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ORIGINAL ARTICLE

Direct and indirect costs associated to type 2 diabetes and its complications measured in a social security institution of Argentina

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Abstract
Objectives To estimate direct and indirect costs of care of type 2 diabetes (T2DM) and its complications in Argentina, and compare them with those recorded in people without diabetes (ND).
Methods Observational retrospective case–control study performed in one institution of the Social Security System of Argentina. Participants were identified and randomly selected from the Institution's electronic medical records. We recruited persons with T2DM with (387) or without (387) chronic complications and 774 ND, matched by age and gender. Data were obtained by telephone interviews and supplemented with data from the Institution's records. Parametric and non-parametric tests were used for group comparisons.
Results Direct costs were higher in people with T2DM than in ND: twice as high in people with T2DM without complications and 3.6 times in those with complications. Absenteeism was only higher in T2DM with complications, but there were no differences among groups either in the duration or in the cost of such absenteeism.
Conclusions T2DM and the development of its complications are positively associated with higher direct costs in Argentina.

Keywords Direct costs · Indirect costs · Type 2 diabetes · Chronic complications · Argentina

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Introduction

Several studies have clearly shown the increasing cost of diabetes worldwide with its negative impact on health care budgets (Zhang et al. 2010) and productivity (Tunceli et al. 2005). In the case of the US, the American Diabetes Association (ADA) estimated that in 2012 people with diabetes incurred $306 billion in direct medical costs, more than 1 of 5 dollars spent on medical care (American Diabetes Association 2013a). It has also been estimated that the annual medical expenditures of people with diagnosed diabetes are approximately 2.3 times higher than those of people without the disease (American Diabetes Association 2013a). A recent publication shows that in China, within a completely different context, health care use and costs for people with diabetes are much higher than those for people with normal glucose tolerance (Yang et al. 2012); in relative terms, such costs were higher than those of industrialized countries.

The increasing economic burden of diabetes is due to (a) the increase in the number of people with diagnosed

diabetes (International Diabetes Federation 2011), (b) the increased frequency of chronic complications, particularly cardiovascular and renal disease, which change health care practices (Zhuo et al. 2013), and (c) the wider application of new and expensive technologies and treatments (Alexander et al. 2008).

In Argentina, diabetes prevalence rose from 8.4 % in 2005 to 9.6 % in 2009 (Ferrante et al. 2011). This figure indicates that the economic burden of the disease will certainly increase in the near future unless certain effective policies are implemented to prevent diabetes growth. However, in Argentina as well as in many developing countries, there are few studies on diabetes costs, particularly type 2 diabetes (T2DM) and its complications. These data are important for health authorities to design effective health policies and to allocate adequate human and economic resources for their implementation according to real demand. Consequently, the aim of this study was to obtain an economic perspective of T2DM costs in Argentina to cover such gap.

Methods

Study design and people included

This is an observational retrospective research study carried out as a case–control study, comparing direct and indirect cost of people with T2DM with (w/C) or without (w/o C) micro- and macrovascular chronic complications and those of people without the disease (non-diabetic group, ND) matched by gender and age (±3 years).

The study was performed in one institution of our Social Security System (SSS), the Hospital Privado de Córdoba (HPC), with similar organizational characteristics and patient population to other entities of this system. The HPC has electronic ambulatory medical records of all affiliates that include personal information (age, gender), diagnosis [International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) (World Health Organization 2008)], clinical, biochemical and therapeutic data, diagnostic procedures and treatment prescriptions. In these records, we identified people with T2DM (American Diabetes Association criteria) (American Diabetes Association 2013b) who had between 20 and 75 years of age and at least 2 years of follow-up at the HPC. These people were thereafter classified, according to the above mentioned ICD-10 into: i) people without micro and macrovascular chronic complications (T2DM w/o C), and ii) people with any chronic microvascular (retinopathy, neuropathy and nephropathy) and macrovascular (myocardial infarction, cerebrovascular accident and amputations) complications (T2DM w/C). In the records, these complications were assessed by clinical evaluation, laboratory and special tests results. From this list of candidates, we randomly selected 500 people with T2DM w/o C and 500 T2DM w/C paired by age and gender. In a second step, we identified from the database ND persons between 20 and 75 years, sorted out and stratified by age and gender. Thereafter, people with T2DM were matched for age and gender with 1,500 ND affiliates (3:1 ratio). The ND affiliates were selected by stratified simple random sampling.

