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ORIGINAL ARTICLE

Relationship between health care insurance status, social determinants and prevalence of diabetes-related microvascular complications in patients with type 1 diabetes: a nationwide survey in Brazil

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Abstract

Aims To evaluate the relationship between social determinants, health care insurance status and occurrence of diabetes-related chronic complications (DRCC) in Brazilian patients with type 1 diabetes.

Methods A multicenter cross-sectional study conducted between August 2011 and August 2014 in 14 public clinics in 10 Brazilian cities. Data were obtained from 1760 patients, aged 29.9 ± 11.9 years, with diabetes duration of 15.5 ± 9.3 years; 55.9% female, 54.5% Caucasians, 69.7% were attended exclusively by the public Brazilian National Health Care System (BNHCS) and 30.3% had also private health care insurance. Patients' information was obtained through a questionnaire and a chart review form.

Results The social determinants associated with having both private and public health care insurance were being employed, belonging to medium or high socioeconomic status, having more years of school attendance and having younger age. Regarding DRCC, patients that had private and public health care had lower rates of diabetic retinopathy and of any other DRCC. Chronic kidney disease was not associated with health care coverage status after adjusting for classical clinical risk factors.

Conclusions Brazilian patients with type 1 diabetes had better clinical control and lower rates of DRCC, mainly retinopathy, when also having private health care insurance. These patients presented less frequently predictors of chronic complications such as high levels of HbA1c and blood pressure. BNHCS should change the approach for screening DRCC such as diabetic retinopathy, using methods such as telemedicine that would lead to earlier diagnosis, better outcomes and will be cost-effective sometime after its implementation.

Keywords Type 1 diabetes · Microvascular chronic complications · Health care insurance · Retinopathy

Introduction

Type 1 diabetes (T1D) and its complications became an important health problem and a financial burden due to its high rates of morbidity and mortality which cause an increase in its costs [1–8]. Zhang et al. evaluating health care expenditure on diabetes, estimated that in 2010 about 12% of the world's health budget was spent on the treatment of people with diabetes, and that by 2030, an extra 35% increase will occur [6].

An adequate glycemic control can avoid or postpone diabetes-related chronic complications (DRCC) as has been shown previously [9, 10]. The occurrence of short- and long-term complications is influenced by several factors including

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educational and socioeconomic status [11], age, gender and probably the type of health care insurance status [12]. Data regarding the association between health care insurance status and glycemic control are contradictory, with better glycemic control found in some studies among people with private insurance, compared with those receiving public health care [12, 13]. Another study, conducted in the US, has found an association between poor glycemic control and lack of health care coverage [14]. However, Lotstein et al. evaluating 185 adolescent patients with T1D, found a threefold increase in the odds of worsening glycemic control when they were transferred to adult care, that was not associated with health care insurance status [15].

It is important to know to what extent both public and private health insurance invest in prevention, monitoring, treatment and reduction of DRCC rates through its regular screening [16, 17]. In the presence of chronic diseases such as diabetes, the care model delivered both by public and private insurances should go beyond physical health and reach the social sphere in order to attend the most vulnerable populations (minorities and people from lower socioeconomic status) [13, 17].

Rates of health care utilization and treatment access for diabetes-related adverse outcomes are variable among the studies, and most of them have been conducted with patients with type 2 diabetes, with public or private health care. In Brazil, the majority of the population depends on the Brazilian National Health Care System (BNHCS), that delivers health care to every citizen, free of charge, and only 22.7% of the population has also private health care [18]. The Exchange Study, was also conducted with T1D patients, although 75% of them had private insurance [19].

This study aimed to evaluate the relationship between social determinants, health insurance status and the occurrence of DRCC in patients with T1D in Brazil. Data obtained in this study will help guide public and private insurance companies to improve diabetes care as a whole, in Brazil.

Research design and methods

This was a cross-sectional, multicenter study conducted between August 2011 and August 2014 at 14 public clinics, located in ten Brazilian cities. Research design and methods have been detailed previously [4, 20]. Briefly, each clinic provided data of at least 50 outpatients with T1D, ≥ 13 years old, attended in these centers for at least 6 months. Our sample included 1760 patients diagnosed with T1D between 1960 and 2014 (Supplementary material, sections 1 and 2). This study was approved by the ethics committee of each center. Written informed consent was obtained from all patients.

