

## Burden of type 2 diabetes mellitus in Brazil

Carga do diabetes mellitus tipo 2 no Brasil

Carga de la diabetes mellitus tipo 2 en Brasil

Amine Farias Costa <sup>1</sup>  
Luísa Sorio Flor <sup>2</sup>  
Mônica Rodrigues Campos <sup>2</sup>  
Andreia Ferreira de Oliveira <sup>3</sup>  
Maria de Fátima dos Santos Costa <sup>4</sup>  
Raulino Sabino da Silva <sup>2</sup>  
Luiz Cláudio da Paixão Lobato <sup>2</sup>  
Joyce Mendes de Andrade Schramm <sup>2</sup>

doi: 10.1590/0102-311X00197915

### Abstract

*Type 2 diabetes mellitus currently ranks high among indicators used in Global Burden of Disease Studies. The current study estimated the burden of disease attributable to type 2 diabetes mellitus and its chronic complications in Brazil, 2008. We calculated disability-adjusted life years (DALYs), years of life lost (YLLs), and years lived with disability (YLDs) stratified by gender, age bracket, and major geographic region. Type 2 diabetes mellitus accounted for 5% of the burden of disease in Brazil, ranking 3rd in women and 6th in men in the composition of DALYs. The largest share of DALYs was concentrated in the 30-59-year age bracket and consisted mainly of YLDs. The highest YLL and YLD rates were in the Northeast and South of Brazil, respectively. Chronic complications represented 80% of YLDs from type 2 diabetes mellitus. Type 2 diabetes mellitus ranked as a leading health problem in Brazil in 2008, accounting for relevant shares of mortality and morbidity.*

*Chronic Disease; Diabetes Mellitus; Disability-Adjusted Life Years; Indicators of Morbidity and Mortality*

### Correspondence

A. F. Costa  
Instituto Nacional de Câncer José Alencar Gomes da Silva,  
Rio de Janeiro, Brasil  
Rua Equador 831, Rio de Janeiro, RJ 20220-410, Brasil.  
acosta@inca.gov.br

<sup>1</sup> Instituto Nacional de Câncer José Alencar Gomes da Silva, Rio de Janeiro, Brasil.

<sup>2</sup> Escola Nacional de Saúde Pública Sergio Arouca, Fundação Oswaldo Cruz, Rio de Janeiro, Brasil.

<sup>3</sup> Fundação Cesgranrio, Rio de Janeiro, Brasil.

<sup>4</sup> Instituto Nacional de Saúde da Mulher, da Criança e do Adolescente Fernandes Figueira, Fundação Oswaldo Cruz, Rio de Janeiro, Brasil.



## Introduction

Chronic non-communicable diseases (CNCDs) are an important cause of morbidity and mortality in the world. According to data from the *Global Burden of Disease Study*, CNCDs accounted for 43% of disability-adjusted life years (DALYs) in 1990, increasing to 54% in 2010<sup>1</sup>. According to the World Health Organization, the human and socioeconomic impact of CNCDs affects progress with the *Millennium Development Goals*, and the consequences are felt in the majority of countries, especially in low and middle income countries and in vulnerable populations<sup>2,3</sup>. In Brazil, the obesity epidemic is considered the leading cause of the increase in prevalence of CNCDs, directly affecting the *Millennium Development Goals*<sup>4,5</sup>.

Among the CNCDs, type 2 diabetes mellitus is considered an epidemic and accounts for approximately 90% of total diabetes cases<sup>6</sup>. According to estimates for the year 2010, 285 million individuals over 20 years of age were living with diabetes in the world, and by 2030 this figure could reach 439 million<sup>7</sup>. It is believed that approximately 50% of diabetics are unaware of their disease<sup>6</sup>.

In Brazil, the most comprehensive study on type 2 diabetes mellitus prevalence was performed in 1988 in nine state capitals and estimated the prevalence at 7.4% of adults 30 to 69 years of age<sup>8</sup>. According to the International Diabetes Federation, Brazil ranked fourth among the world's countries in number of diabetics, with some 11.9 million in 2013<sup>9</sup>.

Population aging, growing obesity prevalence, sedentary lifestyle, and urbanization are considered the leading factors in the increase in type 2 diabetes mellitus incidence and prevalence worldwide<sup>3,10</sup>. This scenario is taking a high social and financial toll on patients and the health system, since type 2 diabetes mellitus is also associated with such complications as renal failure, lower limb amputation, blindness, and cardiovascular disease, among others<sup>6</sup>.

These chronic complications of type 2 diabetes mellitus compromise individuals' functional capacity, autonomy, and quality of life. As for the magnitude of costs with diabetes in Brazil, results show that up to 15.3% of hospital costs in Brazilian Unified National Health System (SUS) from 2008 to 2010 were attributed to diabetes<sup>11</sup>. As for outpatient treatment costs in the SUS, one study identified annual expenses of USD 2,108 per patient (63.3% direct and 36.7% indirect costs)<sup>12</sup>.

Due to the relevance of type 2 diabetes mellitus as a public health problem in Brazil and worldwide, as well as its chronic complications with varying degrees of severity, the current article presents the findings of the *Global Burden of Disease Study* in Brazil for the year 2008, with an emphasis on type 2 diabetes mellitus and its complications stratified by gender, age, and region.

