

# Estimated hospitalizations attributable to Diabetes Mellitus within the public healthcare system in Brazil from 2008 to 2010: study DIAPS 79

ROGER ROSA<sup>1</sup>, MARCELO EIDI NITA<sup>2</sup>, ROBERTO RACHED<sup>2\*</sup>, BONNIE DONATO<sup>3</sup>, ELAINE RAHAL<sup>2</sup>

<sup>1</sup>Federal University of Rio Grande do Sul/UFRGS, Porto Alegre, RS, Brazil

<sup>2</sup>Medical Division, Bristol-Myers Squibb, São Paulo, SP, Brazil

<sup>3</sup>Health Economics and Outcome Research, Bristol-Myers Squibb, São Paulo, SP, Brazil

## SUMMARY

**Objective:** to estimate the number of hospitalizations attributable to diabetes mellitus (DM) and its complications within the public healthcare system in Brazil (SUS) and the mean cost paid per hospitalization.

**Methods:** the official database from the Hospital Information System of the Unified Health System (SIH/SUS) was consulted from 2008 to 2010. The proportion of hospitalizations attributable to DM was estimated using attributable risk methodology. The mean cost per hospitalization corresponds to direct medical costs in nursing and intensive care, from the perspective of the SUS.

**Results:** the proportion of hospitalizations attributable to DM accounted for 8.1% to 12.2% of total admissions in the period, varying according to use of maximum (self-reported with correction factor) or minimal (self-reported) DM prevalence. The hospitalization rate was 47 to 70.8 per 10.000 inhabitants per year. The mean cost per hospitalization varied from 1.302 Brazilian Reals (BRL) to 1,315 BRL. Assuming the maximum prevalence, hospitalizations were distributed as 10.3% as DM itself, 36.6% as chronic DM-associated complications and 53.1% as general medical conditions. Advancing age was accompanied by an increase in hospitalization rates and corresponding costs, and more pronounced in male patients.

**Conclusion:** the results express the importance of DM in terms of the use of health care resources and demonstrate that studies of hospitalizations with DM as a primary diagnosis are not sufficient to assess the magnitude of the impact of this disease.

**Key words:** health evaluation, diabetes complications, costs and cost analysis, diabetes mellitus.

Study conducted at Bristol-Myers Squibb, São Paulo, SP

Article received: 02/06/13

Accepted for publication: 01/09/14

\*Correspondence:

Medical Division, Bristol-Myers Squibb

Address: Rua Verbo Divino, 1711

Chácara Santo Antônio

ZIP Code: 04719-002

São Paulo, SP, Brazil

Phone: +55 11 3882-2013

roberto.rached@bms.com

<http://dx.doi.org/10.1590/1806-9282.60.03.010>

Conflict of interest: no

## INTRODUCTION

The increased prevalence of diabetes mellitus (DM) has been identified worldwide. According to the World Health Organization (WHO), more than 300 million cases of diabetes have already been recorded and the forecast is that the number of deaths associated with the disease will increase more than 50% in the next 10 years, becoming the seventh major cause of death by 2030.<sup>1</sup> In 2004, 3.4 million deaths were recorded owing to problems related to hyperglycemia.<sup>1</sup> The main long term complications related to DM include the development of retinopathy, nephropathy and neuropathy.<sup>2,3</sup> The association

between diabetes, lack of access to health services and inadequate control of blood glucose levels may lead to complications such as blindness, amputations and kidney failure.<sup>1</sup>

The majority of DM cases occur in developing countries, leading to around 80% of deaths attributable to the disease.<sup>1</sup> In these countries the most affected age profile is between 35 and 64 years, while in developed countries this impairment occurs at more advanced ages, generally after retirement. The increased impact of DM worldwide, especially in developing countries and at lower age

ranges is related to multiple causes, including overweight, obesity and physical inactivity.<sup>1,4</sup>

The importance of DM as a public health problem has increased in Brazil and other countries worldwide.<sup>5-8</sup> At the end of the 1980s, a study with national coverage demonstrated the prevalence of diabetes in the population aged 30 to 69 years as 7.6%.<sup>9</sup> New domestic studies have been conducted demonstrating a prevalence of DM2 at 12.1% in the city of Ribeirão Preto, SP,<sup>10</sup> 2.4% in the city of Alegre, RS<sup>11</sup> and 7.1% in the city of Pelotas, RS.<sup>12</sup>

Data from the VIGITEL survey of 2010 (Surveillance of Risk and Protective Factors for Chronic Diseases Telephone Survey, Ministry of Health)<sup>13</sup> indicated that the frequency of adults that report a previous diagnosis of diabetes in the Brazilian population is 6.3%. In both sexes the disease becomes more common as age increases reaching more than 20% in those aged over 65 years. Between 2007 and 2010 there was an increase in the frequency of people with diabetes. In men the increase was an average of 0.25 % per year in the period from 2006 to 2010. In women the same increase was 0.45 % per year, in the period from 2007 to 2010.