The following variables were assessed: current age, age at diagnosis, diabetes duration, years of school attendance, frequency of self-monitoring of blood glucose (SMBG), smoking status, type of prescribed insulin therapeutic regimens (ITR), self-reported adherence to diet (following at least 80% of the time the prescribed diet) [21], presence of comorbidities, last month's self-reported frequency of any hypoglycemia including severe hypoglycemia [22], employment status (yes or no), BMI and hospitalization due to any cause in the last year.

Good glycemic control was defined as HbA1c < 7.5% for adolescents and < 7% for adults [23]. Poor glycemic control was defined as HbA1c ≥ 9% (Supplementary material, section 3). HbA1c was measured using high-performance liquid chromatography (HPLC, Bio-Rad Laboratories, Hercules, California, USA). Last year's HbA1c value was the one obtained before the interview. Smoking was defined as the current use of more than one cigarette per day. ITRs were stratified as follows: exclusive use of intermediate insulin (NPH) or long-acting insulin analogs, use of intermediate/long plus short acting insulin, or use of continuous subcutaneous insulin infusion (CSII). Quality of life, was evaluated by the EQVAS from Euroqol-5D-3l questionnaire [24].

According to health care insurance status, patients were classified as those who received free health care only from the BNHCS, that guarantees free NPH and regular insulins, syringes, needles, glucometers and strips for SMBG and those who received health care both from BNHCS and private insurance plans.

Evaluation of any diabetes-related microvascular chronic complication

After examination of both eyes by mydriatic binocular indirect ophthalmoscopy diabetic retinopathy (DR) was classified as (absent, non-proliferative and proliferative). For DR severity classification, the worst eye was considered [25].

Renal function was estimated by the CKD-EPI equation [26] in adults and by the Schwartz formula in adolescents [27] and was expressed as glomerular filtration rate (GFR) in milliliters per minute per 1.73 m^2 (ml/min), after the determination of creatinine using a colorimetric assay kit (Biosystems). Albuminuria was measured twice, in a first morning urine sample after instructions. Urinary albumin dosage was made by immunoturbidimetry. Albuminuria was defined as albuminuria ≥ 30 mg/dl [28], resulting from a mean of two samples. Patients were stratified according to GFR and albuminuria as having normal renal function or chronic kidney disease (CKD) [29].

Sensitive and autonomic neuropathy were evaluated and stratified according to Moreira et al. and Vinik et al., respectively [30, 31].

Data regarding the screening of DRCC in the previous year were obtained from the medical charts.

Sample calculation and economic status definition

The sample size was based on the Brazilian Type 1 Diabetes Study Group (BrazDiab1SG) [4, 20, 32, 33] (Supplementary material, section 2). Economic status was defined according to the Brazilian Economic Classification Criteria [34] (Supplementary material, section 4). Economic status was classified as: high, middle, low and very low.

Statistical analysis

Data are presented as means (± SD) for continuous variables and numbers (relative frequencies) for discrete variables according to exploratory analysis. Independent, two-sided *t* tests, ANOVA with Sidak correction or two-sided *Z* tests, were used when indicated. We have performed four models of multivariate logistic regression: model 1 was performed with BNHCS (group A) as the only type of health care insurance, and both BNHCS and private health (group B) as dependent variables and ethnicity (Caucasian or non-Caucasian), economic status, years of school attendance, gender, employment status (yes or no) and age as independent variables; model 2 was performed with retinopathy (absent or present) as the dependent variable and ethnicity, economic status, age, years of school attendance, gender, duration of diabetes, number of SMBG performed daily, health care insurance status, GFR, presence of hypertension (yes, no) as independent variables. Model 3 was performed with CKD (present and absent) as the dependent variable with the same independent variables described in model 2, except for GFR, and model 4 was performed with any of the following DRCC (retinopathy, nephropathy, sensitive neuropathy and autonomic neuropathy) as the dependent variables without GFR as independent variable. Multivariate analysis was not performed with sensitive or autonomic neuropathy as dependent variables. These complications were considered in model 4. In all models, we used the Forward Wald stepwise logistic regression analysis and as independent variables those variables that reach a $p < 0.1$ in the exploratory analysis. The Nagelkerke R-squared value was also calculated. Analyses were performed using SPSS version 17.0 (SPSS, Inc., Chicago, Illinois). Odds ratios with 95% CIs were expressed as indicated. A two-sided *p* value less than 0.05 was considered significant.