## Materials and methods

The *Global Burden of Disease Study* in Brazil was conducted by the Center for Research in Applied Methods for Global Burden of Disease Studies at the Sergio Arouca National School of Public Health, Oswaldo Cruz Foundation (ENSP/Fiocruz) in 2010-2013, using 2008 as the reference year for the data analysis. The study was approved by the Institutional Review Board of ENSP/Fiocruz (CAAE: 0054.0.031.000-11).

The indicator used in burden of disease studies is disability-adjusted life year (DALY), a summary measure aimed at grasping the impact of morbidity and mortality on the population's state of health. DALY thus consists of two components, one that measures years of life lost to premature death (years of life lost – YLLs) and another that measures years of healthy life lost due to health problems or disability (years lived with disability – YLDs)<sup>13</sup>. Meanwhile, health problems/chronic complications are subdivided into major analytical groups: I – communicable diseases, maternal/perinatal conditions, and nutritional conditions; II – non-communicable diseases; and III – external causes.

To calculate DALYs, a 3% discount on future benefits was adopted. YLLs were estimated considering deaths from a given disease and life expectancy in Japan according to the reference methodology proposed by Murray & Lopez<sup>13</sup>. Mortality data were obtained from the Mortality Information System (SIM) of the SUS, taking the mean value for 2007-2009. Deaths were then selected whose principal cause was coded from E10 to E14 in the International Classification of Diseases, 10<sup>th</sup> revision (ICD-10), disaggregated by state, gender, and age bracket. A correction was performed for

under-recording of deaths in each state of Brazil, according to gender and age bracket, with a national correction of 28% for individuals under 1 year of age and 13% for individuals over 1 year. According to the traditional *Global Burden of Disease Study* methodology, deaths from ill-defined causes and cases defined as garbage codes were redistributed proportionally by gender, age bracket, and cause of death in each state of Brazil <sup>14</sup>.

YLDs were calculated with incident cases, duration of disease, and weight of disabilities taken from the *Global Burden of Disease Study* in 1990 <sup>13</sup>. YLDs were calculated for uncomplicated cases of type 2 diabetes mellitus and the chronic complications considered in *Global Burden of Disease Stud*: diabetic retinopathy (DR), blindness due to DR (B-DR), diabetic neuropathy (DN), diabetic chronic renal failure (CRF-D), diabetic foot (DF), and amputations. The definitions used in the study were those proposed by Lopez et al. <sup>15</sup>.

After a literature review for definition of clinical and epidemiological parameters on diabetes and related chronic complications, a consensus seminar was held with experts in type 2 diabetes mellitus and its complications, including endocrinologists, ophthalmologists, and clinicians, selected to cover the range of clientele (public and private) and practices in outpatient and hospital care administration, teaching, and research. This selection procedure aimed to avoid biases in selection and measurement of parameters defined by consensus. The expert panel was intended to agree on parameters to be included subsequently in modeling in the DisMod II package (EpiGear, Noosa, Australia; [http://www.epigear.com/index\\_files/dismod\\_ii.html](http://www.epigear.com/index_files/dismod_ii.html)) <sup>16</sup> for obtaining the final parameters.

Type 2 diabetes mellitus prevalence was then estimated as the ratio between type 2 diabetes mellitus prevalence obtained in the *Multicenter Study on Diabetes Prevalence* in 1986-1988 <sup>8</sup> and the population's nutritional status according to the *National Survey on Health and Nutrition* 1989 <sup>17</sup> and the *Family Budgets Survey* 2008-2009 <sup>18</sup>. DR and DN prevalence rates were agreed on in the expert consensus: 20% of patients with type 2 diabetes mellitus present some type of DR (47.7% mild DR, 19.4% moderate, and 32.9% severe) and 40% some degree of DN. The study by Resnikoff et al. <sup>19</sup> was used to estimate prevalence of B-DR. Incidence of CRF-D was estimated using data from the Outpatient Information System of the SUS (SIA-SUS), compiling the Authorizations for High-Complexity Procedures (APAC) for the year 2008, in which 25.7% of cases with ICD-10 codes N18 or N19 and 41.8% of cases with type 2 diabetes mellitus and arterial hypertension were attributed to type 2 diabetes mellitus <sup>20</sup>. Incidence of amputations was estimated using data from the Hospital Admissions System of the SUS (SIH-SUS) by compiling Authorizations for Hospital Admissions (AIH). The mean for years 2008 to 2010 was used, and 50% of total non-traumatic amputations were attributed to type 2 diabetes mellitus <sup>21</sup>. This incidence was later corrected, taking as the target the percentage of the population with private health plans in relation to the percentage without such plans, according to data from the Brazilian National Health Agency <sup>22</sup> (correction factor: 1.27 Brazil; 1.10 North and Northeast; 1.50 Southeast; 1.26 South; and 1.16 Central-West). Incidence of diabetic foot was estimated based on the incidence of amputation <sup>23</sup>.

The study assumed remission zero for uncomplicated cases of type 2 diabetes mellitus, DR, B-DR, DN, and amputation and 9.5% remission for CRF-D, considering transplant cases registered in 2008 in APAC. The study used relative risk (RR) of mortality from type 2 diabetes mellitus of 2.0 between 30 and 69 years and 1.0 under 29 years and 70 years and older. For DR, B-DR, and DN, we used RR of 1.0 in the age bracket up to 29 years and 2.0 for 30 years and older (parameters agreed on in the expert consensus). RR for amputation was generated by the ratio between mean RR of uncomplicated diabetes mellitus cases <sup>24</sup> and the RRs reported by Begg et al. <sup>23</sup>. Case-fatality from CRF-D was calculated using the number of deaths recorded in 2008 in APAC.

