DOI: 10.1590/1413-81232022274.05612021

Supply and demand of procedures related to diabetes mellitus and its complications in Brazil

Jéssica Muzy (https://orcid.org/0000-0003-2526-2317) [1]
Monica Rodrigues Campos (https://orcid.org/0000-0002-7443-5977) [1]
Isabel Emmerick (https://orcid.org/0000-0002-0383-2465) [2]
Raulino Sabino (https://orcid.org/0000-0002-4027-2743) [1]

Abstract *This article aims to present a methodology for monitoring the procedures recommended in the care protocol for diabetic patients, based on the indicator of the ratio between supply and demand for exams, according to Brazil, macro-regions, federative units (FUs), and municipalities. The prevalence of diabetes mellitus (DM) and its complications were estimated using a multinomial model. The offer of DM procedures was obtained from the Ambulatory Information System (SIA/SUS) and the demand from the number of tests defined in the protocol as necessary per year, according to disease risk categories. Based on this, the supply-demand ratio indicator was created. The innovation here consists of analyzing the demand for diabetic care according to established parameters and the supply of health services together. The connection between the recommended treatment protocol and the existence of the service offered concerning the demand for care based on the prevalence of the disease provides a key monitoring tool. And, when analyzed together with the indicator of the ratio between supply and demand for procedures, these measures become a proxy for the quality of prevention and care for patients with the disease.*

Key words *Diabetes mellitus type 2, Diabetes complications, Primary health care, Medical examination, Secondary prevention*

[1] Escola Nacional de Saúde Pública Sergio Arouca, Fundação Oswaldo Cruz. R. Leopoldo Bulhões 1480 Manguinhos, 21041-210. Rio de Janeiro RJ Brasil. jehmuzy@gmail.com
[2] University of Massachusetts Medical School. Massachusetts USA.

Introduction

Diabetes *mellitus* (DM) currently stands out as an important cause of morbidity and mortality. Global estimates indicate that 382 million people are living with DM (8.3%), and that number could reach 592 million in 2035[1]. The aging of the population, the growing prevalence of obesity and sedentary lifestyle, and urbanization processes are considered to be the main factors responsible for the increase in the incidence and prevalence of DM worldwide[1–3]. DM ranks ninth among the diseases that cause loss of healthy years of life[4].

Nationally, DM is a health problem of great magnitude. In Brazil, for the year of 2013, the estimated prevalence of DM was 6,9%, being 6,5% among men and 7,2% among women[5]. In that same year, Brazil ranked fourth among the countries with the highest number of people of diabetes, with 11.9 million cases among adults[3]. This high prevalence scenario has generated high social and financial costs to the patient and the health system. Rosa *et al.*[6] estimated that DM accounted for 12% of all hospitalizations not related to pregnancy and for up to 15,4% of hospital costs in the Brazilian Unified Health System (SUS) between 2008 and 2010.

DM care is complex and involves lots of aspects beyond simple glycemic control, although this is associated with the reduction in the risk of developing both microvascular and macrovascular complications[7–10]. Among the chronic complications, diabetic retinopathy (DR), blindness due to DR, diabetic neuropathy (DN), diabetic chronic renal failure (CRF-D), diabetic foot and amputations stand out[11].

The high prevalence of DM and its complications point to the need for investments in prevention, disease control, and longitudinal care[3]. In Brazil, there is a line of care for patients with DM, which aims to strengthen and qualify care for people with this disease[10]. The Primary Care Booklet nº36 establishes the care protocol for patients with DM, listing, among other measures, a series of procedures that must be performed periodically, according to the risk classification. Among the main procedures, we highlight the dosages of glucose, cholesterol, triglycerides, glycated hemoglobin (HbA1C), creatinine and microalbumin in urine, urinalysis, funduscopy, binocular color retinography, laser photocoagulation and electrocardiogram[10].

Due to its silent nature, where 50% of people with diabetes are unaware of having the disease[2], the screening of DM patients and people at risk, through exams, is one of the main measures for prevention, early diagnosis and treatment[10]. The tracking and prevention of DM must be carried out by AB, the main gateway to SUS, which is organized municipally. Thus, it is important to have methods to assess the adequacy of the care provided to patients with diabetes, with the highest level of disaggregation possible.

Despite the aforementioned need, no methodologies were identified in the literature that would allow the monitoring of health care for people with diabetes at the desired level of disaggregation for planning AB actions. Thus, this article aims to present a methodology for monitoring the procedures recommended in the care protocol for patients with diabetes, based on the ratio indicator between supply and demand for tests, according to Brazil, macro-regions, FUs, and municipalities.

Methodology

The National Health Survey (2013) was used to obtain the self-reported prevalence of DM, by BMI, age group, and gender. Based on data from the Brazilian Institute of Geography and Statistics (IBGE) the proportion of individuals aged 25 or over who have 8 years of education or less and the GDP per capita (2012) was obtained. From this last source, the Brazilian population was also obtained, by age group and municipalities for the year 2012. The outpatient procedures recommended in the care protocol for people with diabetes[10] were obtained from the SUS Outpatient Information System (SIA/SUS), nationwide, for the triennium of 2012 to 2014.

The study period was defined according to the availability of information from the databases at the time of its execution. The PNS-2019 Chronic Diseases module became available after the writing of this article.

For the monitoring of these procedures, the indicator of the ratio between supply and demand of procedures was constructed. For this, three previous steps were necessary: (1) first, to estimate the prevalence of DM at the municipal level; (2) from the prevalence of DM, estimate the demand for procedures by people with diabetes; (3) estimate the share of procedures performed by people with diabetes and, finally, (4) estimate the ratio indicator between supply and demand of procedures for people with diabetes.

Ciência & Saúde Coletiva, 27(4):1653-1667, 2022

Estimate of the prevalence and incidence of DM and complications

The prevalence of type 2 DM by sex was estimated for Brazil by municipalities and later aggregated according to population size (small – up to 100 thousand inhabitants; medium – 100-500 thousand inhabitants; and large – more than 500 thousand inhabitants), FU, macro-regions, and country. These estimates were made from the methodology proposed by the Burden of Disease Study – 2008, a specific component of diabetes *mellitus* presented in Costa[15] and updated for 2013[16], at the level of municipalities, using a multinomial regression model.

This model has as an outcome the prevalence of eutrophic, pre-obese, and obese individuals (Less than 25,0 kg/m2, from 25 to 29,9 kg/m2, greater than or equal to 30 kg/m2, respectively), as recommended by the World Health Organization[15,19]. BMI was used considering its strong association with the prevalence of the disease in overweight and obesity cases[17,18]. Additionally, other demographic and socioeconomic factors (exposure variables) were included in the model, such as gender, age group (30 to 44 years old, 45 to 59 years old, 60 to 69 years old and 70 years old or more), education (proportion of individuals with 25 years old or more who have 8 years of schooling or less) and GDP per capita;

The coefficients of the final model were generated for the 27 states, the lowest level of disaggregation available in the sources used;

The coefficients were subsequently applied to the municipalities, using the equation of the final model and inserting the exposure variables at the municipal level, generating the respective proportions of each BMI range, according to sex, age group, in the population.

From this distribution, the number of eutrophic, overweight, and obese individuals in the municipalities, by sex and age group, was obtained;

Finally, to obtain the number of individuals with DM in the city, the prevalence of DM stratified by sex, age and BMI ranges of each macro-region from the 2013 PNS was applied to the population strata estimated above. Thus, the prevalence of DM (number of individuals with DM/population) in Brazilian municipalities was obtained.