Considering the high morbidity and mortality associated, diabetic patients require more health care, leading to greater use of resources. In addition to higher direct costs, the indirect costs relating to loss of productivity and early mortality should be considered, as well as the negative impact on quality of life related to health.<sup>14,15</sup> The costs with this population are 2 to 3 times higher compared to non-diabetic individuals.<sup>4</sup>

As the true prevalence of DM is underestimated, the negative impact of the disease becomes even greater and unknown. DM is often not recorded as the underlying cause of hospitalization, given that patients mainly seek health services as a result of its chronic complications. Also, accessing health services is difficult, and there is lack of or delayed diagnosis. Therefore, factors such as under-registration and under-diagnosis make a true measurement of the impact of the disease more difficult. The analyses undertaken on the impact of DM should consider these limitations and some studies use the attributable risk method to get around them.<sup>7,16</sup> In addition to the evaluation of the impact of the disease, it is believed that studies about DM hospitalizations may serve as indicators of the effectiveness of current care and the interventions implemented in preventing and controlling the disease.<sup>17</sup>

Given the scarcity of information, the objective of this study is to estimate the magnitude of hospitalizations of attributable to DM and its complications in the

Brazilian healthcare system (SUS) in the period from 2008 to 2010, as well as evaluate the mean cost paid per hospitalization.

## METHODS

Raw hospitalization data were obtained from the files on the Hospital Information System of the Unified Health System (SIH/SUS) available from the website of the SUS IT Department- DATASUS relating to the 2008-2010 period. The SIH/SUS is the national system used to control the payment of services rendered by public and private hospitals to the SUS. The information was organized in electronic spreadsheets after verification and cleansing.

For the physical dimensioning of hospitalizations, only the normal type hospitalization authorizations (HA) were considered, while for financial dimensioning the costs of long term authorizations were summed with the normal type, as the amount spent per patient in the previous type already follows. To establish the annual fluctuations, the mean physical and financial volumes of the hospitalizations in the period were calculated according to the ICD-10 classification, using five patient residence areas (IBGE macro-regions), sex and eighteen age intervals at the time of hospitalization (less than 1 year, 1 to 4 years, then every 5 years up to 80 years or over).

Hospitalizations were categorized into three groups: DM itself, chronic complications attributable to DM and general medical condition.<sup>7,16,18,19</sup> The first group correspond to hospitalizations with a main diagnosis of ICD-10 E10 to E14. The second group included as the main diagnosis all those listed as chronic complications attributed to diabetes by the American Diabetes Association<sup>7,16,18</sup> as per ICD-9, and identified in the codes of the three-digit categories of the ICD-10. These codes were grouped into seven subgroups of chronic complications (neurological, vascular, peripheral, cardiovascular, renal, endocrine/metabolic and ophthalmological diseases and other chronic complications). The third group (general medical conditions) corresponded to the main diagnosis for hospitalization from any other categories in the ICD-10, excluding the first and second groups.<sup>18</sup>

The proportion of hospitalizations owing to DM were estimated using the attributable risk method for the second and third groups.<sup>18,19</sup> This method considers that diabetic patients use health services more than non-diabetic patients and that a portion of the care associated to these medical conditions can be attributed to DM.<sup>7,16,18</sup> The risk of presenting a determined medical condition according to the presence of diabetes or otherwise, and the proportion of the population with the disease are

combined to calculate the etiologic fraction. The calculation is obtained using the formula:  $RAP_i = [P \times (RR_i - 1)] / [P \times (RR_i - 1) + 1]$ , where  $RAP_i$  is the fraction of population attributable risk for the medical condition “i” owing to diabetes; P represents the diabetes prevalence rate, and  $RR_i$  is the relative risks or odds ratio of the medical condition “i” for people with diabetes compared to those without the disease.<sup>16</sup>

The same relative risks or odds ratio of hospitalization of the study realized with the hospitalizations of the SUS for the 1999-2001 period were used.<sup>20</sup> The prevalence of diabetes was initially obtained using the self-reported morbidity on the Vigitel from 2006.<sup>21</sup> This system is a monitoring initiative by the Ministry of Health that uses probabilistic samples of adults resident at homes serviced by a fixed telephone line in 27 capitals. Its methodology is described in another publication.<sup>22</sup> This prevalence was denominated as minimum for dealing with self-reported data derived from the positive response of the interviewees when asked if a physician had already told them they have diabetes, designed for the Brazilian population according to Vigitel correction factors. The mean of the respective state capitals on the Vigitel was used as the minimum DM prevalence for each of the residence regions of the patients weighted by the general population of these cities according to sex, as per the 2010 demographic census. The Vigitel prevalence for 18 to 24 year olds was used for age ranges under 20 years.

For the maximum prevalence, the portion of diabetic individuals that are unaware of their conditions was compensated for using a correction factor. The minimum prevalence was multiplied by 1.85, considering the 4.1% ratio of undiagnosed cases in 7.6% of the total cases from the National Diabetes Census of 1988.<sup>23</sup>

Attributable fractions<sup>16</sup> were calculated considering the minimum and maximum prevalence per sex, eighteen age ranges and five regions and applied to the respective annual mean hospitalizations and amounts spent for each ICD-10 code calculated with the same stratification. The results were grouped into seven subgroups of chronic complications, and by sex and five age ranges (0-19, 20-44, 45-59, 60-74 and 75+ years) in the general medical conditions group per region of the country. A sensitivity analysis was conducted with addition and reduction of 20% on the risk values used for calculation of attributable fractions.