DisMod II <sup>16</sup> was used to estimate parameters not available in the literature and to test the internal consistency of the available parameters. After modeling, for individuals up to 29 years of age, the value zero was assigned to incidence rates of uncomplicated cases of type 2 diabetes mellitus and chronic complications. Entry variables in the data modeling were prevalence (type 2 diabetes mellitus, DR, B-DR, and DN) or incidence (CRF-D and amputation) of diseases, remission, mortality (only for type 2 diabetes mellitus), case-fatality (only for CRF-D), and RR (type 2 diabetes mellitus, DR, B-DR, DN, and amputation). Modeling was not necessary for DF, since the incidence was used, estimated from amputations (ratio 1:10) and duration of 2 months for the condition <sup>23</sup>.

For uncomplicated cases of type 2 diabetes mellitus, B-DR, DN, DF, amputation, and CRF-D, we used the weights for disabilities reported by Murray & Lopez <sup>13</sup>. For type 2 diabetes mellitus, B-DR,

DN, and DF, the weights were weighted by the proportion of treatment for each condition (50%, 0%, 40%, 40%, and 0%, respectively), agreed on in the expert consensus. DR used the mean weight reported by Stouthard et al.<sup>25</sup> weighted by the prevalence of types of DR.

Table 1 describes the methodology used to obtain the clinical-epidemiological parameters.

Data analysis used the SPSS, version 17.0 (SPSS Inc., Chicago, USA), and estimates were calculated for Brazil and its major geographic regions, stratified by gender and age.

## Results

Table 1 shows the incidence rates per 100 thousand inhabitants for type 2 diabetes mellitus cases and chronic complications in men and women in Brazil, after modeling in DisMod II. In general, no relevant differences were found between incidence rates in men and women, with slightly higher rates in men and for amputation and diabetic foot. Chronic complications with the highest incidence were DN and diabetic foot.

Table 2 shows YLLs, YLDs, and DALYs for all non-communicable diseases and injuries (Group II) and specifically for type 2 diabetes mellitus in Brazil and by region. There were 195 DALYs per 1,000 inhabitants in Brazil in 2008. Group II of CNCs accounted for approximately 77% of the burden of disease that year, ranging from 71.5% in the North to 79.5% in the Southeast. Group II also showed a high share of YLLs and YLDs (65.3% and 89%, respectively).

Type 2 diabetes mellitus accounted for nearly 5% of the burden of disease in Brazil, with 9.2 DALYs per 1,000 inhabitants. Among non-communicable diseases (Group II), the share of type 2 diabetes mellitus was higher: 6.1% in Brazil as a whole (Table 2).

**Table 1**

Parameters used to estimate number of disability-adjusted life years (DALYs) due to type 2 diabetes mellitus and chronic complications. Brazil, 2008.

Parameters	Type 2 diabetes mellitus						
	Uncomplicated cases	DR	B-DR	Chronic complications			CRF
				DN	Amputation	DF	
Definition <sup>15</sup>	Plasma glucose $\geq 11.1$ mmol/L (200 mg/dL) 2h after 75g oral glucose challenge	Microaneurysms or worse lesions in at least one eye; progressive damage to retinal blood vessels	Incapacity to distinguish fingers at 3 meters, or less than 5% of remaining vision compared to an individual with normal sight; visual acuity less than 3/60, or corresponding loss of visual field in the better eye with the best possible correction, due to DR	Decrease in reflexes and vibration; damage and dysfunction in sensory, motor, or autonomic nerves attributable to type 2 diabetes mellitus	Partial or total surgical removal of lower limb due to gangrene	Chronic or recurrent ulcers on DF	Lesion present for 3 months or more, defined by structural or functional kidney anomalies, with or without decrease in GFR, manifested by pathological anomalies or markers of renal injury, including blood or urinary alterations, or in imaging tests GFR $< 60$ mL/min/1.73m <sup>2</sup> for a period of 3 months, with or without renal lesion

(continues)

Table 1 (continued)