The methodological details of the multinomial model and its steps are found in annex 2 of the Logbook for the calculation of the Global Burden of Disease[20].

The complications of DM (prevalence and incidence) were also estimated by sex just for the country as a whole, using the definitions of Lopez[14], which are: neuropathy, retinopathy and blindness and incidence of diabetic foot, amputations and necropathy (chronic kidney failure due to DM).

Estimated demand for procedures by people with diabetes

The demand for each procedure for people with diabetes was estimated based on the number of tests defined as necessary per year, in the diabetes patient care protocol, according to disease risk categories, which are: no risk (5%), low (20%), medium (50%), high (20%) and very high (5%)[10]. Each type of exam has a specific demand according to risk classification. The DM prevalences estimated in the previous step were multiplied by the proportions of each risk category and then applied to the population. So we find the number of people with diabetes by each risk category. Then, the population with diabetes, according to risk, was multiplied by the respective number of annual procedures, by type, as recommended in the protocol. Thus, the estimated number of annual procedures, by type (demand), is obtained.

Estimate of the offer of procedures related to DM

Data regarding to the "offer of DM-related outpatient procedures" were obtained from the SUS Outpatient Information System (SIA/SUS), nationwide, from 2012 to 2014. The identification of the two procedures from the SIGTAP – SUS Table of Procedures, Artifacts, Practices and Materials (OPM) and Medicines Management System – using ICD-10, which are: P1. Glucose dosage; P2. Total cholesterol dosage; P3. HDL cholesterol dosage; P4. LDL cholesterol dosage; P5. Triglyceride dosage; P6. Glycated hemoglobin dosage; P7. Creatinine dosage; P8. Analysis of physical characteristics, elements and sediments in urine; P9. Microalbumin dosage in urine; P10. Fundoscopy; P11. Binocular color retinography; P12. Laser photocoagulation; P13. Electrocardiogram. Furthermore, in estimating the supply of procedures, it was necessary to perform an extrapolation to obtain the total number of procedures performed in the public (SUS) and private (non-SUS) sectors. For this purpose, a correction factor was estimated from the relationship between the number of births in SINASC and SIH/SUS, applied to the number of procedures performed in SUS[16].

Due to its high coverage, the number of births registered at SINASC was used as a proxy for universal coverage (both public and private). The proportion of births performed in the private sphere was identified according to municipalities, and this proportion was applied to exams as an extrapolation factor.

The "apportionment of these tests" was estimated to identify the portion performed by people with and without diabetes, considering parameters obtained through a literature review[21], estimates of research on the subject (PNS, 2013; National Program for Improving Access and Quality of Primary Care (PMAQ-AB) and data from the National Supplementary Health Agency (ANS). Prorating allows you to estimate the number of tests attributable exclusively to people with diabetes, providing a more accurate measure. Details of the apportionment can be seen in Table 2. It is noteworthy that this stage of the process was carried out only for macro-regions, due to the unavailability of parameters for the smaller scope of the analysis. Further methodological details can be found in the PMA report[16].

Ratio between supply and demand of procedures for people with diabetes: monitoring indicator

The supply-demand ratio indicator shows how many times more (or less, if < 1) procedures are performed among people with diabetes, given the predefined need (demand).

$$\text{Ratio} = \frac{\begin{array}{c}\text{Offer of exam X}\\ \text{for people with diabetes}\end{array}}{\begin{array}{c}\text{Demmand of exam X}\\ \text{for people with diabetes}\end{array}}$$

This indicator was estimated by municipalities and later aggregated (average) by population sizes (municipalities), FUs, macro-regions, and Brazil. An ordering of this indicator was carried out to show the maximum values found by municipalities.

Results

Having the innovative methodology presented in this article as focus, which relates the offer and the demand of care facing the prevalence of the disease, the necessary components for its calculation will be presented. They are: estimated prevalence, the volume of procedures offered and demanded by people with diabetes, and the proportion of procedures attributable to people with diabetes.

The prevalence of DM and the incidence/prevalence of complications, according to sex, FU, region, and municipal size (small, medium, and large) were presented in Table 1. The prevalence of DM was 9,22% for the country, being 8,14% for males and 10,21% for females. The prevalence according to regions ranged from 6,25% (North) to 12,83% (Southeast).

In the Northeastern region, it was found that half of the FUs had 7% of its inhabitants had diabetes (Maranhão, Piauí, Ceará, Rio Grande do Norte, and Paraíba), and the other FUs in the region had a prevalence of around 18% (Pernambuco, Alagoas, Sergipe, and Bahia). In the Southeastern region, all FUs have a prevalence of approximately 8%, except for São Paulo, which reaches 17%. The chronic complications with the highest prevalence was neuropathy (3,0%) and retinopathy (1,8%), and the one with the highest incidence was the diabetic foot (0,3%).

The volume of procedures offered and demanded by people with diabetes, the proportion of procedures attributable to people with diabetes (apportionment), and the ratio between supply and demand of procedures, according to the regions of the country, are shown in Table 2. The procedure with the greatest demand was the measurement of glycated hemoglobin, totaling 25 million exams for Brazil. The most offered tests in the country were the ones of basic biochemistry, especially urine tests (31 million) and glucose dosage (30 million).

Using specific parameters for the apportionment of tests performed by people with and without diabetes, based on the PNS data, it was observed that the regions with the lowest prevalence of DM (Southern and Midwestern regions) had the lowest apportionment parameter, that is – a lower proportion of tests offered to people with diabetes, except for the Northern region, which presented the lowest prevalence of DM in the country, but offered tests to patients with diabetes in the same proportion as regions with higher prevalence.

Binocular color retinography (P11) and laser photocoagulation (P12) procedures presented demand in the order of 10 million and 2 million, respectively. However, the performance was only 3% and 7%. Due to the clear insufficiency, it was decided not to analyze these procedures.

Ciência & Saúde Coletiva, 27(4):1653-1667, 2022

Table 1. Prevalence of Diabetes Mellitus (DM) by region and sex according to sex and population size of municipalities and prevalence/incidence of complications caused by DM. Brazil, 2013.

Scopes	Male (%)	Female (%)	Total (%)
Brazil	8,14	10,21	9,22
Size of municipality			
Small	8,17	10,20	9,19
Medium	7,91	9,90	8,98
Large	8,11	10,40	9,37
North	5,41	7,11	6,25
Rondônia	5,47	6,82	6,13
Acre	5,40	7,03	6,22
Amazonas	5,19	6,76	5,97
Roraima	5,27	6,49	5,86
Pará	5,45	7,34	6,39
Amapá	5,01	6,43	5,72
Tocantins	5,85	7,53	6,68
Northeast	9,53	14,65	12,24
Maranhão	5,47	8,15	6,85
Piauí	5,71	8,66	7,26
Ceará	5,65	8,72	7,28
Rio Grande do Norte	5,51	8,62	7,16
Paraíba	5,78	9,17	7,60
Pernambuco	11,21	17,29	14,50
Alagoas	13,81	21,22	17,76
Sergipe	13,79	21,06	17,66
Bahia	13,76	21,04	17,57
Southeast	12,63	13,01	12,83
Minas Gerais	8,36	8,72	8,55
Espírito Santo	7,92	8,22	8,08
Rio de Janeiro	8,34	8,85	8,61
São Paulo	16,70	17,06	16,89
South	6,89	7,43	7,18
Paraná	6,36	6,89	6,64
Santa Catarina	6,05	6,77	6,42
Rio Grande do Sul	7,87	8,29	8,09
Midwest	6,24	8,85	7,58
Mato Grosso do Sul	6,66	9,34	8,03
Mato Grosso	6,20	8,61	7,38
Goiás	6,49	9,11	7,83
Distrito Federal	5,21	8,10	6,77
Complications by DM			
Neuropathy	2,57	3,40	3,00
Retinopathy	1,55	2,04	1,80
Blindness	0,02	0,02	0,02
Diabetic foot (incidence)	0,37	0,20	0,28
Amputation (incidence)	0,04	0,02	0,03
Nephropathy (incidence)	0,02	0,01	0,01

Source: Authors based on a multinomial model.