The economic perspective adopted was the universal public finance – the Brazilian Unified Health System – responsible for the direct cost associated with hospital

treatment of DM. The amounts correspond to the costs of nursing (hospital services, professionals and examinations) and intensive treatment, which according to the SIH/SUS correspond to payment of public and private hospital service providers, as established by the national direction of the SUS.

In relation to ethical aspects, data extracted from the SIH/SUS are in the public domain and safeguard against identification of subjects, guaranteeing confidentiality and anonymity.

## RESULTS

According to the minimum and maximum prevalence criteria adopted, it is estimated that 896.7 to 1.353.2 thousand hospitalizations attributable to DM occurred in the SUS from 2008 to 2010. The annual costs represented by these hospitalizations are between BRL 1.17 billion and BRL 1.78 billion, under the perspective of the SUS. Compared to the total hospitalizations in the SUS for the same period of time, the occurrence of DM related hospitalizations represents 8.1% to 12.2% of the total and its costs represent from 10.1% to 15.4% of the total.

The distribution and annual medical costs of the hospitalizations, segmented by age range and disease group are demonstrated in Table 1 and Table 2. Assuming the estimated maximum prevalence, the 1.353 thousand hospitalizations would be distributed as follows: 10.3% recorded as DM itself (ICD-10 from E10 to E14); 36.6% associated with chronic complications resulting from DM; and 53.1% attributed to general medical conditions. The respective costs correspond to 4.7%, 48.8% and 46.5% of the total spent.

Hospitalizations for chronic complications attributable to DM are around four times more numerous than those whose main diagnosis is recorded as ICD-10 from E10 to E14. Cardiovascular and peripheral vascular diseases stand out among chronic complications for their frequency. The annual costs with hospitalizations owing to chronic complications of DM are approximately ten times higher than those for E10 to E14. The most significant values among chronic complications are those attributed to cardiovascular and neurological diseases.

It is estimated that from 47 to 70.8 hospitalizations attributable to DM occur in the SUS per 10,000 inhabitants. The magnitude of these rates is similar for both sexes within the five age ranges studied. However, women presented a higher number of hospitalizations in general compared to men (50.8 to 75.5 *versus* 43 to 65.9 per

10.000 inhabitants, respectively). However, for age ranges above 45 years the male sex is predominant.

Table 3 presents the distribution of hospitalizations attributable to DM per 10.000 inhabitants, also segmented by age range. The hospitalization rate of the population aged 75 years or more is 3.3 times higher than that found for the population aged 45 to 64 years, and more than thirty times higher compared to the 0 to 19 years age range. This increase in the hospitalization rate is accompanied by an increase in the cost corresponding to the minimum and maximum estimates.

The Southern region presents twice the number of hospitalizations (63.8 to 95.9 per 10.000 inhabitants) compared to Northern region (31.9 to 48.8 per 10.000 inhabitants). The highest and lowest hospitalization rates for each of the three groups (E10 to E14, chronic complications and general medical conditions) were also found in the South and North of the country, respectively.

The mean cost associated with hospitalizations attributed to DM was estimated at an amount varying from BRL 1301.83 to BRL 1314.69 according to the estimated prevalence assumed. Assuming the maximum prevalence, the hospitalization of patients between 65 and 74 years presented the highest mean cost (BRL 1557.93), although the quantities and total amounts are concentrated in the 45 to 64 years age range. This situation remains essentially the same when using the minimum estimated based on the prevalence of self-reported DM, reducing the mean cost in the 65 to 74 years age range to BRL 1536.36.

In the maximum estimate the mean costs were higher for cardiovascular diseases (BRL 2189.03) and neurological diseases (BRL 1699.50) among the chronic complications attributable to DM compared to hospitalizations for E10 to E14 (BRL 608.72) as the main diagnosis. Costs were also more significant for men (BRL 1473.84) than for women (BRL 1181.39) and in the Southeast (BRL 1517.43) and South (BRL 1458.00) regions compared to the North (BRL 847.02), Northeast (BRL 981.67) and Mid-West (BRL 1118.90). The predominance of higher medical expenditure for males is repeated in all regions. Likewise, the higher mean expenditure in the Southeast and South in relation to the other regions in the order presented is constant regardless of sex.

The sensitivity analysis with a 20% increase on the risk values used for calculating the attributable fractions generated estimates of 1102 thousand (57.8 per 10.000 inhabitants) and 1653 thousand (86.4 per 10.000 inhabitants) annual hospitalizations considering the minimum and maximum prevalence criteria, respectively. The corresponding amounts reached BRL 1.44 billion and BRL

2.16 billion. On the other hand, the 20% reduction in the risks used lowered the estimates to 669.3 million (35.1 per 10.000 inhabitants) and 1005.9 thousand (52.7 per 10.000 inhabitants) hospitalizations per year in accordance with the same criteria. In this case the costs would be BRL 0.87 billion and BRL 1.33 billion, respectively.