Parameters	Type 2 diabetes mellitus						
	Uncomplicated cases	DR	B-DR	Complicações crônicas			CRF
				DN	Amputation	DF	
Prevalence	Ratio between prevalence of type 2 diabetes mellitus in EMPD 1986-1988 <sup>8</sup> and population's nutritional status according to PNSN <sup>17</sup> and POF <sup>18</sup>	20% of prevalent cases of type 2 diabetes mellitus: 47.7% mild DR, 19.4% moderate DR, and 32.9% severe DR	7% of prevalent cases of blindness in general population <sup>19</sup> using data from 2010 <i>Demographic Census</i> <sup>*</sup>	40% of prevalent cases of type 2 diabetes mellitus <sup>**</sup>	***	***	***
Incidence	***	Furnished by modeling in DisMod II <sup>16</sup>	Furnished by modeling in DisMod II <sup>16</sup>	Furnished by modeling in DisMod II <sup>16</sup>	AIH-SIH/SUS (mean from 2008 to 2010) in which 50% of all non-traumatic amputations were attributed to type 2 <sup>21</sup> diabetes mellitus with subsequent correction for coverage by SUS <sup>22</sup>	One amputation for every 10 cases of DF <sup>23</sup>	APAC-SIA/SUS (2008) in which 25.7% of cases with ICD-10 codes N18-N19 and 41.8% of cases with type 2 diabetes mellitus and arterial hypertension were attributed to type 2 diabetes mellitus <sup>20</sup>
Incidence per 100,000 inhabitants modeling in DisMod II <sup>16</sup>	Men: 245.1 Women: 246.2	Men: 6.8 Women: 5.6	Men: 1.8 Women: 1.6	Men: 137.7 Women: 123.1	Men: 27.2 Women: 15.6	Men: 306.5 Women: 183.4	Men: 4.7 Women: 3.2
Duration	Parameter obtained from modeling in DisMod II <sup>16</sup>	Parameter obtained from modeling in DisMod II <sup>16</sup>	Parameter obtained from modeling in DisMod II <sup>16</sup>	Parameter obtained from modeling in DisMod II <sup>16</sup>	Parameter obtained from modeling in DisMod II <sup>16</sup>	2 months <sup>23</sup>	Parameter obtained from modeling in DisMod II <sup>16</sup>
Remission	Zero	Zero	Zero	Zero	Zero	***	9.5% (transplant cases recorded in APAC in 2008)
Mortality RR	SIM-SUS 2.0 from 30 to 69 years and 1.0 up to 29 years and 70 years and older <sup>**</sup>	*** Zero up to 29 years and 2.0 for 30 years and older <sup>**</sup>	*** 1.0 up to 29 years and 2.0 for 30 years and older <sup>**</sup>	*** 1.0 up to 29 years and 2.0 for 30 years and older <sup>**</sup>	*** 4.4 for men and 5.4 for women. Ratio between mean RR in uncomplicated type 2 diabetes mellitus cases <sup>24</sup> and RR reported by Begg et al. <sup>23</sup>	***	***
Case fatality	***	***	***	***	***	***	Number of deaths reported in APAC (2008)
Treatment (%)	50 <sup>**</sup>	***	0 <sup>**</sup>	40 <sup>13</sup>	0 <sup>**</sup>	40 <sup>13</sup>	100

(continues)

Table 1 (continued)

Parameters	Type 2 diabetes mellitus						
	Uncomplicated cases	DR	B-DR	Complicações crônicas			CRF
				DN	Amputation	DF	
Weights	0.023 calculated as the weighted mean <sup>3</sup> considering 50% treatment <sup>**</sup>	0.184 calculated as mean of weights reported by Southard et al. <sup>25</sup> considering DR prevalence and severity	0.6 calculated as weighted mean <sup>3</sup> considering 0% treatment <sup>**</sup>	0.072 calculated as weighted mean <sup>#</sup> considering 40% treatment <sup>13</sup>	0.134 calculated as weighted mean <sup>#</sup> considering 0% treatment <sup>**</sup>	0.155 calculated as weighted mean <sup>#</sup> considering 40% treatment <sup>13</sup>	0.107 for individuals under 45 years of age and 0.096 for 45 years or older <sup>13</sup>

AIH: Authorization for Hospital Admission; APAC: Authorization for High-Complexity Procedure; B-DR: blindness from diabetic retinopathy; CRF-D: diabetic chronic renal failure; DF: diabetic foot; DN: diabetic neuropathy; DR: diabetic retinopathy; EMPD: *Multicenter Study on Diabetes Prevalence*; GFR: glomerular filtration rate; PNSN: *National Survey on Health and Nutrition*; POF: *Family Budgets Survey*; RR: relative risk; SIA: Outpatient Information System; SIH: Hospital Information System; SUS: Brazilian Unified National Health System.

\* 2010 *Demographic Census* (Instituto Brasileiro de Geografia e Estatística. <http://www.ibge.gov.br>);

\*\* Expert consensus;

\*\*\* Parameter not used;

# Mean calculated considering weights for treated and untreated cases<sup>13</sup> and respective percentage of treatment of disease/sequela.

The largest component of the type 2 diabetes mellitus burden was morbidity (53.2%), with 930,478 YLDs. The type 2 diabetes mellitus share of total YLDs for Group II was higher in the South and Southeast, with 7.1% and 6%, respectively, when compared to the national mean of 5.6%. The share of type 2 diabetes mellitus in total YLLs for Brazil was 4.5% (816,716 YLLs), reaching 5.4% in the Northeast. Specifically within Group II, the share of diabetes mellitus increased to 6.9%, with even higher regional rates in the Northeast and North (8.3% and 7%, respectively) (Table 2).

Figure 1 shows the ranking of DALYs from type 2 diabetes mellitus compared to other health problems by age bracket and gender. In all groups starting at 30 years and in both genders, type 2 diabetes mellitus ranked among the five leading health problems in terms of burden of disease in Brazil. Type 2 diabetes mellitus ranked 2<sup>nd</sup> in men 59 years or younger, dropping to 5<sup>th</sup> starting at 60 years. Among women, type 2 diabetes mellitus ranked 2<sup>nd</sup> and 3<sup>rd</sup> in the 30-44 and 45-69-year age brackets, respectively, dropping to 4<sup>th</sup> in women 70 years or older.

There was a higher proportion of DALYs from type 2 diabetes mellitus in individuals 30 to 59 years of age (59.7%). As for gender, men up to 59 years of age had a slightly higher share of DALYs when compared to women. From 60 years onward there was a higher share in women in the 60-69 and 70 and older age brackets (55.5% and 63.2%, respectively). As for the distribution of YLDs and YLLs in the composition of DALYs from type 2 diabetes mellitus according to age bracket, up to 59 years of age there was a higher proportion of DALYs attributed to morbidity, especially in the 30 to 44-year age bracket, with 86.8% YLDs. From 60 years on there was a reversal of this profile, with a larger share of the mortality component, especially in the 70 and older age bracket, with 82.1% YLLs. That is, age showed an important gradient in the increasing share of mortality from type 2 diabetes mellitus (Figure 2).