Basic biochemistry procedures (P1; P2; P3; P4; P5; P7 and P8), in general, presented a ratio in the range between 47% and 62% of offer for people with diabetes.

Glycated hemoglobin (P6) has a lower supply than demand in the entire country, with the worst scenario in the Northern and Northeastern regions, where not even 10% of the demand is met. The procedures for measuring microalbumin in urine (P9), fundoscopy (P10), and electrocardiogram (P13) present almost all of all of their offer aimed at people with diabetes in all regions; the ratio for the electrocardiogram being around 85%. Fundoscopy, specifically in the Northern region, has a lower apportionment for people with diabetes than in other regions (80,9%)

Regarding the ratio between supply and demand for procedures, in general, basic biochemistry tests had higher values in all regions (around 3 for Brazil). For tests such as urine analysis and glucose dosage, the values reach 7,2 and 5 respectively in the Northern region.

The Northeastern region stands out negatively for the lowest reason, with supply below demand for most procedures, while the other regions present a ratio greater than two. This region showed the greatest variation in prevalence among the FUs. The fundoscopy exam (P10) in the Northern region had a similar ratio to the regions with the highest offer (0,4), although the apportionment is not 100% for people with diabetes.

The ratio between supply and demand for procedures in sizes and regions is shown in Table 3. This ratio, regardless of region, varies in proportion to its size, that is – the larger the size, the greater the ratio, except for LDL cholesterol, urine analysis in SE and fundoscopy in CO.

In general, for all investigated procedures, the medium-sized performs twice the quantity of tests as the small-sized, considering their demand. The large-sized performs more procedures than the medium-sized in almost every region, with almost 50% more, except for the Northeast and Southeast regions, where the medium and large-sized are similar regardless of the procedure.

It was noticed a low performance of tests related to the development of nephropathy (P9. microalbumin in urine: ratio = 0,14 for Brazil), being the worst relation between supply and demand among all of the investigated procedures in almost all scopes, except for the large ones in the Southern region (0,69). Then we have fundos-

Table 2. Supply and demand of procedures (Pr) for people with diabetes, proportion of procedures attributable to people with diabetes (apportionment) and ratio between supply and demand by regions. Brazil, 2013.

Region		P1	P2	P3	P4	P5	P6
NO	**Prevalence of DM = 6,25**						
	Estimated demand of DM Pr	481.929	341.366	341.366	341.366	341.366	963.857
	% of Pr offer to DM on SUS	56,2	58,4	58,4	58,4	58,4	96,6
	Total offer of DM Pr*	2.401.702	1.453.405	804.976	759.804	1.347.372	130.771
	Ratio supply/demand	5,0	4,3	2,4	2,2	3,9	0,1
NE	**Prevalence of DM = 12,24**						
	Estimated demand of DM Pr	3.578.149	2.534.522	2.534.522	2.534.522	2.534.522	7.156.298
	% of Pr offer to DM on SUS	54,5	56,6	56,6	56,6	56,6	96,1
	Total offer of DM Pr*	5.435.656	3.801.751	2.369.933	2.229.438	3.320.939	538.738
	Ratio supply/demand	1,5	1,5	0,9	0,9	1,3	0,1
SE	**Prevalence of DM = 12,83**						
	Estimated demand of DM Pr	6.584.095	4.663.734	4.663.734	4.663.734	4.663.734	13.168.190
	% of Pr offer to DM on SUS	56,2	58,4	58,4	58,4	58,4	97,4
	Total offer of DM Pr*	15.860.128	10.828.245	8.480.672	6.311.229	9.928.540	4.619.869
	Ratio supply/demand	2,4	2,3	1,8	1,4	2,1	0,4
SU	**Prevalence of DM = 7,18**						
	Estimated demand of DM Pr	1.252.983	887.529	887.529	887.529	887.529	2.505.965
	% of Pr offer to DM on SUS	47,0	47,6	47,6	47,6	47,6	96,7
	Total offer of DM Pr*	4.030.397	2.779.918	2.029.903	1.358.537	2.533.756	1.063.047
	Ratio supply/demand	3,2	3,1	2,3	1,5	2,9	0,4
CO	**Prevalence of DM = 7,58**						
	Estimated demand of DM Pr	522.089	401.607	381.527	381.527	401.607	1.253.056
	% of Pr offer to DM on SUS	56,2	62,1	100,0	80,9	83,1	96,4
	Total offer of DM Pr*	1.184.142	2.884.981	70.575	156.552	417.24	287.387
		2,3	7,2	0,2	0,4	1,0	0,2

it continues

copy (P10) concerning diabetic retinopathy and blindness, which is the second among the least offered procedures, with a ratio of 0,35 in the country. As for microalbumin, there is a slightly better situation for the large size of the Southern region.

Table 4 shows the average ratio between supply and demand and the maximum ratio of procedures by municipality, according to regions and municipal size (P1; P6; P7; P8; P10 and P13). The methodology used allows the identification of municipalities with maximum values for the ratio between supply and demand when compared to the average ratio for the region, according to specific procedures. It appears that there is less fluctuation between the values obtained in the large size when compared to the small size.

Figure 1 shows the volume of procedures (completion of the map in grayscale) and their respective ratios between supply and demand (circumference diameters) according to FU. In general, one can see the differences in the supply and demand ratio according to the type of exam and FU. The lowest ratio values for all exams are found in the Northern and Northeastern regions. From the intensity of the background color on the maps, it can be inferred that there is a very low volume of measurement of glycated hemo-

Ciência & Saúde Coletiva, 27(4):1653-1667, 2022

Table 2. Supply and demand of procedures (Pr) for people with diabetes, proportion of procedures attributable to people with diabetes (apportionment) and ratio between supply and demand by regions. Brazil, 2013.