## DISCUSSION

This study was undertaken with the objective of estimating the number of hospitalizations attributable to DM and its complications, as well as evaluating the mean cost paid in the period from 2008 to 2010 in the Brazilian Unified Health System. It is estimated that 896.7 thousand to 1353.2 thousand hospitalizations occurred per year, or 47 to 70.8 per 10.000 inhabitants per year, varying in accordance with the use of the minimum and maximum prevalence. The annual costs attributable to such hospitalizations would vary from BRL 1.17 billion to BRL 1.78 billion and the mean cost per hospitalization varied from BRL 1301.83 to BRL 1314.69 according to the estimated prevalence assumed.

The data relating to the 2008 to 2010 period demonstrate that the amount of hospitalizations attributable to DM in the SUS increased compared to the study conducted with the same methodology for the period from 1999 to 2001.<sup>20,24</sup> The complications of DM are among the Primary Care Sensitive Conditions (CSAP) and hospitalizations attributed to these complications constituted an indirect indicator of the effectiveness of the first level of healthcare,<sup>25</sup> given that DM has been recognized in national and international lists as a cause of hospitalization sensitive to the actions of primary care.<sup>26</sup> In Brazil, a recent study stated that optimization of the use of effective treatments within the scope of primary care would reduce hospitalizations attributable to cardiovascular complications associated with DM by up to 48%.<sup>27</sup> However, Brazil presents a growing prevalence of DM, which could also justify the increase in cases of hospitalization. If the prevalence in the study from 1999 to 2001 (using the 1988 National Diabetes Census as a source) was maintained for the fractions to be applied to hospitalizations from 2008 to 2010 the increase identified in hospitalizations would be 7.8%. The total amount of hospitalizations in the SUS presented a slight reduction between both studies. These data indicate that the other reasons for hospitalization were displaced, taking into account that we noted the growth of hospitalizations attributed to DM, even though the prevalence and risks relating to hospitalization for diabetes remained constant.

In terms of self-reported prevalence, based on the estimated minimum prevalence used, two relevant national inquiries describe compatible results and make the minimum estimate adopted coherent. The 2008 PNAD (National Household Sample Survey) indicated that the percentage of people over 20 years reporting that they have had diabetes diagnosed by a physician increase over time in all social classes in Brazil. In the total population, the percentage of diabetics went from 3.3% in 1998 to 5.3% in 2008.<sup>28</sup> When specifically evaluating the elderly population, the prevalence of self-reported diabetes increased significantly, moving from 10.3% in 1998 to 16.1% in 2008, regardless of age and sex.<sup>29</sup> The data extracted from the VIGITEL survey indicate the self-reported prevalence at 5.3% in 2006,<sup>21</sup> compatible with that found in the 2008 PNAD.

The estimated maximum prevalence depended on the correction factor applied to the self-reported prevalence. Studies conducted in two cities in the state of São Paulo, Ribeirão Preto in 1997<sup>30</sup> and São Carlos in 2008,<sup>31</sup> demonstrated respectively that 75% and 85% of diabetic individuals between 30-79 years already had a previous diagnosis.<sup>32</sup> In these situations, the correction factors for undiagnosed cases would be substantially lower (1.3 and 1.18, respectively) than the one used (1.85) and the most common applied (2).<sup>21</sup> The 1.33 factor would generate 1086.7 thousand hospitalizations or 57 per 10.000 inhabitants. It is worth reiterating, however, that these cities have a very different socioeconomic level and access to health services than the rest of the national territory, which justifies maintaining a 1.85 factor for the maximum estimate in our study.

For maximum estimate of hospitalizations attributable to DM, an increase in 62% was detected between the two periods evaluated (1999 to 2001 and 2008 to 2010). In terms of population, the variation was 44% in the same period, moving from 49.3 per 10.000 inhabitants<sup>20</sup> to 70.8 per 10.000 inhabitants. It is possible that this variations is lower considering two situations that are not mutually exclusive: (i) underestimated data from 1999-2001 owing to the use of the prevalence from the 1988 Diabetes Census and (ii) overestimated data from 2008-2010 owing to the correction factors used for the self-reported prevalence.

The slightly significant percentage of hospitalizations with a main diagnosis of E10 to E14 using the ICD-10 (10.3%) in relation to chronic and general medical complications is compatible with others studies published.<sup>7,16,18,20</sup> In the USA, the use of DM as the main diagnosis for hospitalization corresponds to a small

proportion of hospitalization days.<sup>7</sup> In Brazil, these hospitalizations in the SUS reached 7.2 per 10.000 inhabitants verified between 1999 and 2001.<sup>32</sup> In absolute figures, the increase reaches 25.8% (137.5 thousand *versus* 109.3 thousand). According to the literature published, diabetes as the main cause of death increased 11% from 1996 to 2000 but then decreased 8% in 2007. On the other hand, mortality associated with diabetes, defined as any mention of such on the death certificate, increase 8% from 2000 to 2007.<sup>8</sup> In a study that estimated the number of hospitalizations attributable to DM and its complications in the private health system, in the region of Ribeirão Preto, São Paulo, only 5.2% of hospitalizations were recorded with DM itself.<sup>33</sup>

Hospitalizations generated by the chronic DM complications and general medical conditions groups predominated (89.7%) in relation to those whose main diagnosis recorded was E10 to E14 from the ICD-10. The importance of hospitalizations owing to cardiovascular disease (CVD) and peripheral vascular disease (PVD) as chronic complications of DM can be seen in Table 1, corresponding to 75.1% of hospitalizations attributable to DM, with 56.3% for CVD and 19% for PVD. In the ADA study (2008),<sup>7</sup> CVD and PVD were responsible for 60.3% of the hospitalizations days attributable to DM (50.7% for CVD and 9.6% for PVD).