As for type 2 diabetes mellitus and its various chronic complications, the burden of morbidity (YLDs) consisted mainly of diabetic retinopathy (42.4%), DN (27.7%) and uncomplicated cases of type 2 diabetes mellitus (20.9%). Regional variation in YLDs showed a concentration in the Southeast. The proportion of YLDs according to regions for type 2 diabetes mellitus as a whole (cases and chronic complications) was 47.3% in the Southeast and 6.1% in the North (Table 3).

**Table 2**

Absolute number, rate, and proportion of years of life lost (YLL), years lived with disability (YLD), and disability-adjusted life years (DALY) for causes, non-communicable diseases, and problems (Group II) and type 2 diabetes mellitus. Brazil and major geographic regions, 2008.

Region	Total DALY	DALY					
		DALY Group II		DALY	DALY/1,000	Diabetes	
		n	Group II/Total (%)			DALY/Total (%)	DALY/Group II (%)
North	2,728,320	1,949,395	71.5	108,633	7.17	4.0	5.6
Northeast	11,142,081	8,391,663	75.3	511,540	9.64	4.6	6.1
Southeast	15,487,348	12,310,422	79.5	747,357	9.32	4.8	6.1
South	5,177,989	4,071,152	78.6	271,227	9.86	5.2	6.7
Central	2,421,925	1,825,057	75.4	108,437	7.92	4.5	5.9
Brazil	36,957,662	28,547,690	77.2	1,747,194	9.21	4.7	6.1

Region	YLD Total	YLD					
		YLD Group II		YLD	YLD/1,000	Diabetes	
		n	Group II/Total (%)			YLD/Total (%)	YLD/Group II (%)
North	1,383,537	1,207,225	87.3	56,440	3.73	4.1	4.7
Northeast	5,264,491	4,613,166	87.6	196,539	3.70	3.7	4.3
Southeast	8,068,065	7,291,246	90.4	440,050	5.49	5.5	6.0
South	2,715,968	2,392,039	88.1	170,905	6.22	6.3	7.1
Central	1,264,611	1,128,290	89.2	66,544	4.86	5.3	5.9
Brazil	18,696,672	16,631,966	89.0	930,478	4.91	5.0	5.6

Region	YLL Total	YLL					
		YLL Group II		YLL	YLL/1,000	Diabetes	
		n	Group II/Total (%)			YLL/Total (%)	YLL/Group II (%)
North	1,344,783	742,170	55.2	52,193	3.45	3.9	7.0
Northeast	5,877,590	3,778,498	64.3	315,001	5.93	5.4	8.3
Southeast	7,419,283	5,019,176	67.7	307,307	3.83	4.1	6.1
South	2,462,021	1,679,113	68.2	100,321	3.65	4.1	6.0
Central	1,157,314	696,767	60.2	41,893	3.06	3.6	6.0
Brazil	18,260,990	11,915,724	65.3	816,716	4.31	4.5	6.9

Note: major analytical groups: Group I – communicable diseases, maternal and perinatal conditions, and nutritional conditions; Group II – non-communicable diseases; and, Group III – external causes.

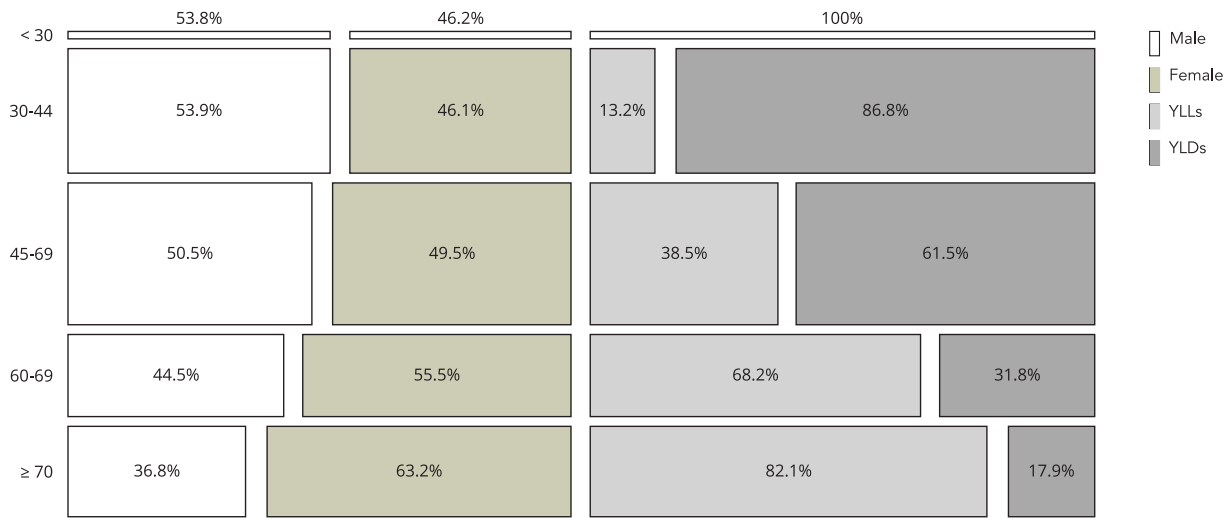
## Discussion

This study addressed the importance of CNCs and type 2 diabetes mellitus in Brazil's epidemiological scenario. According to the main findings, type 2 diabetes mellitus showed the most important share among CNCs, ranking 2<sup>nd</sup> in DALYs. The share of YLLs increased with age, especially in Northeast Brazil, while YLDs consisted mostly of chronic complications and were concentrated in the most developed and urbanized regions of Brazil.