From the 2,500 persons invited to participate in the study (1,500 ND, 500 T2DM w/o C and 500 T2DM w/C), 1,877 agreed to do so and answered the questionnaire (Fig. 1). From this population, 37 cases were excluded because they did not fully fit the inclusion criteria (they were not within the age range selected or their T2DM was inappropriate for the criteria chosen), 38 cases for serious inconsistencies between their questionnaire answers and data in their clinical records, and 8 cases because their expenditure figures were far from the whole expenditure distribution and associated to severe diseases unrelated to diabetes. From the remaining 1,796 cases, 248 cases were finally excluded because it was not possible to find an appropriate age- and gender-matched pair either in the diabetes (w/and w/o C) or the ND groups. The final sample size was thus 1,548 cases: 774 ND and 774 with T2DM (387 w/o C and 387 w/C). No significant differences were found in the baseline data recorded in the clinical and metabolic profiles between the participating cases and those excluded.

We estimated that a sample size of 275 subjects in each group was necessary to assure an approximate 80 % power, at an alpha and beta error of 0.05 and 20 %, respectively, based on the differences in expenditure values among the three experimental groups. We thereafter increased this sample size assuming that there would be approximately 25 % of non-responses. Consequently, we included 344 persons with T2DM per group (w/C or w/o C) and 688 persons in the ND group.

Data collection

People from every group were invited by phone to participate in the study (March to April 2011); as already mentioned, 1,877 persons agreed to participate. Acceptance rate was similar in both T2DM groups and higher than in the ND group (Fig. 1). Such difference could be due to the fact that the former groups are regularly contacted by phone as part of the HPC follow-up program of chronic diseases.

For the telephone interviews, we used the questionnaire developed and implemented by the International Diabetes Federation (IDF) to determine the social and economic impact of diabetes (International Diabetes Federation 2010). For this purpose, we obtained IDF consent to use

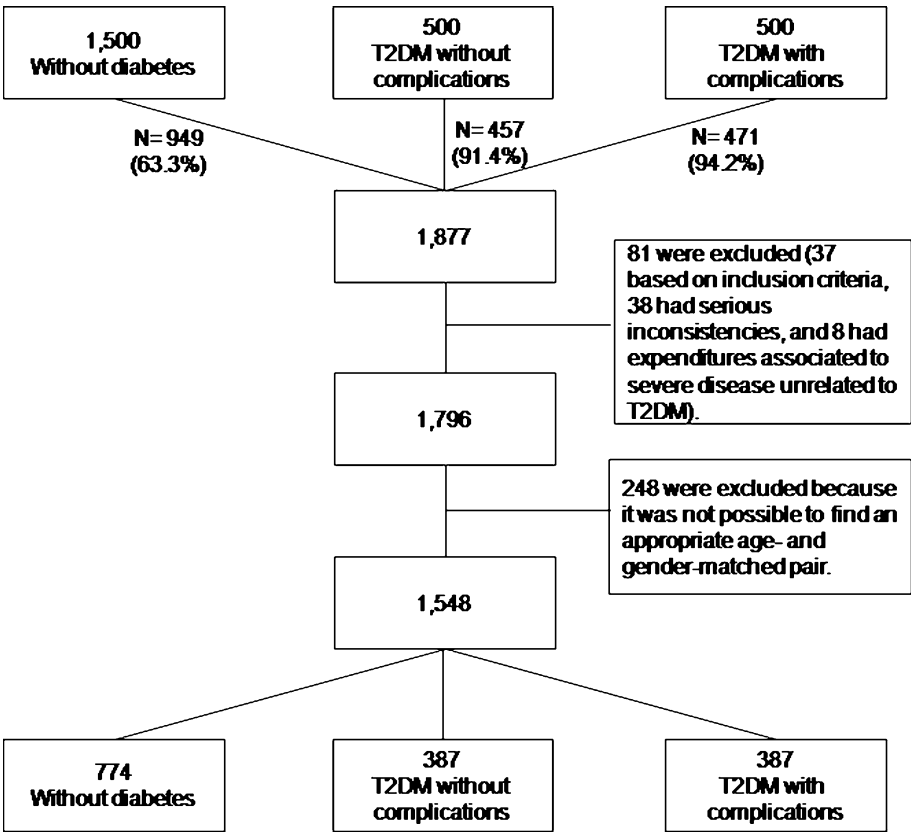

Fig. 1 Flowchart depicting the process of sample selection

and adapt this questionnaire to our context, mainly the way to formulate the questions, as well as to have scientific advice during the study implementation.