The higher mean cost for cardiovascular diseases among the chronic complications attributable to DM was expected, given that such complications present significantly higher costs for their management.<sup>34</sup> Studies that evaluate hospitalization for DM, in addition to serving as indicator of the effectiveness of interventions practiced in terms of prevention and control of DM are also fundamental to estimating the economic impact of the disease and its associated complications for various health system. There is currently a growing need to carry out research in the health technology assessment (HTA) area aimed at determining the effectiveness or efficiency of a health intervention as well as the costs associated with treatment so that only alternatives with cost and effectiveness proven as favorable are incorporated into health systems.<sup>35,36</sup>

It is possible to note an increase in the amount of hospitalizations per 10.000 inhabitants with the increase in age range in practically all conditions, which occurs for both sexes. Females predominated over males when using this indicator per 10.000 inhabitants. The findings are compatible with other studies, such as in Italy, in which women presented higher rates of hospitalization for type DM than men<sup>37</sup> or in the Unified Health System in Brazil.<sup>20</sup>

**TABLE 1** Hospitalizations attributable to diabetes mellitus in the public network per age range, Brazil, 2008-2010

Both sexes	Hospitalizations						
	0 to 19	20 to 44	45 to 64	65 to 74	75+	Total	(%)
<b>Minimum estimated (*)</b>							
Diabetes (E10-E14)	7.964	19.685	53.214	30.934	25.699	137.496	15.3
Chronic complications	2.439	17.267	136.318	104.336	80.549	340.908	38
-- Neurological disease	58	1.069	14.441	13.981	16.488	46.037	-
-- Peripheral vascular disease	333	8.095	32.815	15.321	11.949	68.513	-
-- Cardiovascular disease	218	5.189	77.641	67.037	43.423	193.508	-
-- Renal complications	1.313	2.613	9.942	7.010	7.800	28.678	-
-- Endocrine/metabolic complications	47	33	200	151	210	641	-
-- Ophthalmological complications	7	14	203	192	117	534	-
-- Other chronic complications	463	255	1.076	644	561	2.999	-
General medical conditions	46.188	65.024	166.122	72.255	68.736	418.324	46.6
Total	56.591	101.975	355.653	207.525	174.983	896.727	100
<b>Maximum estimate (**)</b>							
Diabetes (E10-E14)	7.964	19.685	53.214	30.934	25.699	137.496	10.2
Chronic complications	4.426	29.668	198.964	144.790	118.061	495.910	36.6
-- Neurological disease	105	1.894	22.462	20.715	24.545	69.721	-
-- Peripheral vascular disease	604	13.561	44.976	19.532	15.323	93.995	-
-- Cardiovascular disease	396	8.945	112.792	91.986	64.514	278.634	-
-- Renal complications	2.382	4.716	16.220	10.945	12.219	46.481	-
-- Endocrine/metabolic complications	86	59	336	245	340	1.068	-
-- Ophthalmological complications	13	25	323	292	180	832	-
-- Other chronic complications	841	467	1.855	1.076	941	5.179	-
General medical conditions	84.115	118.407	279.764	121.524	115.946	719.756	53.1
Total	96.506	167.759	531.943	297.249	259.706	1.353.162	100

(\*) Fractions attributable to chronic complications and general medical conditions calculated based on the self-reported prevalence from the VIGITEL survey

(\*\*) Fractions attributable to chronic complications and general medical conditions calculated based on the self-reported data expended to include the undiagnosed

In relation to the sensitivity analysis performed with risk variations, this affects only the groups with chronic complications attributable to DM and general medical conditions, given that the data for hospitalizations for DM itself do not depend on the attributable risk method to be calculated. The absolute impact, both for the increase and reduction of risks, was stronger in relation to physical and financial amounts and indicators per 10.000 inhabitants based on the criteria of higher prevalence in relation to lower prevalence owing to the potentiating effect exercised by the former on the proposed variations.

Among the possible limitations of the study we can cite the use of a secondary database not specifically developed to be used in economic studies, instead of obtaining primary data. This limitation was also reported in the last study by the ADA (2008)<sup>7</sup> which, unlike previous ones, used etiologic fractions from a large private da-

tabase. Furthermore, risks relating to hospitalizations attributable to DM derived from international studies were used, given that national data were not located. Lastly, the estimated prevalence of DM originates from extrapolations using self-reported data, even if recent and with national coverage.<sup>21</sup>

## CONCLUSION

In this Brazilian study that estimated the number of hospitalizations attributed to DM in the Unified Health System, the results not only express the importance of DM in terms of the use of health resources but also show that the study of hospitalizations considering only those with DM as the main diagnosis is not sufficient to assess the magnitude of the impact of the disease on public health services and society. The need to use different methodologies was reinforced, such as the attributable risk method, considering that variations in the prevalence of hospitalizations can be