Table 1 Clinical and socio-demographic data of the studied participants

Variable	
N	1760
Gender, female *n* (%)	983 (55.9)
Age, y	29.9 ± 11.9
< 19 y, *n* (%)	297 (16.9)
≥ 19 y, *n* (%)	1463 (83.1)
Duration of diabetes, y	15.5 ± 9.3
Age of diagnosis, y	14.7 ± 8.9
Time of follow-up, y	9.7 ± 7.6
Ethnicity, *n* (%)	
Caucasians	959 (54.5)
Non-Caucasians[a]	801 (45.5)
Economic status, *n* (%)	
High	53 (3.0)
Medium	801 (45.5)
Low	849 (48.3)
Very low	57 (3.2)
Employed, yes, *n* (%)	844 (50.2)
Public health insurance, *n* (%)	1227 (69.7)
Insulin regimens, *n* (%)	
Intermediate or long acting	86 (4.9)
Intermediate/long plus short acting	1612 (91.6)
CSII	62 (3.5)
Insulin (IU/kg)	0.86 ± 0.38

Data are presented as numbers (percentage) or means ± SD

y year, *CSII* continuous subcutaneous insulin infusion

[a]African-Brazilians, Mulattos, Asians, and Native Indians

Results

Overview of the studied population

The majority of our patients had exclusively public health insurance $n = 1227$ (69.7%). Table 1 shows the socio-demographic data, health care insurance status and the respective ITRs of the studied population.

Overview of the studied population according to health care insurance status

Clinical, demographic and laboratory data stratified according to health care insurance status are described in Table 2. Patients that used exclusively the BNHCS were older, had fewer years of school attendance, mostly non-Caucasians, from low and very low socioeconomic status and used more frequently NPH and regular insulins.

Regarding glycemic control, patients with exclusively public health care insurance used higher daily insulin doses, presented higher current and last year's levels of HbA1c and

Table 2 Clinical, demographic and laboratory data stratified by type of health insurance

Variables	Type of health insurance		*p* value
	Public	Private and public	
N (%)	1227 (69.7)	533 (30.3)	
Gender, female *n* (%)	680 (55.4)	309 (58.0)	0.3
Duration of diabetes, y	15.4 ± 9.3	15.6 ± 9.2	0.6
Age, y	30.3 ± 12.2	29.3 ± 11.2	0.07
Mean age at diagnosis, y	15.1 ± 9.2	13.7 ± 8.2	< 0.002
Follow-up, y	9.6 ± 8.1	9.5 ± 7.9	0.7
Years of study, y	11.5 ± 3.5	13.7 ± 3.8	< 0.001
Ethnicity, *n* (%)			0.007
Caucasian	642 (52.3)	316(59.4)	
Non-Caucasian[a]	585 (47.7)	217(40.7)	
Economic status, *n* (%)			< 0.001
High	10 (0.8)	43 (8.1)	
Medium	487 (39.7)	314 (58.9)	
Low	677 (55.2)	172 (32.3)	
Very low	53 (4.3)	4 (0.8)	
Diabetes treatment, *n* (%)[b]			< 0.001
NPH or NPH + regular	628 (60)	163(20.6)	
Insulin analogs (long or short acting) or CSII	419 (40)	266 (38.6)	
Insulin U//kg	0.87 ± 0.3	0.82 ± 0.4	0.01
Glycemic control			
HbA1c[c] (%), current	9.2 ± 2.2	8.5 ± 1.8	< 0.001
HbA1c (mmol/mol)	77.2 ± 24.2	69.7 ± 20.0	
HbA1c (%), last year ($n = 1530$)	9.2 ± 2.4	8.4 ± 1.8	< 0.001
HbA1c (mmol/mol)	77.2 ± 25.9	69.0 ± 20.4	
HbA1c (good), *n* (%)[c]	144 (20.2)	109 (39.1)	< 0.001
Hb1Ac (poor), *n* (%)[c]	568 (79.8)	171 (61.1)	
Hypoglycemia (severe), yes, *n* (%)	185 (20.8)	66 (15.4)	0.02
Diabetes management			
SMBG, yes, *n* (%)	1141 (93.0)	522 (97.9)	0.001
SMBG, *n*	3.5 ± 1.5	3.9 ± 1.3	< 0.001
Adherence to insulin therapy[d], yes, *n* (%)	130 (19.0)	36 (11.9)	0.005
Adherence to diet, yes, *n* (%)	611 (57.4)	292 (60.3)	0.2
Smoking status, yes, *n* (%)	73 (6.0)	19 (3.6)	0.04
Cardiovascular factors			
sBP	119.8 ± 19.1	117.6 ± 1717.7	0.02
dBP	75.7 ± 11.3	74.4 ± 10.2	0.02
BMI (kg/m^2)	24.3 ± 3.6	24.1 ± 4.3	0.3
Exercise[e], yes, *n* (%)	632(51.5)	278 (52.4)	0.7
Statin users, yes, *n* (%)	278 (22.7)	104 (19.5)	0.1
General data			
Hospitalization[f], y *n* (%)	210 (17.1)	66 (12.4)	0.01
Hospitalization, *n*	1.8 ± 1.2	1.8 ± 1.7	0.7
Cause of hospitalization			0.5
Acute complications, *n* (%)	111 (54.4)	31 (47.0)	
Chronic complications, *n* (%)	19 (9.3)	6 (9.1)	
Not related to diabetes, *n* (%)	74 (36.3)	29 (43.9)	
Clinical medical visits, *n*	3.7 ± 1.7	3.6 ± 1.7	0.7
EQ-VAS	70.6 ± 18.1	73.3 ± 15.4	0.003
Diabetes chronic complications			