To collect the data, all the participants answered identical questions except for a few about diabetes treatment that were asked only to people with T2DM. To improve the accuracy of recall during the interview, we asked about events occurring only during the previous 90 days. In the questionnaire, we requested information about demographics characteristics, impact of diabetes on income, employment characteristics and education level attained, as well as about quality of life and use of medical resources. To ensure a more precise description of resource utilization and costs of care, the interview data were supplemented with data obtained from the HPC database for the same period of time. These data comprised the expenditure of medications, laboratory tests and procedures, hospitalizations and medical and other associated health professional outpatient visits (consultations) from each participant of the study.

Estimated cost

Direct medical and indirect costs were estimated for each group and are expressed during a 3-month period (90 days).

Direct medical costs comprised the costs related to medications (including out-of-pocket payment for prescribed drugs), laboratory tests and procedures, hospitalizations, medical and other associated health professional outpatient visits (consultations). Direct medical costs and health care utilization were obtained from the administrative database; they reflect charges without adjustment and are expressed in Argentine pesos (AR$) for the year 2011.

The indirect costs assessed were absenteeism and the resulting loss of productivity for patients and their caregivers. The human capital approach was adopted to estimate indirect costs (Rice 1967). This method assumes that the value of lost work is equal to the amount of money, which the individual would have been paid to do that work. The mean monthly income for each group and the value of working days were used to calculate the cost of lost workdays. The data needed were obtained from the telephone cost questionnaire.

Data analysis

The data collected through questionnaires and HPC's records were electronically stored into a database. Statistical analyses were done using the Statistical Package for Social Sciences version 15 (SPSS Inc, Chicago, IL, USA). Descriptive statistics are presented as percentages and mean with a 95 % confidence interval. Group comparisons for continuous variables were performed by ANOVA, the Student *t* test, Mann–Whitney *U* test and Kruskal–Wallis test according to the data distribution profile. The Chi-

Table 1 Demographic and socioeconomic characteristics of the study population, Argentina, 2011

Variable	ND	T2DM w/o C	T2DM w/C
n	774	387	387
Female (%)	54.7	54.7	54.7
Age (years, mean ± SD)	62.4 ± 9.3	62.8 ± 9.5	63.3 ± 9.1
Diabetes duration (years, mean ± SD)	–	8.1 ± 8.4	10.8 ± 9
University degree (%)	54.1	44.5†	42.4†
Monthly household income (AR$, median [IQR])	5,674 (3,486–7,111)*‡	4,000 (2,906–6,642)	3,929 (2,895–5,000)
Monthly income > AR$ 5,000 (%)	52.6	33.2†	24.5*†

ND without diabetes, *T2DM w/o C* T2DM without complications, *T2DM w/C* T2DM with complications, *SD* standard deviation, *IQR* interquartile range

* Significant compared with T2DM w/o complications ($P < 0.05$)

† Significant compared to ND ($P < 0.05$)

‡ Significant compared to T2DM w/complications ($P < 0.05$)

squared statistic was used to test differences between proportions. The two-sided level of significance was established at $P \leq 0.05$.

Ethical issue

The study protocol was analyzed and approved by the Bioethical Committee of the National University of La Plata and the Ethical Committee of the HPC. The study was developed according to the Good Practice Recommendations (International Harmonisation Conference) and the ethical guidelines of the Helsinki Declaration. Likewise, this procedure ensured compliance with the National Law 25.326 of Personal Data Protection. The protocol was read to each participant who was incorporated into the study only after providing oral informed consent. The data collected were numerically coded for anonymity and protection from unauthorized use by people not involved in the study.