**TABLE 2** Annual costs attributable to diabetes mellitus in the public network per age range, Brazil, 2008-2010

Both sexes	Annual cost (BLR x 1.000)						
	0 to 19	20 to 44	45 to 64	65 to 74	75+	Total	(%)
<b>Minimum estimate (*)</b>							
Diabetes (E10-E14)	6.297,44	15.420,48	29.824,03	17.462,62	14.691,13	83.695,7	7.2
Chronic complications	1.681,29	18.050,21	254.444,56	205.979	119.929,65	600.084,7	51.4
-- Neurological disease	124,63	2.428,02	28.925,35	23.219,24	23.300,36	77.997,6	
-- Peripheral vascular disease	162,35	4.865,19	28.574,22	19.211,76	15.830,2	68.643,72	
-- Cardiovascular disease	487,2	8.365,58	183.669,51	156.230,48	74.853,54	423.606,31	
-- Renal complications	690,65	2.222,72	12.377,35	6.671,14	5.383,93	27.345,79	
-- Endocrine/metabolic complications	20,41	19,75	109,29	76,55	89,34	315,34	
-- Ophthalmological complications	3,78	7,61	107,23	99,12	61,48	279,21	
-- Other chronic complications	192,26	141,34	681,62	470,71	410,8	1.896,73	
General medical conditions	42.369,18	53.779,26	207.792,18	95.391,53	84.272,97	483.605,11	41.5
Total	50.347,90	87.249,95	492.060,76	318.833,15	218.893,74	1.167.385,51	100
<b>Maximum estimate (**)</b>							
Diabetes (E10-E14)	6.297,44	15.420,48	29.824,03	17.462,62	14.691,13	83.695,70	4.7
Chronic complications	3.050,22	31.203,62	373.522,43	285.367,04	175.910,01	869.053,33	48.9
-- Neurological disease	226,14	4.300,80	44.980,35	34.344,53	34.639,12	118.490,94	
-- Peripheral vascular disease	294,83	8.148,93	38.932,32	24.482,19	20.265,59	92.123,86	
-- Cardiovascular disease	884,10	14.441,19	267.886,42	215.075,24	111.649,27	609.936,22	
-- Renal complications	1.252,07	4.004,80	20.194,09	10.403,44	8.428,61	44.283,01	
-- Endocrine/metabolic complications	37,09	35,90	183,95	124,33	145,02	526,29	
-- Ophthalmological complications	6,88	13,63	170,54	150,95	94,11	436,11	
-- Other chronic complications	349,10	258,38	1.174,76	786,37	688,29	3.256,91	
General medical conditions	77.290,35	97.774,81	348.921,61	160.261,77	141.994,40	826.242,94	46.5
Total	86.638,01	144.398,91	752.268,08	463.091,43	332.595,54	1.778.991,96	100

(\*) Fractions attributable to chronic complications and general medical conditions calculated based on the self-reported prevalence from the VIGITEL survey

(\*\*) Fractions attributable to chronic complications and general medical conditions calculated based on the self-reported data expended to include the undiagnosed

attributed to chronic complications in DM and not the disease itself. The increased number of hospitalizations and its associated costs in higher age ranges shows the possible failures existing in the prevention and rigorous control of the disease that could avoid this progression, improving the health of patients and avoiding high treatment costs.

## RESUMO

Hospitalizações atribuíveis ao diabetes melito no sistema de saúde público do Brasil (2008 a 2010): estudo DIAPS 79

**Objetivo:** estimar o número de hospitalizações atribuíveis ao diabetes melito (DM) e suas complicações no Sistema Único de Saúde (SUS) brasileiro e avaliar o valor médio pago por hospitalização.

**Métodos:** foram consultados bancos de dados do Sistema de Informações Hospitalares do Sistema Único de Saúde (SIH/SUS), no período de 2008 a 2010. As proporções de hospitalizações atribuíveis ao DM foram estimadas por meio da metodologia do risco atribuível. O custo médio por hospitalização correspondeu aos custos diretos médicos em enfermagem e tratamento intensivo, sob a perspectiva do SUS.

**Resultados:** hospitalizações atribuíveis ao DM corresponderam a 8,1 a 12,2% do total de internações no período, variando de acordo com a utilização de prevalência máxima (autorreferida com fator de correção) ou mínima (autorreferida) para DM. A taxa de hospitalização foi de 47 a 70,8 por 10 mil habitantes por ano. O custo médio por hospitalização variou de R\$ 1.302 a R\$ 1.315. Assumindo-se a prevalência máxima, as hospitalizações se

**TABLE 3** Hospitalizations attributable to diabetes mellitus per 10.000 inhabitants in the public network, per age range, Brazil, 2008-2010