Region						
NO	**Prevalence of DM = 6,25**	3.876.328	2.981.791	2.832.701	2.832.701	2.981.791
	Estimated demand of DM Pr	54,5	61,6	100,0	100,0	83,3
	% of Pr offer to DM on SUS	2.959.564	5.289.349	82.614	333.340	1.820.428
	Total offer of DM Pr*	0,8	1,8	0,0	0,1	0,6
	Ratio supply/demand					
NE	**Prevalence of DM = 12,24**	7.132.770	5.486.746	5.212.409	5.212.409	5.486.746
	Estimated demand of DM Pr	56,2	62,0	100,0	100,0	84,1
	% of Pr offer to DM on SUS	12.392.479	15.439.016	535.624	1.402.852	6.503.414
	Total offer of DM Pr*	1,7	2,8	0,1	0,3	1,2
	Ratio supply/demand					
Region	**Prevalence of DM = 12,83**	**1.357.398**	**1.044.152**	**991.945**	**991.945**	**1.044.152**
SE	**Estimated demand of DM Pr**	47,0	61,9	100,0	98,6	83,7
	% of Pr offer to DM on SUS	3.008.316	4.312.923	215.553	560.635	1.763.025
	Total offer of DM Pr*	2,2	4,1	0,2	0,6	1,7
	Ratio supply/demand					
	Prevalence of DM = 7,18	678.739	522.107	496.001	496.001	522.107
SU	**Estimated demand of DM Pr**	48,3	62,0	100,0	100,0	83,9
	% of Pr offer to DM on SUS	1.586.402	2.968.991	90.074	181.413	853.535
	Total offer of DM Pr*	2,3	5,7	0,2	0,4	1,6
	Ratio supply/demand	3.008.316	4.312.923	215.553	560.635	1.763.025
	Prevalence of DM = 7,58	2,2	4,1	0,2	0,6	1,7
CO	**Estimated demand of DM Pr**					
	% of Pr offer to DM on SUS	678.739	522.107	496.001	496.001	522.107
	Total offer of DM Pr*	48,3	62,0	100,0	100,0	83,9
	Ratio supply/demand	1.586.402	2.968.991	90.074	181.413	853.535
	Razão oferta/ demanda	2,3	5,7	0,2	0,4	1,6

* From the total volume of procedures performed in SUS, the correction factor for SUS and non-SUS expansion and the apportionment percentage were applied to estimate the use among diabetics.

DM procedures according to protocol: P1. Glucose dosage; P2. Total cholesterol; P3. HDL cholesterol dosage; Q4. LDL cholesterol dosage; Q5. Triglyceride dosage; P6. Glycated hemoglobin dosage; P7. Cretinine dosage; P8. Analysis of physical characteristics, elements and sediments in urine; P9. Microalbumin dosage in urine; P10. Fundoscopy; P11. Binocular color retinography; Q12. Laser photocoagulation; Q13. Electrocardiogram.

Note: procedures P11 (Binocular color retinography) and P12 (Laser photocoagulation) presented demand of 10 million and 2 million, respectively, while the performance was only 3% and 7% considering that all the performances were among diabetics. Thus, given the clear insufficiency, it was decided not to analyze these procedures.

Source: Authors.

globin (P6) and fundoscopy (P10) in most of the FUs in the country. There is a better distribution of less complex tests in the territory, such as glucose dosage (P1) and urine analysis (P8).

Discussion

The findings of this study reinforce the potential of the methodology for monitoring and evaluating compliance with the care protocol for pa-

Table 3. Ratio between supply/demand for procedures among people with diabetes, in regions, according to municipal size and kind of procedure. Brazil, 2013.

Region	Size	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P13
NO	P	4,23	3,72	1,60	1,54	3,42	0,09	1,61	6,77	0,15	0,06	0,71
	M	5,24	4,33	2,65	2,25	4,03	0,08	2,53	6,77	0,27	0,34	1,32
	G	6,98	5,64	4,13	4,07	5,33	0,33	3,87	8,81	0,17	1,26	1,62
	Total	4,98	4,26	2,36	2,23	3,95	0,14	2,27	7,18	0,18	0,41	1,04
NE	P	1,25	1,32	0,64	0,60	1,10	0,03	0,45	1,54	0,01	0,15	0,38
	M	1,90	1,84	1,36	1,24	1,66	0,11	1,08	2,35	0,04	0,48	0,78
	G	1,96	1,76	1,40	1,35	1,63	0,17	1,33	2,05	0,07	0,63	1,05
	Total	1,52	1,50	0,94	0,88	1,31	0,08	0,76	1,77	0,03	0,12	0,61
SE	P	2,43	2,43	1,66	1,45	2,24	0,20	1,32	2,83	0,05	0,45	1,30
	M	2,96	2,96	2,37	2,09	2,63	0,43	2,16	3,58	0,11	0,86	1,55
	G	2,78	2,55	2,14	1,21	2,36	0,51	2,34	3,00	0,17	0,80	1,19
	Total	2,41	2,32	1,82	1,35	2,13	0,35	1,74	2,81	0,10	0,27	1,19
SU	P	2,58	2,66	1,66	1,05	2,36	0,20	1,37	3,01	0,07	0,32	1,04
	M	3,74	3,53	2,79	1,90	3,20	0,52	2,78	5,11	0,28	0,50	2,37
	G	4,57	4,08	3,66	2,60	4,02	1,11	4,45	6,50	0,69	1,75	2,84
	Total	3,22	3,13	2,29	1,53	2,85	0,42	2,22	4,13	0,22	0,57	1,69
CO	P	2,87	2,67	1,31	1,13	2,28	0,05	1,24	4,55	0,01	0,14	1,25
	M	3,96	3,54	3,07	2,74	3,17	0,24	1,95	5,52	0,25	1,06	1,99
	G	5,60	4,33	3,73	2,87	3,95	0,47	4,08	7,53	0,40	0,79	2,13
		3,96	3,37	2,43	2,00	3,01	0,23	2,34	5,69	0,18	0,37	1,63
Brazil		3,22	2,92	1,97	1,60	2,65	0,24	1,86	4,32	0,14	0,35	1,23

DM procedures according to protocol: P1. Glucose dosage; P2. Total cholesterol dosage; P3. HDL cholesterol dosage; Q4. LDL cholesterol dosage; Q5. Triglyceride dosage; P6. Glycated hemoglobin dosage; P8. Analysis of physical characteristics, elements and sediments in urine; P9. Microalbumin dosage in urine; P10. Fundoscopy; Q13. Electrocardiogram.
Municipal size: S= <100 thousand inhab.; M= 100 a 500 thousand inhab.; L = >500 thousand inhab.

Source: Authors.

tients with diabetes, considering the indicator of the ratio between supply and demand for procedures. It is noteworthy that this methodology is reproducible and opportune for studies of adequacy of care, and since it allows its application to other diseases that have necessary procedures defined, enabling the detection of possible distortions in the supply.

The innovation presented here consists of jointly analyzing the demand of care for patients with diabetes according to established parameters and the supply of health services. The connection between the recommended treatment protocol and the existence of service offered concerning the demand for care based on the prevalence of the disease as a monitoring tool. And, when analyzed together with the indicator of the ratio between supply and demand for procedures, these measures become a proxy for the quality of prevention and care for patients with the disease.

It is noteworthy that the use of data from the PNS-2013 allowed the creation of a baseline for this indicator, which can be compared with estimates based on more recent research, such as the PNS-2019, made available after the execution of this study.

The prevalence of DM estimated in this study was similar to the one found by Malta *et al.* (2019), based on the examination of glycated hemoglobin and self-reported diagnosis, which was 9,4[22]. The variation in prevalence according to sex was also similar, with 10,8 (10,2) in the model) for the female population and 7,8 for the male population (8,1 in the model)[22]. The parity between the results obtained here and the current literature demonstrates the robustness of the methodological model.