Table 2 (continued)

Variables	Type of health insurance		*p* value
	Public	Private and public	
Retinopathy, yes, *n* (%) (*n* = 1644)	450 (39.2)	139 (28.0)	< 0.0001
Retinopathy absent, non-proliferative, proliferative, yes, *n* (%)			< 0.001
Retinopathy, absent, *n* (%)	698 (60.8)	357 (72.0)	
Retinopathy non-proliferative, yes, *n* (%)	329 (28.7)	88 (17.7)	
Retinopathy proliferative, yes, *n* (%)	121 (10.5)	51 (10.3)	
Fundoscopy in the last year, yes, *n* (%)	684 (56.0)	374 (70.6)	< 0.001
Nephropathy, yes, *n* (%)	331 (27.5)	104(19.4)	0.001
Any chronic complication, yes, *n* (%)	729 (59.1)	252 (47.5)	< 0.001

The data are presented as a percentage, mean ± SD

y year, *F* female, *CSII* continuous subcutaneous insulin infusion

[a]African-Brazilians, Mulattos, Asians, Native Indians

[b]For this analysis we considered *n* = 1476 patients [patients using exclusively insulin provided by the government, free of charge (NPH or regular) and those using only insulin analogs (long/short acting or CSII)]

[c]HbA1c at goal was defined as HbA1c < 7.5% (58 mmol/mol) for T1D patients between 13 and 19 years old and < 7.0% (53 mmol/mol) for adult T1D patients. HbA1c > 9.0% (75 mmol/mol) was defined as poor glycemic control; SMBG self-monitoring of blood glucose (3–4 times daily is the recommended frequency)

[d]Adherence to insulin therapy was considered the maximum adherence according to Morisky, patients using CSII were excluded

[e]Exercise was considered any type at leas two times/week

[f]Hospitalization for any cause

less frequently adequate HbA1c levels. They also showed higher frequency of severe hypoglycemia and performed less frequently daily SMBG but were more frequently adherent to the prescribed ITRs. Cardiovascular risk factors such as current smoking were more frequently found in this group that presented also higher levels of both sBP and dBP. These patients had more hospitalizations, presented lower quality of life scores and higher rates of non-proliferative retinopathy and nephropathy.

Multivariate analysis with type of health care insurance as dependent variable

A multivariate analysis was performed to evaluate the effects of years of school attendance, ethnicity, economic status, age, gender, employment status (yes or no) on the likelihood of patients having both private and public health care insurance. The adjusted model revealed that the independent variables could explain 18% (Nagelkerke R-squared) of the variance for a given patient having both private and public health care insurance. After adjustment, the independent significant variables associated with having both private and public health care insurance were: younger age, more years of school attendance, high and medium economic status and being employed. The adjusted final data are described in Table 3.

Multivariate analysis with retinopathy as dependent variable

Considering the overall sample of the 1760 patients, a total of 1644 (93.4%) performed fundoscopy and were included in this study. Among these patients, 1055 (64.2%) did not have retinopathy and 589 (35.8%) presented DR. A multivariate analysis with the presence of retinopathy as dependent variable and years of school attendance, ethnicity, economic status, age, gender, health insurance status (public and public plus private), HbA1c, number of daily SBGM, presence of hypertension and GFR was performed. The adjusted model revealed that the independent variables evaluated could explain 35.0% (Nagelkerke R-squared) of the variance for a given patient having retinopathy. After adjustment, the independent significant variables associated with having retinopathy were: longer duration of diabetes, higher levels of HbA1c, having hypertension, higher age and having only public health care insurance. Lower value of GFR was a protective factor. The adjusted final data are described in Table 3.