	Hospitalizations					
	Total	0 to 19	20 to 44	45 to 64	65 to 74	75+
<b>Minimum estimate (*)</b>						
Diabetes (E10-E14)	7.2	1.3	2.6	14.5	36	46.7
Chronic complications	17.9	0.4	2.2	37.1	121.6	146.5
-- Neurological disease	2.4	0	0.1	3.9	16.3	30
-- Peripheral vascular disease	3.6	0.1	1.1	8.9	17.9	21.7
-- Cardiovascular disease	10.1	0	0.7	21.1	78.1	79
-- Renal complications	1.5	0.2	0.3	2.7	8.2	14.2
-- Endocrine/metabolic complications	0	0	0	0.1	0.2	0.4
-- Ophthalmological complications	0	0	0	0.1	0.2	0.2
-- Other chronic complications	0.2	0.1	0	0.3	0.7	1
General medical conditions	21.9	7.3	8.4	45.2	84.2	125
Total	47	9	13.2	96.8	241.8	318.2
<b>Maximum estimate (**)</b>						
Diabetes (E10-E14)	7.2	1.3	2.6	14.5	36	46.7
Chronic complications	26	0.7	3.8	54.1	168.6	214.5
-- Neurological disease	3.7	0	0.2	6.1	24.1	44.6
-- Peripheral vascular disease	4.9	0.1	1.8	12.2	22.7	27.8
-- Cardiovascular disease	14.6	0.1	1.2	30.7	107.1	117.2
-- Renal complications	2.4	0.4	0.6	4.4	12.7	22.2
-- Endocrine/metabolic complications	0.1	0	0	0.1	0.3	0.6
-- Ophthalmological complications	0	0	0	0.1	0.3	0.3
-- Other chronic complications	0.3	0.1	0.1	0.5	1.3	1.7
General medical conditions	37.7	13.3	15.3	76	141.4	210.5
Total	70.8	15.3	21.8	144.5	346	471.7

(\*) Fractions attributable to chronic complications and general medical conditions calculated based on the self-reported prevalence from the VIGITEL survey

(\*\*) Fractions attributable to chronic complications and general medical conditions calculated based on the self-reported data expended to include the undiagnosed

distribuíram em 10,3% como DM propriamente dito, 36,6% associadas às complicações crônicas do DM e 53,1% atribuídas a condições médicas gerais. O avanço da idade foi acompanhado pelo aumento nas taxas de hospitalizações e nos custos médios correspondentes, sendo mais acentuado nos pacientes do gênero masculino.

**Conclusão:** os resultados expressam a importância do DM em termos de utilização de recursos de saúde e evidenciam que o estudo das hospitalizações com diagnóstico principal de DM não são suficientes para avaliar a magnitude do impacto dessa doença no SUS.

**Unitermos:** avaliação em saúde; complicações do diabetes; custos e análise de custo; diabetes melito.

## REFERENCES

- World Health Organization. WHO Diabetes programme; 2011 [cited 2011 Dec 28]. Available from: <http://www.who.int/diabetes/en/>.
- Brownlee M. Biochemistry and molecular cell biology of diabetic complications. *Nature*. 2001;414(6865):813-20.
- Brownlee M. The pathobiology of diabetic complications: a unifying mechanism. *Diabetes*. 2005;54(6):1615-25.
- World Health Organization. Screening for type 2 diabetes. Geneva: WHO; 2003.
- Barceló A, Rajpathak S. Incidence and prevalence of diabetes mellitus in the Americas. *Pan Am J Publ Health*. 2001;10(5):300-8.
- Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care*. 2004;27(3):1047-53.
- American Diabetes Association. Economic costs of Diabetes in the U.S. in 2007. *Diabetes Care*. 2008;31(3):596-615.
- Schmidt MI, Duncan BB, Azevedo e Silva G, Menezes AM, Monteiro CA, Barreto SM, et al. Chronic non-communicable diseases in Brazil: burden and current challenges. *Lancet*. 2011;377(9781):1949-61.
- Malerbi DA, Franco LJ. Multicenter study of the prevalence of diabetes mellitus and impaired glucose tolerance in the urban Brazilian population aged 30-69 yr. The Brazilian non-communicable diseases in Brazil: Prevalence. *Diabetes Care*. 1992;15(11):1509-16.
- Torquato MTDCG, Montenegro Junior RM, Viana LAL, Souza RAHGD, Lanna CMM, Lucas JCB, et al. Prevalence of diabetes mellitus and impaired glucose tolerance in the urban population aged 30-69 years in Ribeirão Preto (São Paulo), Brazil. *São Paulo Med J*. 2003;121(6):224-30.
- Schaan BDA, Harzheim E, Gus I. Cardiac risk profile in diabetes mellitus and impaired fasting glucose. *Rev Saúde Pública*. 2004;38(4):529-36.