The prevalence according to regions found in this study presented a different structure from the one estimated by Malta *et al.*[22] from the hemoglobin test and use of medications. A possible expla-

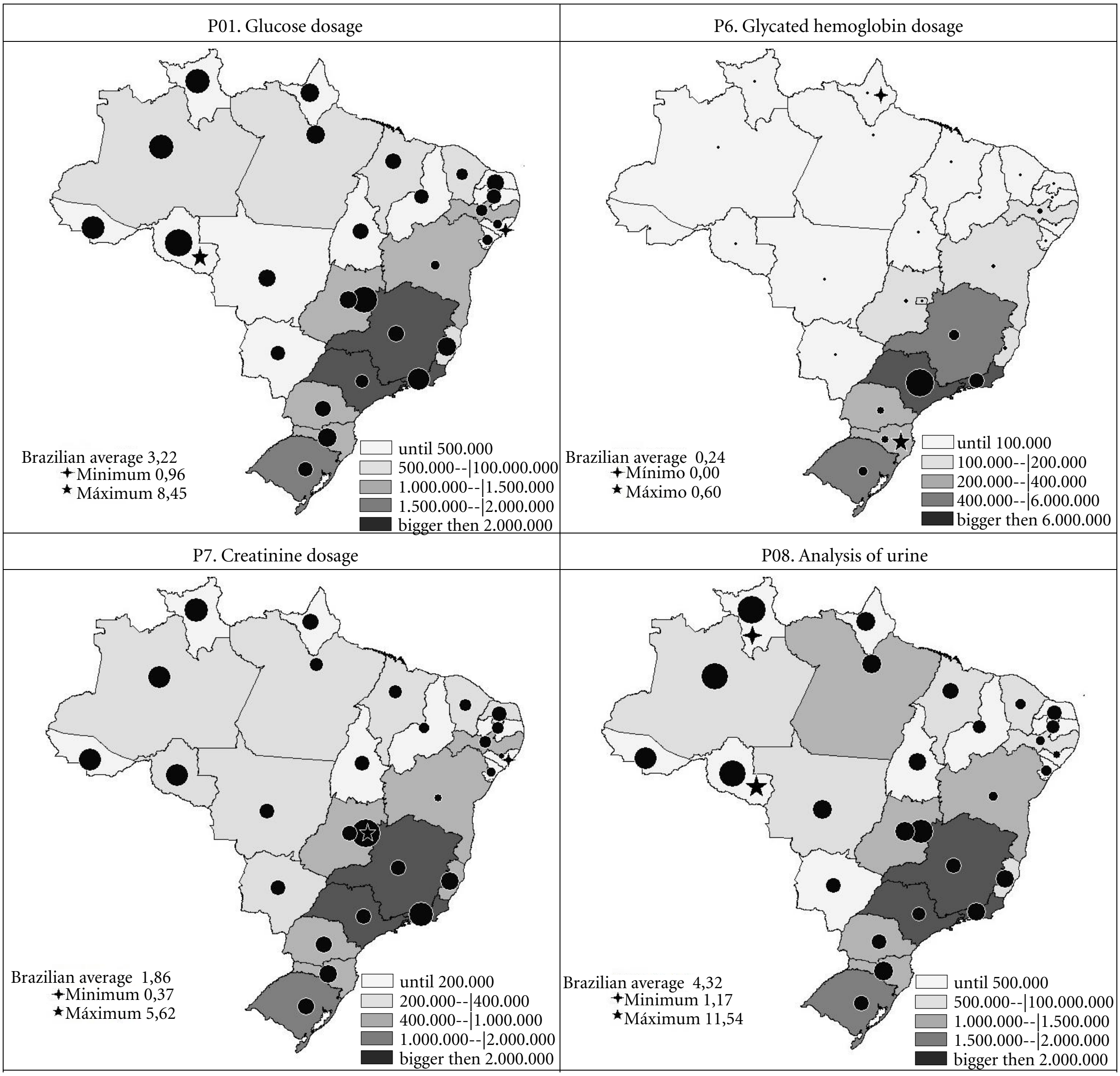
Ciência & Saúde Coletiva, 27(4):1653-1667, 2022

Table 4. Average ratio between supply and demand for procedures in the regions and maximum ratio per municipality, according to municipal size. Brazil, 2012-2014.

Region	Proc.	Average ratio of the region	Small sized	Ratio	Medium sized	Ratio	Large sized	Ratio
NO	P1	4,98	Itapiranga (AM)	30,27	Tucuruí (PA)	9,99	Manaus (AM)	9,17
	P6	0,14	Borba (AM)	1,95	Parauapebas (PA)	0,28	Manaus (AM)	0,51
	P7	2,27	Itapiranga (AM)	10,80	Rio Branco (AC)	6,51	Manaus (AM)	5,58
	P8	7,18	Acará (PA)	59,27	Parauapebas (PA)	16,57	Manaus (AM)	12,24
	P10	0,41	Porto Nacional (TO)	2,02	Parintins (AM)	1,51	Belém (PA)	1,92
	P13	1,04	Vilhena (RO)	6,30	Altamira (PA)	5,76	Manaus (AM)	2,28
NE	P1	1,52	Fartura do Piauí (PI)	17,96	Sobral (CE)	6,48	São Luís (MA)	4,94
	P6	0,08	Maracaçumé (MA)	1,58	Bacabal (MA)	1,33	Recife (PE)	0,32
	P7	0,76	Bento Fernandes (RN)	12,39	Sobral (CE)	3,57	São Luís (MA)	3,08
	P8	1,77	Brejo de Areia (MA)	24,92	Sobral (CE)	8,31	Lastro (PB)	6,32
	P10	0,12	Independência (CE)	4,39	Campina Grande (PB)	2,39	Recife (PE)	0,78
	P13	0,61	Brejo de Areia (MA)	16,84	Sobral (CE)	4,54	São Luís (MA)	2,38
SE	P1	2,41	Lindóia (SP)	20,84	Angra dos Reis (RJ)	21,09	São Gonçalo (RJ)	11,69
	P6	0,35	Cristália (MG)	2,90	Volta Redonda (RJ)	1,99	Duque de Caxias (RJ)	0,96
	P7	1,74	Quissamã (RJ)	14,78	Angra dos Reis (RJ)	11,75	São Gonçalo (RJ)	4,91
	P8	2,81	Lindóia (SP)	27,84	Angra dos Reis (RJ)	19,68	Duque de Caxias (RJ)	6,73
	P10	0,27	Lindóia (SP)	9,71	Betim (MG)	4,60	Nova Iguaçu (RJ)	1,32
	P13	1,19	Américo Brasiliense (SP)	15,01	Araruama (RJ)	9,77	Uberlândia (MG)	2,40
SU	P1	3,22	São João do Sul (SC)	18,22	Itajaí (SC)	8,81	Londrina (PR)	5,02
	P6	0,42	Cruzmaltina (PR)	4,72	Itajaí (SC)	1,84	Londrina (PR)	1,24
	P7	2,22	Joaçaba (SC)	9,36	Araucária (PR)	6,41	Porto Alegre (RS)	5,47
	P8	4,13	Joaçaba (SC)	19,43	Araucária (PR)	13,31	Londrina (PR)	8,27
	P10	0,57	Três de Maio (RS)	15,88	Passo Fundo (RS)	3,17	Londrina (PR)	5,73
	P13	1,69	Campina Grande do Sul (PR)	9,84	São José (SC)	26,44	Porto Alegre (RS)	3,55
CO	P1	3,96	Portelândia (GO)	19,43	Anápolis (GO)	5,96	Brasília (DF)	7,31
	P6	0,23	Nova Veneza (GO)	1,08	Águas Lindas de Goiás (GO)	0,92	Goiânia (GO)	0,54
	P7	2,34	Chapadão do Céu (GO)	9,04	Anápolis (GO)	3,14	Brasília (DF)	5,62
	P8	5,69	Chapadão do Céu (GO)	41,27	Formosa (GO)	11,99	Goiânia (GO)	8,65
	P10	0,37	Água Fria de Goiás (GO)	8,03	Águas Lindas de Goiás (GO)	7,04	Brasília (DF)	0,89
	P13	1,63	Campinaçu (GO)	10,69	Várzea Grande (MT)	6,24	Goiânia (GO)	3,32