Results

Sample characteristics

Fifty-five percent were women with an average age of 63 ± 9 years. Diabetes duration was significantly longer in T2DM w/C than in T2DM w/o C (10.8 ± 9 versus 8.1 ± 8.4). Table 1 summarizes the demographic and socioeconomic features of the sample.

Use of medical services

As shown in Fig. 2, over 80 % of people with T2DM both w/o and w/C self-reported using some type of medical service/resource during the preceding 90 days (this includes visiting any kind of health institution to obtain any kind of medical care or service). ND used significantly less medical resources than both T2DM w/o C (74.2 versus 84.2 %) and T2DM w/C (74.2 versus 87.5 %).

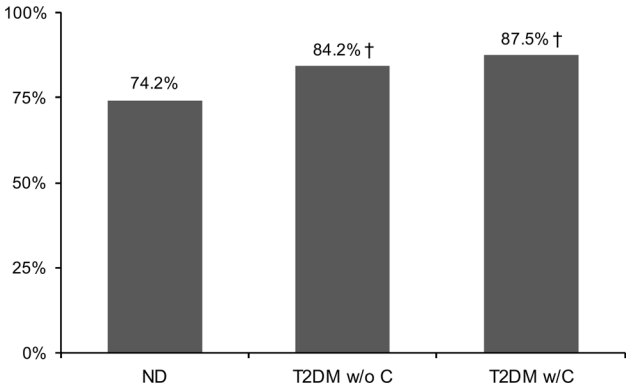

Fig. 2 Self-reported use of medical services, Argentina, 2011. *ND* People without diabetes, *T2DM w/o C* T2DM without complications, *T2DM w/C* T2DM with complications. †Significant compared with ND ($P < 0.05$)

Medical resource use was also measured based on the HCP's personal records (Table 2). This assessment confirmed that people with T2DM either w/or w/o C consumed significantly more medical resources than those in the ND group ($P < 0.05$).

On the other hand, medication and procedure consumption was significantly higher in T2DM w/than w/o C ($P < 0.05$).

Direct costs

The main components of direct medical costs (physician visits, medications, procedures, laboratory tests and hospitalizations) are summarized in Table 3. Total cost and each cost component were significantly higher in people

Table 2 Use of medical service recorded in the institutional database, Argentina, 2011

Type of resource	Group		
	ND (%)	T2DM w/o C (%)	T2DM w/C (%)
Physician visit	48.1	83.7†	89.3†
Medication	19.3	64.5†	77.3*†
Procedures	29.7	52.7†	65.3*†
Laboratory tests	22.9	64.5†	71.5†
Hospitalization	4.6	4.5	9.9†
Use of any type of medical service	51.2	89.4†	91.3†

ND without diabetes, *T2DM w/o C* T2DM without complications, *T2DM w/C* T2DM with complications

* Significant compared with T2DM w/o complications ($P < 0.05$

† Significant compared with ND ($P < 0.05$)

with T2DM w/C compared with either T2DM w/o C (78 %) or the ND group (262 %). On the other hand, only physician visits and medication were significantly higher in people with T2DM w/o C compared with the ND group.

Indirect costs

While figures for absenteeism were significantly higher in T2DM w/C than in the other two groups, there were no differences among groups either in the duration or in the cost of such absenteeism (Table 4). Interestingly, absenteeism cost was higher but not significant in the ND group, due to the higher income of this group as compared with the other two (Table 1).

The percentage of people requiring home care was significantly larger in the T2DM w/C than in the other two groups; however, no significant differences were recorded either in the length of days or in the family caregiver cost (Table 4). Once again, the percentage of non-relative caregiver was significantly larger in the group of T2DM w/C than in the other two groups.