The estimated total number of DALYs dropped by approximately 1.5% compared to the GBD Study for Brazil in 1998, consistent with the results of the recent world *Global Burden of Disease Study* of 2010<sup>1</sup>. The results were also similar for the share of type 2 diabetes mellitus in total DALYs, which remained around 5% in the last 10 years in Brazil. However, the share of type 2 diabetes mellitus in total DALYs

**Figure 1**

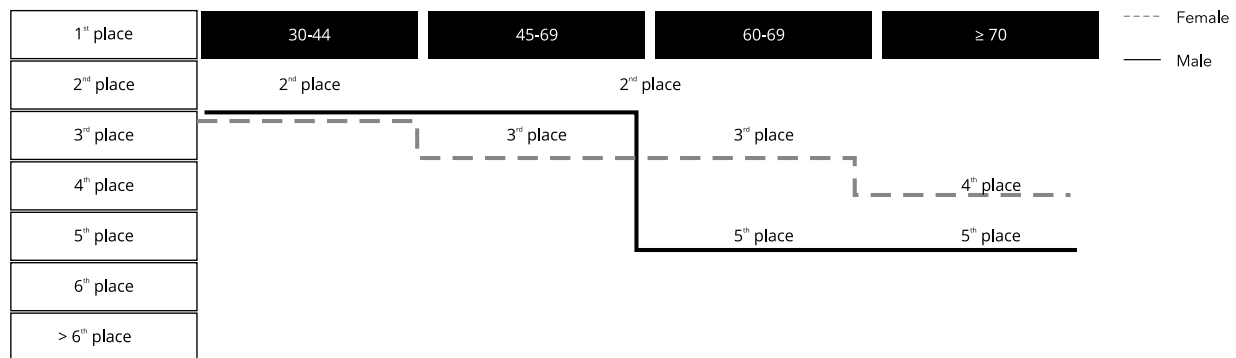
Ranking of disability-adjusted life years (DALY) from type 2 diabetes mellitus according to age bracket and gender. Brazil, 2008.



YLD: years lived with disability; YLL: years of life lost.

**Figure 2**

Distribution of disability-adjusted life year (DALY) from type 2 diabetes mellitus by gender and by ears of life lost (YLL) and years lived with disability (YLD) according to age bracket. Brazil, 2008.



from Group II increased when compared to the share in the *Global Burden of Disease Study* for Brazil in 1998, from 66.3% to 77.2%.

The share of YLDs in total DALYs from type 2 diabetes mellitus remained higher in the last 10 years when compared to the share of YLLs, which can be explained by the increase in prevalence and maintenance of the mortality rate from type 2 diabetes mellitus in Brazil <sup>6,26</sup>. According to Newton et al. <sup>27</sup>, who analyzed burden of disease in England, there was an important reduction in the burden of mortality due to diabetes, from 1990 (17<sup>th</sup> place), to 2005 (27<sup>th</sup> place), to 2013 (not ranking among the first 31 places).



**Table 3**

Distribution of rates and proportional years lived with disability (YLD) in cases of type 2 diabetes mellitus and chronic complications, by regions. Brazil, 2008.

Problems/Chronic complications	Regions					Brazil	
	North	Northeast	Southeast	South	Central	YLD	Tax
<b>YLD rate/100 thousand</b>							
DF	2.4	4.1	7.4	5.7	3.3	10,508	5.5
DN	106.2	102.7	149.5	176.8	136.2	257,788	136.0
B-DR	12.4	11.9	16.8	13.4	12.1	27,015	14.2
DR	161.7	157.9	228.5	271.3	209.2	394,773	208.2
Amputation	10.9	14.8	31.5	25.1	15.1	43,713	23.1
CRF-D	1.8	0.5	1.3	1.1	1.5	2,133	1.1
Type 2 diabetes mellitus (cases + chronic complications)	372.7	370.2	548.8	621.5	485.9	930,478	490.7
Diabetes mellitus tipo 2 (casos + complicações crônicas)	372,7	370,2	548,8	621,5	485,9	930.478	490,7
<b>Proportional distribution</b>						<b>YLD</b>	<b>% Line</b>
Uncomplicated cases	6.0	21.4	46.9	18.1	7.6	194,549	100.0
DF	3.5	20.8	56.5	15.0	4.3	10,508	100.0
DN	6.2	21.1	46.5	18.9	7.2	257,788	100.0
B-DR	6.9	23.5	49.8	13.7	6.1	27,015	100.0
DR	6.2	21.2	46.4	18.9	7.3	394,773	100.0
Amputation	3.8	17.9	57.8	15.8	4.7	43,713	100.0
CRF-D	12.9	12.9	50.5	14.0	9.6	2,133	100.0
Type 2 diabetes mellitus (cases + chronic complications)	6.1	21.1	47.3	18.4	7.2	930,478	100.0
<b>Proportional distribution</b>						<b>YLD</b>	<b>% Column</b>
Uncomplicated cases	20.7	21.1	20.7	20.6	22.3	194,549.5	20.9
DF	0.6	1.1	1.3	0.9	0.7	10,508.0	1.1
DN	28.5	27.7	27.2	28.4	28.0	257,788.1	27.7
B-DR	3.3	3.2	3.1	2.2	2.5	27,014.8	2.9
DR	43.4	42.6	41.6	43.7	43.1	394,772.6	42.4
Amputation	2.9	4.0	5.7	4.0	3.1	43,712.6	4.7
CRF-D	0.5	0.1	0.2	0.2	0.3	2,133.0	0.2
Type 2 diabetes mellitus (cases + chronic complications)	100.0	100.0	100.0	100.0	100.0	930,478	100.0

B-DR: blindness from diabetic retinopathy; CRF-D: diabetic chronic renal failure; DF: diabetic foot; DN: diabetic neuropathy; DR: diabetic retinopathy.