DM procedures according to protocol: P1. Glucose dosage; P6. Glycated hemoglobin dosage; P7. Creatinine dosage; P8. Analysis of physical characteristics, elements and sediments in urine; P10. Fundoscopy; Q13. Electrocardiogram. Municipal size: Small = <100 thousand inhabitants; Average = 100 to 500 thousand inhabitants; Large = 500 thousand inhabitants.

Source: Authors based on data from the Ambulatory Information System (SIA/SUS).



it continues

Figure 1. Ratio between supply and demand and volume of procedures among people with diabetes, by type of procedure, according to FU. Brazil, 2012-2014.

nation is the different access to diagnosis, which leads to regions with better socioeconomic status and access to health services. The variations in the prevalence of regions and FU estimated by the multinomial model were consistent with those obtained from the self-reported prevalence obtained in the PNS, although this one is at a lower level[23], since self-report does not consider the population with diabetes, but the population which has not been diagnosed yet.

Ciência & Saúde Coletiva, 27(4):1653-1667, 2022

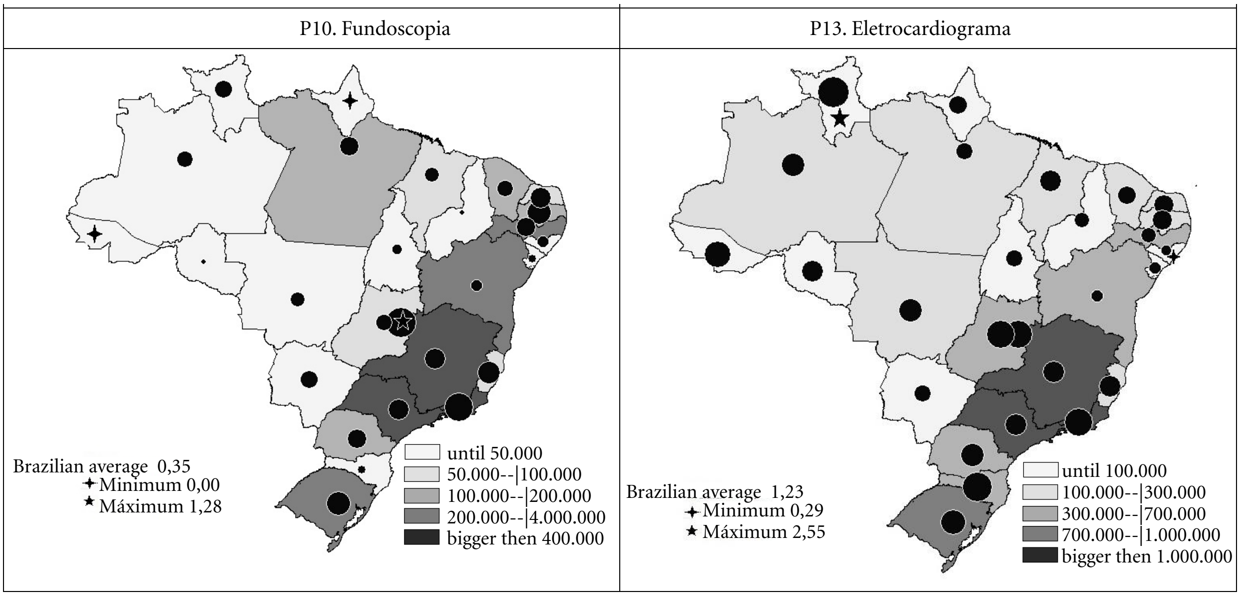


Figure 1. Ratio between supply and demand and volume of procedures among people with diabetes, by type of procedure, according to FU. Brazil, 2012-2014.

Circle: Corresponds to the ratio between supply and demand for procedures among diabetics
Gray scale: corresponds to the volume of procedures performed among diabetics

Source: Authors based on data from the Ambulatory Information System (SIA/SUS).

The performance of procedures falls far short of what is established in the care protocol for people with diabetes[10]. It is recommended that blood glucose fasting and HbA1C tests to be performed at least twice a year and the other tests at least once a year, increasing the frequency according to the severity of the patient[10]. As in Muzy *et al.*[24], there was low performance of specific exams related to the most prevalent chronic complications of DM, contrasting with the high performance of basic biochemistry procedures.

Although the prevalence of DM did not vary by population size, the performance of procedures, measured by the ratio between supply and demand, showed differences. The increased in the ratio was directly proportional to the size (the medium size performs twice as many tests as the small, and the large size performs about 50% more than the medium size). That shows that although the prevalence of DM is similar, the care provided to patients varies according to the size. The gaps in diabetes care can lead to the lack of control of the disease and, with that, the development of complications, loss of quality of life, and even death[15,24]. The differentials found in size may be related to the greater availability of resources and the consequent greater offer of health services in larger municipalities, as observed by Salazar (2017) regarding the portfolio of services offered and adequacy to the DM protocol by UBS[25].

In the FUs of the Northeastern region, where the greatest variations in prevalence were observed, there is less variation in the ratio between supply and demand according to sizes. The greater variability of prevalence here may be associated with fewer tests being performed in the large territory of the region concerning the others, which directly impacts the control of the disease. The unequal performance of DM procedures in the Northeastern region may be reflected in the mortality rate from complications of the disease, one of the highest in the country[26].

In addition to the fact that testing is essential for tracking people with diabetes and preventing health problems, this is also the most sustainable strategy financially. A higher cost can be expected when treating diabetic patients[27], especially those who have been living with the disease for a long time or those who have developed complications[28]. Patients with vascular complications, for example, have their demand for medication and the frequency of examinations increased, resulting in higher treatment costs[29].

As for the specific tests, it is important to highlight the contrast of the hemoglobin test (P6) being the most demanded in the regions and at the same time having very low performance with a ratio between supply and demand lower than 0,4 in all scopes. The measurement of glycated hemoglobin is essential for monitoring the control of DM, as an adequate A1C level significantly reduces the risk of developing micro and macrovascular complications of the disease concerning those who are not controlled[30].

Binocular color retinography (P11) and laser photocoagulation/fundoscopy (P12) exams showed demand in the order of 10 million, respectively, while the performance was only 3% and 7%, even considering that all achievements were among people with diabetes. This finding corroborates what was observed in other studies that pointed out the low performance of eye tests in patients with diabetes[24,31].

The most suitable treatment for diabetic retinopathy, which is one of the main complications of DM, is prevention. With the evolution of this complication, whether due to lack of diagnosis or lack of access to treatment, the chances of blindness increase[32]. Blind patients demand a greater spectrum of attention, with significant losses in quality of life.