Multivariate analysis with chronic kidney disease as dependent variable

Considering the overall sample of the 1760 patients, a total of 1725 (98.0%) had data regarding their renal function. Of

Table 3 Multivariate analysis results of all models performed

Variables	*N*	*β*	OR	95% CI	*p* value
Model 1 (private health care insurance plus public health care vs only public health care)					
Age	1757	−0.15	0.985	0.976–0.995	0.004
Years of study	1757	0.126	1.134	1.096–1.173	< 0.001
Employment status, y	884	0.386	1.471	1.173–1.845	0.001
Employment status, no	873		Reference		
Economic status					
High	53		18.847	5.325–66.706	< 0.001
Medium	799		3.944	1.419–11.584	< 0.009
Low	848		2.100	0.738–5.977	0.165
Very low	57		Reference		
Model 2 (retinopathy vs absence of retinopathy)					
Age	1521	0.19	1.020	1.006–1.034	0.005
Duration of diabetes	1521	0.07	1.072	1.054–1.091	< 0.001
Only public health care	1047	0.424	1.527	1.166–2.001	0.002
Private health care plus public health care	479		Reference		
HbA1c	1521	0.197	1.218	1.186–1.350	< 0.001
Hypertension, y	263	0.839	2.314	1.648–3.248	< 0.001
Hypertension, no	1258		Reference		
GFR	1521	−0.011	0.989	0.984–0.994	< 0.001
Model 3 (chronic kidney disease (CKD) vs absence of CKD)					
Gender, female	910	0.366	1.441	1.122–1.851	0.004
Duration of diabetes	1613	0.044	1.047	1.033–1.061	< 0.001
HbA1c	1613	0.142	1.153	1.087–1.222	< 0.001
Hypertension, y	276	1.186	3.273	2.431–4.406	< 0.001
Hypertension, no	1337		Reference		
Economic status					
High	53	−1.871	0.154	0.049–0.488	< 0.001
Medium	746	−0.717	0.488	0.255–0.935	< 0.001
Low	766	−0.639	0.528	0.277–1.006	0.52
Very low	48		Reference		
Model 4 (presence of any diabetes-related chronic complication vs absence of any diabetes-related chronic complication)					
Age		0.065	1.028	1.013–1.043	< 0.001
Ethnicity, non-Caucasian	601	0.422	1.526	1.192–1.953	0.001
Caucasian			Reference		
Duration of diabetes			1.067	1.047–1.088	< 0.001
Only public health care insurance	904	0.335	1.398	1.074–1.821	0.013
Private health care plus public health care	399		Reference		
HbA1c	217	0.239	1.270	1.192–1.353	< 0.001
Hypertension, y	217	0.830	2.293	1.523–3.453	< 0.001
Hypertension, no			Reference		

y yes, *GFR* glomerular filtration rate

these, 435 (27.4%) were classified as having CKD. A multivariate analysis with the presence of CKD as the dependent variable and years of school attendance, ethnicity, economic status, age, gender, health insurance status (public and public plus private), HbA1c, number of daily SBGM and presence of hypertension was performed. The adjusted model revealed that the independent variables used could explain 16.4% (Nagelkerke R-squared) of the variance for a given patient having CKD. After adjustment, the independent significant variables associated with having CKD were: longer duration of diabetes, higher HbA1c levels, having hypertension, female gender. High and medium economic status were protective factors. The adjusted final data are described in Table 3.

Multivariate analysis with any microvascular diabetes-related chronic complication as dependent variable

Considering the overall sample of the 1760 patients, 1757 (99.8%) had their data analyzed. Overall, 976 patients (55.5%) had any type DRCC. A multivariate analysis with the presence of any DRCC as dependent variable and years of school attendance, ethnicity, economic status, age, gender, health insurance status (public and public plus private), HbA1c, number of daily SBGM, presence of hypertension and health insurance status (public and public plus private) was performed. The adjusted model revealed that the independent variables that were evaluated could explain 24.9% (Nagelkerke R-squared) of the variance for a given patient having any DRCC. After adjustment, the independent significant variables associated with having any DRCC were: higher age, longer duration of diabetes, higher levels of HbA1c, having hypertension, being non-Caucasian and having only public health care insurance.

Discussion

To the best of our knowledge, this is the first report that has been performed in Brazil, a medium income country, evaluating the influence of health care insurance status on DRCC. The majority of the patients who had both types of health care (public and private) insurance had more years of school attendance, were from high and medium socioeconomic classes, were employed, had lower prevalence of any type of DRCC, mainly DR. Moreover, these patients had lower HbA1c, sBP and dBP levels, lower prevalence of severe hypoglycemia, performed more frequently SMBG and were more frequently using insulin analogs and CSII.

