions for advanced age (45). The ADVANCE study (Action in Diabetes and Vascular disease: Preterax and Diamicron-MR Controlled Evaluation) investigated older hypertensive type 2 diabetes patients in a specific sub-analysis (42). The authors emphasized that adequate hypertension treatment in individuals > 65 years of age (i.e. reducing SBP by approximately 5.6 mmHg in a sample with a baseline mean BP of 145/81 mmHg) led to a corresponding reduction in the risk of mortality and major macrovascular and microvascular complications, mainly albuminuria (42). However, this study may have analyzed a sample of healthier diabetic patients, since the ADVANCE study did not include type 2 diabetes patients on long-term insulin therapy (47). We decided not to adapt the BP goals in our cohort according to age.

Regarding diabetic chronic complications in our population, it was observed that 56% had DKD, 47% had retinopathy, 43% had peripheral neuropathy, and 33% had macrovascular disease. These numbers seem to be on the high end of the most recent International Diabetes Federation data, in which the reported prevalence of diabetic peripheral neuropathy ranged from 16–66% and the prevalence of any retinopathy was 35% (1). Likewise, there was a high prevalence of DKD and cardiovascular disease in our sample, since global statistics show ranges of 12–55% and 12–31.7%, respectively, for these complications (1,48,49). Patients at the target HbA1c levels had a higher prevalence of macrovascular disease. The possible explanations are that this group was older and that the adopted HbA1c target for patients with previous ischemic heart disease or stroke were higher, facilitating this sub-sample to achieve HbA1c target. In addition, patients with macrovascular disease might have more intense health care attention due to these higher risk conditions. On the other hand, patients in the uncontrolled blood pressure group had a higher prevalence of ischemic heart disease or stroke and DKD. These results could be explained by the fact that poor lifelong blood pressure control resulted in kidney damage, but also that impaired kidney function indeed interferes with blood pressure control.

Limitations: Since we evaluated cross-sectional data, the results are snapshots of diabetes care during the survey periods. Our study was conducted in a specialized tertiary health center involving patients with a predictable worse glycemic and blood pressure control, since those with good results are discharged to primary care units. Furthermore, for the same reason, the prevalence of chronic complications is overrepresented. Therefore, it reflects a specific setting. An additional limitation was that data on physical exercise and socioeconomic profile were not collected, and this limits the interpretation of the results regarding the ethnic and gender differences found in the analysis. More distinct mechanisms and associations still remain to be clarified.

Strengths: Data was collected from the expressive number of 602 outpatients, for about 5 years, in a number of well-characterized categories that involved diagnosis and monitoring of diabetes and its complications, following a comprehensive and standardized protocol. Thus, our large sample was able to identify specialized care figures and comorbidity risks with great reliability. There have been few studies on the profile of diabetic patients that involved so many variables in our geographic area.

Conclusions

In conclusion, since more than half of the type 2 diabetes patients in this Brazilian cohort were not at target glycemic and blood pressure levels, there is a major call to overcome therapeutic inertia and treat to target for an individual patient. Our study confirmed that certain predictive factors can influence this setting, and focused strategies to help patients with these clinical characteristics are essential to better achieve glycemic targets and reduce the burden of diabetes related co-morbidities.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Ethics Committee (GPPG# 140073).

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no conflict of interest.

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Authors' contributions

CBF, SC, LB and CKD acquired the data and drafted the manuscript. FS and TZ interpreted the data and reviewed the manuscript. SPS designed the study, interpreted the data and reviewed the manuscript. All authors read and approved the final manuscript.

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Figures

Figure 1

Prevalence of microvascular (diabetes kidney disease, diabetic retinopathy and neuropathy) and macrovascular complications in type 2 diabetes patients.