12. Costa JSD, Olinto MTA, Assunção MCF, Gigante DP, Macedo S, Menezes AMB. Prevalence of Diabetes Mellitus in Southern Brazil : a population-based study. *Rev Saude Pública.* 2006;40(3):542-5.
13. Brasil, Ministério da Saúde, Secretaria de Vigilância em Saúde. *Vigitel Brasil 2010: vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico.* Brasília (DF): Ministério da Saúde; 2011.
14. Yach D, Stuckler D, Brownell K. Epidemiologic and economic consequences of the global epidemics of obesity and diabetes. *Nat Med.* 2006;12(1):62-6.
15. Barceló A, Aedo C, Rajpathak S, Robles S. The cost of diabetes in Latin America and the Caribbean. *Bull World Health Organ.* 2003;81(1):19-27.
16. American Diabetes Association. Economic costs of Diabetes in the U.S. in 2002. *Diabetes Care.* 2006;26(3):917-32.
17. Gagliardino JJ, Williams R, Clark CM. Using hospitalization rates to track the economic costs and benefits of improved diabetes care in the Americas. *Diabetes Care.* 2000;23(12):1844-6.
18. American Diabetes Association. Economic consequences of diabetes mellitus in the U.S. in 1997. *Diabetes Care.* 1998;21(2):296-309.
19. Dawson KG, Gomes D, Gerstein H, Blanchard KF, Kahler KH. The economic cost of diabetes in Canada, 1998. *Diabetes Care.* 2002;25(8):1303-7.
20. Rosa RS, Schmidt MI. Diabetes mellitus: magnitude das hospitalizações na rede pública do Brasil, 1999-2001 [Resumo]. *Epidemiol Serv Saúde.* 2008;17(2):123-53.
21. Schmidt MI, Duncan BB, Hoffmann JF, Moura L, Malta DC, Carvalho RMSV. Prevalência de diabetes e hipertensão no Brasil baseada em inquérito de morbidade auto-referida, Brasil, 2006. *Rev Saude Pública.* 2009;43(Supl 2):74-82.
22. Moura EC, Moraes Neto OL, Malta DC, Moura L, Silva NN, Bernal R. Vigilância de fatores de risco para doenças crônicas por inquérito telefônico nas capitais dos 26 estados brasileiros e no Distrito Federal (2006). *Rev Bras Epidemiol.* 2008;11(Supl 1):20-37.
23. Malerbi DA, Franco LJ. Multicenter study of the prevalence of diabetes mellitus and impaired glucose tolerance in the urban Brazilian population aged 30-69 yr. *Diabetes Care.* 1992;15(11):1509-16.
24. Rosa RS. Diabetes mellitus: magnitude das hospitalizações na rede pública do Brasil, 1999-2001. Porto Alegre: UFRGS; 2006.
25. Nedel FB, Facchini LA, Martin M, Navarro A. Características da atenção básica associadas ao risco de internar por condições sensíveis à atenção primária: revisão sistemática da literatura. *Epidemiol Serv Saúde.* 2010;19(1):61-75.
26. Alfradique ME, Bonolo PF, Dourado I, Lima-Costa MF, Macinko J, Mendonça CS, et al. 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 Saúde Pública.* 2009;25(6):1337-49.
27. Luft VC, Giugliani C, Harzheim E, Schmidt MI, Duncan BB. Prevalence of use and potential impact of increased use of primary care interventions to prevent cardiovascular hospitalizations in patients with diabetes. *Diabetes Res Clin Pract.* 2009;85(3):328-34.
28. Viacava F. Acesso e uso de serviços de saúde pelos brasileiros, 2010. Rio de Janeiro: FIOCRUZ; 2010.
29. Lima-Costa MF, Matos DL, Camargos VP, Macinko J. Tendências em dez anos das condições de saúde de idosos brasileiros: evidências da Pesquisa Nacional por Amostra de Domicílios (1998, 03, 2008). *Ciênc Saúde Coletiva.* 2011;16(9):3689-96.
30. Torquato MT, Montenegro Júnior RM, Viana LA, de Souza RA, Lanna CM, Lucas JC, et al. Prevalence of diabetes mellitus and impaired glucose tolerance in the urban population aged 30-69 years in Ribeirão Preto (São Paulo), Brazil. *São Paulo Med J.* 2003;121(3):224-30.
31. Bosi PL, Carvalho AM, Contrera D, Casale G, Pereira MA, Gronner MF, et al. Prevalência de diabetes melito e tolerância à glicose diminuída na população urbana de 30 a 79 anos da cidade de São Carlos, São Paulo. *Arq Bras Endocrinol Metab.* 2009;53(6):726-32.
32. Rosa RS, Schmidt MI, Duncan B, Souza MFM, Lima AK, Moura L. Internações por Diabetes Mellitus como diagnóstico principal na Rede Pública do Brasil, 1999-2001. *Rev Bras Epidemiol.* 2007;10(4):465-78.
33. Rosa R, Bahia L, Monteiro R, Asano E, Nita ME, Donato BM; DIAPS79 study group. Hospitalization attributed to diabetes mellitus and its complications in the private health-care system in Ribeirão Preto Region, Brazil. In: ISPOR 13th Annual European Congress, 2010. Praga, República Tcheca. *Value Health.* 2010;13:A286.
34. Mody R, Kalsekar I, Kavookjian J, Iyer S, Rajagopalan R, Pawar V. Economic impact of cardiovascular co-morbidity in patients with type 2 diabetes. *J Diabetes Complications.* 2007;21(2):75-83.
35. Nita ME, Secoli SR, Nobre M, Ono-Nita SK, Campino ACC, Sarti FM, et al. Avaliação de tecnologias em saúde: evidência clínica, análise econômica e análise de decisão. Porto Alegre: Artmed; 2010.
36. Nita ME, Secoli SR, Nobre M, Ono-Nita S. Health technology assessment: research methodology. *Arq Gastroenterol.* 2009;46(4):252-6.
37. Bo S, Ciccone G, Grassi G, Gancia R, Rosato R, Merletti F, et al. Patients with type 2 diabetes had higher rates of hospitalization than the general population. *J Clin Epidemiol.* 2004;57:1196-201.