Northeast Brazil was the only region in which the type 2 diabetes mellitus profile showed a higher proportion of YLLs than YLDs in DALYs. This may reflect a lower rate of early diagnosis due to difficulties in access to health services as well as barriers to on-going treatment, thereby increasing the share of mortality in type 2 diabetes mellitus. Other relevant aspects include health education issues both with diabetics and health professionals and treatment adherence in a chronic condition like type 2 diabetes mellitus.

Brazil's hinterlands and less economically developed regions have experienced difficulties in implementing the SUS ever since its creation. Since most of these small and/or remote communities have small populations, they suffer from inadequate human and financial resources and infrastructure<sup>28</sup>. Mendes et al.<sup>29</sup> presented the results of a study in a state capital in Northeast Brazil which revealed great dissatisfac-

tion with the SUS among users and health professionals, due to difficulties with the supply of medicines, tests, and specialized referrals, besides the long waiting time in primary care units.

Type 2 diabetes mellitus in the current study was among the 10 leading causes of DALYs (3<sup>rd</sup> in women and 6<sup>th</sup> in men), similar to the 8<sup>th</sup> place for tropical Latin America estimated in the world *Global Burden of Disease Study*<sup>1</sup>. This illustrates the relevance of type 2 diabetes mellitus in Brazil, especially due to the rising prevalence of risk factors like obesity and sedentary lifestyle<sup>5,18,30</sup>. The estimated burden was higher in young populations, reaching 2<sup>nd</sup> place in the 30-44-year age group, when compared to the elderly, in whom the burden of cardiac diseases and dementias lead the ranking. The share of YLLs was also higher in DALYs from type 2 diabetes mellitus in the elderly due to this age group's higher mortality rate<sup>10</sup>.

Uncomplicated cases represented only 20.9% of YLDs from type 2 diabetes mellitus, reflecting Brazil's currently challenging situation with early detection and treatment of cases (which should aim to prevent chronic complications). According to Guidoni et al.<sup>31</sup>, the Family Health Strategy, currently the main primary care mechanism in the SUS, fails to fully meet with the prevention and health promotion recommendations for type 2 diabetes mellitus, thus generating gaps that are ultimately reflected in heavy expenditures on high-complexity expenditures for diabetics. Evaluating the profile of type 2 diabetes mellitus patients hospitalized in the SUS, Artilheiro et al.<sup>32</sup> showed that the majority reported treatment for systemic arterial hypertension or some comorbidity associated with type 2 diabetes mellitus, such as DN, DR, or peripheral vascular disease. In addition, 24% of these patients had failed to consult a primary care unit in the previous 12 months due to lack of open slots for scheduling appointments, and that 54% had failed to consult an endocrinologist in the previous 3 years due to lack of referral.

Examples of the impact of chronic complications of type 2 diabetes mellitus on patients' health are DR and B-DR, jointly accounting for approximately 45% of all YLDs due to type 2 diabetes mellitus, 9 times the percentage when compared to estimates from the world *Global Burden of Disease Study*. DR is considered the principal cause of blindness in individuals 20 to 74 years of age, and an estimated 38% of individuals with type 2 diabetes mellitus present some degree of DR at diagnosis<sup>10</sup>.

According to Rezende et al.<sup>33</sup>, some 30% of annual cases of DF in Brazil required hospitalization and some 48% of the costs of these admissions related to amputations. There has been a large increase in major amputations, which the same authors attributed to failure in treatment of DF. The situation is even more complicated because diabetic neuropathy is the main cause of ulcers, often detected at first diagnosis of type 2 diabetes mellitus<sup>10</sup>.

Concerning diabetic chronic renal failure, according to Cherchiglia et al.<sup>34</sup>, 20% of patients that began dialysis in the SUS in 2000 presented diabetes as the cause of CRF. Patients were followed for a mean of 4 years, and annual expenditure per patient ranged from approximately BRL 27,000 to BRL 35,000 (USD 8,000-USD 11,000)

Regardless of the type of chronic complication, the greatest obstacles to decreasing their share of total YLDs in type 2 diabetes mellitus relate to effective early diagnosis and efficient treatment of the disease, both of which are still highly precarious in primary care in Brazil. Importantly, since type 2 diabetes mellitus is a difficult disease to manage, prognosis depends largely on lifestyle changes in combination with access to medication, as well as treatment compliance. According to Alfradique et al.<sup>35</sup>, type 2 diabetes mellitus is a primary care-sensitive health condition, that is, the hospitalization rates can be decreased by effective measures in primary care. Relatively simple preventive and curative measures can be developed to diagnose and follow individuals with diabetes and consequently avoid chronic complications or delay their progression<sup>10,30,32,36,37</sup>.