Specifically concerning Diabetic Nephropathy (CRF), it is worth mentioning the very low performance of microabulmin[33] and creatinine[34] tests, which have a low cost and are easy to perform when compared to the high cost of performing hemodialysis[28]. The timely performance of these tests is essential for early detection of this complication, which enables intervention in modifiable risk factors before the problem worsens[35]. It is noteworthy the high variation in the prevalence of patients undergoing dialysis treatment and its high incidence in the Northeastern region[36], which corroborates what was observed in this study regarding problems in carrying out the prevention of complications in some FUs in the region.

In general, the cost for treating DM patients greatly exceeds what is invested in preventing the disease and its complications in the country. It shows that the challenges for dealing with DM go beyond the financial issue and permeate the choices of management strategy, culminating in the weakening of AB when compared to other agendas.

Most preventive exams for DM complications are low-cost when compared to the value of hospitalization and treatment. The hospitalization of a patient with DM costs an average of 19% more than a patient without diabetes, and this value is even higher for those with renal and cardiovascular complications[28]. It is noteworthy that the hospitalizations with the highest costs in 2014 corresponded to almost 30% of the hospitalizations of people with diabetes. The aggravation of the situation is expected as a result of the scrapping of AB in Brazil.

The information sources used in this study made possible to evaluate the performance of several tests related to DM. However, information such as regular measurement of anthropometric measurements (obtaining weight and height for calculating the body mass index (BMI) and measuring the waist circumference), examination of the oral cavity, regular measurement of blood pressure and heart rate, cardiac and pulmonary auscultation, examination of the feet for skin lesions, nail condition, calluses and deformities, assessment of peripheral arterial pulses and lower limb edema, neurological examinations, and others are not available[10].

Some of the procedures mentioned above, including the diabetic foot, were monitorable using foot examination data in the medical consultation, in the PMAQ-AB cycles. However, in 2020 this system was discontinued, which turned into another important gap in the monitoring care for patients with diabetes. Monitoring the diabetic foot is essential, as this, when unattended, can lead to amputations – irreversible complications with high social and economic impact[37–39].

The comparative analysis of the macro data with the municipal data reveals the discrepancies between them, pointing out the inequalities in health care for patients with diabetes in the country. In an ideal scenario, all recommended tests should be offered at 100% of demand and, in this case, the insufficiency of attention becomes even more evident.

Although it is not possible to estimate the demand for procedures of all scopes based on the available data, it is feasible to compare the offer of tests in DATASUS, even without apportioning the specificity of DM, in the FU and municipalities, to capture possible inconsistencies. As an example, there is the case of fraud verified in Amazonas, where the creatinine dosage was per-

Ciência & Saúde Coletiva, 27(4):1653-1667, 2022

formed 37 times more often in a health region when compared to the FU's average[16].

The limitation of the ratio between supply and demand for procedures presented is the fact that it is not sensitive to inter-municipal migrations for carrying out such tests, as the demand was estimated based on the prevalence of the municipality in question. A possible explanation for the high supply of some diabetes procedures in small and medium sized cities is the capture of demand from other surrounding cities, forming hubs for carrying out some procedures.

Despite the potential and gains evidenced by this study, the situation diagnosis presented from this methodology may underestimate the magnitude of the DM assistance problem at more disaggregated parameters were available, it would be expected to find even worse results, with greater inequalities between the analyzed ranges.

Despite the limitations in the estimates in geographical areas that are more disaggregated than the macro-regions, the methodology allows the estimation of a diagnosis of the situation in an innovative and relevant nature, being sufficiently sensitive to show differences between municipalities. For example, if a municipal BMI parameter were available, the method would be expected to show even more differences.

The analysis of access, supply, and use of health services aimed at the population with diabetes needs to be complemented with assessments on the quality of care provided and studies on access to medications. As long as public health is not a priority agenda and primary care is not properly valued and financed as the main health strategy[40], it will be possible to improve neither the access nor the quality of care for patients with diabetes, as well as other highly prevalent chronic diseases in the country.

The development of new studies replicating this methodology from more current databases to allow the temporal evaluation of evolution in care for patients with diabetes at more disaggregated levels as much as possible is recommended. It emphasizes the importance of developing an evaluative culture based on robust and timely information that allows the identification of the effectiveness of interventions and strategies over time.

Collaborations

J Muzy: conception and design of the study, estimation and analysis of data, writing and critical review of the final contente. MR Campos: conception and design of the study, estimation and analysis of data, writing and critical review of the final contente. I Emmerick: data analysis, writing and critical review of the final contente. R Sabino: estimation and analysis of data and critical review of the final content.