Although health care in Brazil is delivered to every citizen, free of charge by the BNHCS, the health quality performance indicators are below desired levels, with a national average score of 5.4 in a 0–10 scale [35]. Due to excessive demand, patients can wait months or years for an appointment with a specialist and 74% of patients using BNHCS state they would like to have a private health care insurance [36].

Those who have a private health insurance have easier access to specialists, several exams and treatments which could explain some differences found in our study. However, patients with private health care prefer keeping their regular appointments at BNHCS due to the uncertainty of maintaining their health care insurance, mainly for economic reasons (66.8% of the patients have their health insurance provided by their employers which ends with the end of the employment) [18].

A lower frequency of severe hypoglycemia was found in the group with private health insurance. This probably reflects an easier access to insulin analogs, which are known to cause less hypoglycemia and were more frequently used in this group. Another study also found that patients with T1D who had private insurance had better glycemic control than those with public insurance, but this effect disappeared when the analysis was controlled for insulin regimen [37]. Despite lower reported adherence to the prescribed ITRs, which was an unexpected result in this arm of our study, lower HbA1c levels and lower hospitalization rates were found, although there was no difference in the causes of hospitalization. This group probably has a better understanding of the disease, due to higher schooling levels, and easier access to health care. These factors could contribute to an earlier demand for health services, which, associated with better glycemic control, may promote lower hospitalization rates as observed in the present study. In accordance with our findings, a recent study showed that patients that lost private health insurance presented increased HbA1c levels and needed more frequently emergency care [38].

Our study has shown that some risk factors such as longer diabetes duration, higher HbA1c and higher frequency of hypertension were more frequent in the group that had only access to public health care, which could explain at least in part why this group had also a higher frequency of DRCC, mainly DR. Our data are in accordance with those found by French et al. in Chicago, that evaluated 150,661 patients with diabetes among approximately two million patients, when the majority of those with untreated DR lived in areas where primary health care was also provided through Federally Qualified Health Centers [39].

The ADA consensus recommends the annual screening for DR [23]. However, the BNHCS does not provide ophthalmologists in the primary health care setting [40]. This does not occur in patients with private health care insurance who have easier access to ophthalmologists.

Besides that, the BNHCS reimburses very poorly procedures such as consultation and retinography [41], compared with private insurance [42] and with other countries [43].

In this scenario, other alternatives should be sought such as telemedicine, a method that is more cost-effective, allowing non-medical health professionals to perform the digital retinography and send it to reading centers, where specialists are able to classify DR and identify patients who need a specialized service [44].

When we evaluated DR in the exploratory analysis, patients in the group that had access exclusively to the public health system had a higher frequency of CKD and of other associated risk factors such as a higher HbA1c and blood pressure, compared to the group that also had private health care. However, when we performed adjustments in the multivariate analysis with CKD as the dependent variable,

the type of health care insurance did not have a significant association. A possible explanation for this lack of association could be the low cost of serum creatinine measurement. Patients can be classified as having CKD based on levels of serum creatinine, that are used to calculate the GFR, and by the measurement of albuminuria. The measurement of serum creatinine is much cheaper [45] and most patients that are treated only in the public health system, are classified as having or not CKD based only on their GFR.

The major strength of our study was the evaluation of Brazilian patients with T1D belonging to several ethnic and socioeconomic groups living in all geographic regions of the country, using a standardized protocol.

The principal limitations of our research were its cross-sectional design, no measurement of C peptide and autoantibodies and lack of information regarding the time frame each patient had private health care insurance (when this was the case). We measured albuminuria in a morning sample without the measure of urinary creatinine concentration, due to the large sample of patients and because the measurement of albumin alone is less expensive. However, it has higher levels of false-negative and false-positive results.

Conclusions

Our study showed that patients with T1D in Brazil, had better clinical control and lower rates of any DRCC, mainly DR, if they had both private and public health care insurance. In general, they presented less frequently the most important predictors of these complications such as high levels of HbA1c and blood pressure. BNHCS should change the approach for screening DRCC such as DR, using methods that could cover a greater number of patients in our vast territory, such as telemedicine, that would lead to an earlier diagnosis, better outcomes and cost-effectiveness.

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Compliance with ethical standards

Conflict of interest The authors declare they have no conflicts of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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