This study shares two limitations with all studies on global burden of disease in the world: (i) the scarcity of nationally representative studies that estimate diabetes mellitus prevalence and incidence rates and chronic complications, as well as the duration and proportion of treatments performed and (ii) underreporting and incorrect classification of deaths. Another inherent limitation to the traditional method of *Global Burden of Disease Studies* is the exhaustive list of complications to be investigated, evidencing the absence of acute complications from the list, notably hypoglycemia and hyperglycemia, since complications are frequent in patients with diabetic nephropathy and result in emergency department visits or even hospitalizations.

The last multicenter study in Brazil on type 2 diabetes mellitus prevalence in the population using diagnostic tests was in 1986-1988. The current study adjusted this estimate according to the prevalence

of overweight and obese individuals in the Brazilian population, resulting in a 9.7% rate in adults 30 years or older (10.3% in men and 9.1% in women). Considering the difficulties in correctly classifying the share of deaths from acute myocardial infarction attributed to type 2 diabetes mellitus, in the current study the burden of deaths from acute myocardial infarction was computed in the group of ischemic heart diseases rather than as a type 2 diabetes mellitus-associated comorbidity.

The findings corroborate studies on the relevance of type 2 diabetes mellitus in Brazil and worldwide in recent decades. The YLD rate per 1,000 inhabitants is more than half the rate of the entire group that includes infectious and parasitic diseases, maternal causes, perinatal causes, and nutritional deficiencies. The findings thus have implications for planning actions in the Brazilian health system. Since diabetes is a primary care-sensitive condition, it is hoped that strengthening primary care by including relatively simple preventive and curative measures will positively impact the diagnosis and follow-up of individuals with diabetes, thus preventing diabetes mellitus and chronic complications or delaying the latter's progression, helping to enhance care and quality of life for these patients.

## Contributors

A. F. Costa, L. S. Flor, M. R. Campos and A. F. Oliveira participated in the data analysis and interpretation and writing and revision of the article. M. F. S. Costa, R. S. Silva and L. C. P. Lobato contributed in the data analysis, interpretation and revision of the article. J. M. A. Schramm collaborated in the writing and revision of the article.

## Acknowledgments

The authors wish to acknowledge the professionals that participated in the expert consensus: Alessandro Dorileo Paim, Claudia Ramos Marques da Rocha, Domingos Augusto Cherino Malerbi, Jose Egidio Paulo de Oliveira, Paulo Henrique de Avila Morales, Roberta Coelho, and Roselee Pozzan. We thank Dr. Domingos Augusto Cherino Malerbi for his critical revision of the manuscript, as well as the other members of the Global Burden of Disease project, Brazil 2008: Iúri da Costa Leite and Joaquim Gonçalves Valente.

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## Resumo

O diabetes mellitus tipo 2 se destaca, atualmente, na composição dos indicadores dos Estudos de Carga Global de Doença. Este estudo estimou a carga de doença atribuível ao diabetes mellitus tipo 2 e suas complicações crônicas no Brasil, 2008. Foram calculados os anos de vida perdidos ajustados por incapacidade (DALY), anos de vida perdidos por morte prematura (YLL) e os anos de vida perdidos por conta da incapacidade (YLD) estratificados por sexo, faixa etária e região. O diabetes mellitus tipo 2 representou 5% da carga de doença no Brasil, posicionando-se como a 3ª causa mais importante nas mulheres e a 6ª nos homens na construção do DALY. A maioria do DALY se concentrou na faixa etária entre 30 e 59 anos e foi representado majoritariamente pelo YLD. As maiores taxas de YLL e YLD se concentraram nas regiões Nordeste e Sul, respectivamente. As complicações crônicas do diabetes mellitus tipo 2 representaram 80% do YLD. O diabetes mellitus tipo 2 representou um dos principais agravos de saúde no Brasil em 2008, contribuindo com relevantes parcelas de mortalidade e morbidade.

*Doença Crônica; Diabetes Mellitus; Anos de Vida Perdidos por Incapacidade; Indicadores de Morbimortalidade*

## Resumen

La diabetes mellitus tipo 2 se destaca, actualmente, en la composición de los indicadores de los Estudios de Carga Global de Enfermedad. Este estudio estimó la carga de la enfermedad, atribuible a la diabetes mellitus tipo 2 y sus complicaciones crónicas en Brasil, 2008. Se calcularon los años de vida perdidos, ajustados por incapacidad (DALY), años de vida perdidos por muerte prematura (YLL) y los años de vida perdidos, debido a la incapacidad (YLD), estratificados por sexo, franja de edad y región. La diabetes mellitus tipo 2 representó un 5% de la carga de enfermedad en Brasil, posicionándose como la 3ª causa más importante en las mujeres y la 6ª en los hombres en la construcción del DALY. La mayoría del DALY se concentró en la franja de edad entre 30 y 59 años y fue representado mayoritariamente por el YLD. Las mayores tasas de YLL y YLD se concentraron en las regiones del nordeste y sur, respectivamente. Las complicaciones crónicas de la diabetes mellitus tipo 2 representaron un 80% del YLD. El diabetes mellitus tipo 2 representó uno de los principales agravios de salud en Brasil en 2008, contribuyendo con relevantes cuotas de mortalidad y morbilidad.

*Enfermedad Crónica; Diabetes Mellitus; Años de Vida Perdidos por Incapacidad; Indicadores de Morbimortalidad*

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Submitted on 01/Dec/2015  
Final version resubmitted on 07/Apr/2016  
Approved on 02/May/2016