References

1. Guariguata L, Whiting DR, Hambleton I, Beagley J, Linnenkamp U, Shaw JE. Global estimates of diabetes prevalence for 2013 and projections for 2035. *Diabetes Res Clin Practice* 2014; 103(2):137-149.
2. Beagley J, Guariguata L, Weil C, Motala AA. Global estimates of undiagnosed diabetes in adults. *Diabetes Res Clin Pract* 2014; 103(2):150-160.
3. Flor LS, Campos MR. Prevalência de diabetes mellitus e fatores associados na população adulta brasileira: evidências de um inquérito de base populacional. *Rev Brasileira Epidemio* 2017;20(1):16-29.
4. GBD 2013 Mortality and Causes of Death Collaborators. Global, regional, and national age–sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2015; 385(9963):117-171.
5. Brasil. Ministério da Saúde (MS), Secretaria de Vigilância em Saúde (SVS). Vigitel Brasil 2013: vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico. Brasília: MS, SVS; 2014. p. 120.
6. Rosa R, Nita ME, Rached R, Donato B, Rahal E. Estimated hospitalizations attributable to Diabetes Mellitus within the public healthcare system in Brazil from 2008 to 2010: study DIAPS 79. *Rev Assoc Medica Brasileira* 2014; 60(3):222-230.
7. Group - DCCT DC and CTR. Effect of Intensive Diabetes Therapy on the Progression of Diabetic Retinopathy in Patients With Type 1 Diabetes: 18 Years of Follow-up in the DCCT/EDIC. *Diabetes* 2015; 64(2):631-642.
8. Group UPDS (UKPDS), others. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* 1998; 352(9131):837-853.
9. Gonçalves MR, Harzheim E, Zils AA, Duncan BB. A qualidade da atenção primária e o manejo do diabetes mellitus. *Rev Bras Med Fam Comunidade* 2013; 8(29):235-243.
10. Brasil. Ministério da Saúde (MS*). Estratégias para o cuidado da pessoa com doença crônica: Diabetes Mellitus.* 1º ed. Cadernos da Atenção Básica nº 36. Brasília: MS; 2013. 160 p.
11. Sociedade Brasileira de Diabetes (SBD). *Diretrizes da Sociedade Brasileira de Diabetes 2013-2014* [Internet]. 2014 [acessado 2015 maio 6]. Disponível em: http://projetodiretrizes.org.br/diretrizes10/diabetes_mellitus_tipo_2_insulinizacao.pdf
12. Alfradique ME, Bonolo PF, Dourado I, Lima-Costa MF, Macinko J, Mendonça CS, Oliveira VB, Sampaio LFR, Simoni C, Turci MA. Internações por condições sensíveis à atenção primária: a construção da lista brasileira como ferramenta para medir o desempenho do sistema de saúde (Projeto ICSAP-Brasil). *Cad Saude Publica* 2009; 25(6):1337-1349.
13. Neves RG, Duro SMS, Muñiz J, Castro TRP, Facchini LA, Tomasi E. Structure of primary healthcare units for treating persons with diabetes: Cycles I and II of the Brazilian National Program to Improve Access and Quality. *Cad Saude Publica* 2018; 34(4).
14. Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJL. *Global burden of disease and risk factors.* Disease Control Priorities Project, organizador. New York; Washington: Oxford University Press ; World Bank; 2006. 475 p.
15. Costa AF, Flor LS, Campos MR, Oliveira AF, Costa MFS, Silva RS, Lobato LCP, Schramm JMA. Carga do diabetes mellitus tipo 2 no Brasil. *Cad Saude Publica* 2017; 33(2).
16. Schramm JMA, Campos MR, Emmerick I, Sabino R, Sorio LF, Costa MFS, et al. *Relatório de pesquisa: Projeto Carga do Diabetes e acesso ao tratamento e serviços de saúde no Estado do Rio Grande do Sul: um instrumento para gestão, organização e planejamento dos serviços de saúde*. Rio de Janeiro: Fundação Oswaldo Cruz; 2018.
17. Oliveira JEP, Junior RMM, Vencio S, organizadores. *Diretrizes da Sociedade Brasileira de Diabetes 2017-2018.* São Paulo: Editora Clannad; 2017.
18. Moraes SA, Freitas ICM, Gimeno SGA, Mondini L. Prevalência de diabetes mellitus e identificação de fatores associados em adultos residentes em área urbana de Ribeirão Preto, São Paulo, Brasil, 2006: Projeto OBEDIARP. *Cad Saude Publica* 2010; 26(5):929-941.
19. World Health Organization (WHO). Obesity: preventing and managing the global epidemic: report of a WHO consultation. Geneva: WHO; 2000. 253 p.
20. Flor LS, Campos MR, Schramm JMA, Silva RS. *Diário de Bordo - Cáculo das Estimativas de YLD para Diabetes e suas Complicações Crônicas*. 2018.
21. Capilheira MF, Santos IS. Individual factors associated with medical consultation by adults. *Rev Saude Publica* 2006; 40:436-443.
22. Malta DC, Duncan BB, Schmidt MI, Machado IE, Silva AG, Bernal RTI, Pereira CA, Damacena GN, Stopa SR, Rosenfeld LG, Szwarcwald CL. Prevalência de diabetes *mellitus* determinada pela hemoglobina glicada na população adulta brasileira, Pesquisa Nacional de Saúde. *Rev Bras Epidemiol* 2019; 22(Supl. 2):e190006.
23. Iser BPM, Stopa SR, Chueiri PS, Szwarcwald CL, Malta DC, Monteiro HOC, Duncan BB, Schmidt MI. Prevalência de diabetes autorreferido no Brasil: resultados da Pesquisa Nacional de Saúde 2013. *Epidemiol Serv Saude* 2015; 24:305-314.
24. Muzy J, Campos MR, Emmerick I, Silva RS, Schramm JMA. Prevalência de Diabetes *Mellitus* e suas complicações e caracterização das lacunas na atenção à saúde a partir da triangulação de pesquisas. *Cad Saude Publica* 2021; 37(5):e00076120.
25. Salazar BA, Campos MR, Luiza VL. A Carteira de Serviços de Saúde do Município do Rio de Janeiro e as ações em saúde na Atenção Primária no Brasil. *Cien Saude Colet* 2017; 22(3):783-796.
26. Klafke A, Duncan BB, Rosa RS, Moura L, Malta DC, Schmidt MI. Mortalidade por complicações agudas do diabetes melito no Brasil, 2006-2010. *Epidemiol Serv Saude* 2014;23(3):455-462.
27. Ferreira JBB, Borges MJG, Santos LL, Forster AC. Internações por condições sensíveis à atenção primária à saúde em uma região de saúde paulista, 2008 a 2010. *Epidemiol Serv Saude* 2014; 23(1):45-56.

28. Rosa MQM, Rosa RS, Correia MG, Araujo DV, Bahia LR, Toscano CM. Disease and Economic Burden of Hospitalizations Attributable to Diabetes Mellitus and Its Complications: A Nationwide Study in Brazil. *Int J Environ Res Public Health* 2018; 15(2).
29. JFK Saraiva, MN Hissa, JS Felício, CAJ Cavalcanti, GL Saraiva, T Piha, AR Chacra. Diabetes mellitus no Brasil: características clínicas, padrão de tratamento e custos associados ao cuidado da doença. *J Bras Econ Saude* 2016; 8(2):80-90.
30. Sumita NM, Andriolo A. Importância da hemoglobina glicada no controle do diabetes mellitus e na avaliação de risco das complicações crônicas. *J Bras Patol Med Lab* 2008; 44(3).
31. Malta DC, Iser BPM, Chueiri PS, Stopa SR, Szwarcwald CL, Schmidt MI, Duncan BB. Cuidados em saúde entre portadores de diabetes mellitus autorreferido no Brasil, Pesquisa Nacional de Saúde, 2013. *Rev Bras Epidemiol* 2015; 18(Supl. 2):17-32.
32. Lins AA, Aoyama EA. O acometimento da retinopatia em pacientes com diabetes mellitus. *Rev Brasileira Interdisciplinar Saude* 2020; 2(1).
33. Zanella MT. Microalbuminúria: fator de risco cardiovascular e renal subestimado na prática clínica. *Arq Bras Endocrinol Metab* 2006; 50(2):313-321.
34. Neto MPL, Rosa FCP, Barbosa TJA. Monitoramento dos níveis séricos de ureia e creatinina de pacientes com diabetes mellitus em um laboratório público de Teresina-PI. *Rev Interdisciplinar* 2014; 7(3):37-49.
35. Murussi M, Coester A, Gross JL, Silveiro SP. Diabetic nephropathy in type 2 diabetes mellitus: risk factors and prevention. *Arq Bras Endocrinol Metab* 2003; 47(3):207-219.
36. Thomé FS, Sesso RC, Lopes AA, Lugon JR, Martins CT. Brazilian chronic dialysis survey 2017. *J Bras Nefrol* 2019; 41(2):208-214.
37. Fonseca KP, Rached CDA. Complicações do diabetes mellitus. *Int J Health Management Review* 2019 ;5(1).
38. Haddad MCFL, Bortoletto MSS, Silva RS. Amputação de membros inferiores de portadores de diabetes mellitus: análise dos custos da internação em hospital público. *Cienc Cuidado Saude* 2010; 9(1):107-113.
39. Oliveira AF, Marchi ACB, Leguisamo CP, Baldo GV, Wawginiak TA. Estimativa do custo de tratar o pé diabético, como prevenir e economizar recursos. *Cien Saude Colet* 2014; 19(6):1663-1671.
40. Viacava F, Oliveira RAD, Carvalho CC, Laguardia J, Bellido JG. SUS: oferta, acesso e utilização de serviços de saúde nos últimos 30 anos. *Cien Saude Colet* 2018; 23:1751-1762.

Article submitted 23/03/2021
Approved 02/06/2021
Final version submitted 04/06/2021

Chief editors: Romeu Gomes, Antônio Augusto Moura da Silva