Discussion

Our data show that the presence of chronic complications increases the medical direct costs of people with diabetes. These costs were almost twice as much for people with T2DM w/o C and 3.6 times in T2DM w/C compared with the ND group. These data support the concept that the clinical diagnosis of diabetes is often the end of a process leading to established complications and is associated with a larger utilization of care resources (Zhuo et al. 2013). A similar high cost of diabetes has been reported in many studies, regardless of their performance in either developed or developing countries. In Poland, for example, direct medical service costs doubled in the period 2005–2009; the disease was responsible for significant absenteeism and incapacity for work and associated with a productivity decline. The highest direct and indirect costs were associated with treatment of diabetes-related complications (Leśniowska et al. 2014). Similarly, in Saudi Arabia, medical healthcare expenditures of people with diabetes were on average ten times higher than those recorded in the absence of the disease (Alhowaish 2013). In Brazil, people with T2DM and both micro- and macrovascular complications had higher costs (US$ 3,199 per patient) compared with those with either microvascular (US$ 2,062 per patient) or macrovascular (US$ 2,517 per patient) complications only. The greatest portion of direct costs was attributed to medication (48.2 %) (Bahia et al. 2011). Direct medical cost accounted for the largest proportion of the economic costs of diabetes in a rural area of China (Le

Table 3 Mean direct costs of people included in Table 2, Argentina, 2011

Type cost (AR$)	ND		T2DM w/o C			T2DM w/C			*P*
	Mean (95 % CI)	*n*	Mean (95 % CI)	*n*	Ratio[a]	Mean (95 % CI)	*n*	Ratio[a]	
Physician visits	37.3 (34.1–40.5)	373	54.0† (49.7–58.4)	324	1.45	67.1*† (61.3–72.9)	345	1.80	<0.001
Medication	325.7 (275.6–375.8)	150	654.3† (549.3–759.4)	250	2.01	1,140.0*† (924.2–1,355.8)	299	3.50	<0.001
Procedures	338.3 (284.5–392.1)	230	345.7 (275.1–416.3)	204	1.02	486.4*† (410.1–562.7)	253	1.44	0.030
Laboratory tests	142.1 (123.0–161.2)	177	181.3 (166.8–195.8)	250	1.28	238.9*† (212.8–265.1)	277	1.68	<0.001
Hospitalization	1,674.6 (1,226.3–2,122.8)	36	1,005.3 (529.2–1,481.4)	17	0.60	3,079.4* (2,268.9–3,879.8)	38	1.84	0.017
Total medical cost	508.3 (433.2–583.4)	396	904.6† (776.9–1,032.3)	346	1.78	1,841.8*† (1,595.5–2,088.0)	353	3.62	<0.001

ND without diabetes, *T2DM w/o C* type 2 diabetes without complications, *T2DM w/C* type 2 diabetes with complications, *AR$* Argentine pesos, *CI* confidence interval

[a] Based on ND

* Significant compared with T2DM w/o complications ($P < 0.05$)

† Significant compared with ND ($P < 0.05$)

Table 4 Indirect costs, Argentina, 2011

Type	ND	T2DM w/o C		T2DM w/C		*P*
	Value (95 % CI)	Value (95 % CI)	Ratio[a]	Value (95 % CI)	Ratio[a]	
Absenteeism (%)	19.4 (16.7–22.4)	21.5 (17.5–25.9)	1.11	33.0*† (28.2–37.8)	1.70	<0.001
Absenteeism (days/person)	40.2 (34.5–45.9)	39.4 (31.9–46.9)	0.98	49.2 (43.1–55.2)	1.22	NS
Absenteeism cost (AR$)[b]	8,430.3 (6,879.1–9,981.4)	5,515.7 (4,294.4–6,736.9)	0.65	7,957.6 (6,269.8–9,645.3)	0.94	NS
Family caregiver (%)	7.8 (6.0–9.9)	7.8 (5.4–10.9)	1.00	19.2*† (15.4–23.5)	2.46	<0.001
>50 % of a day (%)	39.6 (26.8–53.9)	41.4 (24.1–60.9)	1.05	40.6 (29.1–53.1)	1.03	NS
Family caregiver cost (AR$)[b]	6,138.1 (5,314.6–6,961.6)	5,160.0 (3,916.6–6,403.4)	0.84	5,895.7 (5,114.5–6,676.8)	0.96	NS
Non-family caregiver (%)	3.4 (2.2–4.9)	2.1 (1.0–4.2)	0.62	5.6* (3.7–8.6)	1.65	<0.001

ND without diabetes, *T2DM w/o C* type 2 diabetes without complications, *T2DM w/C* type 2 diabetes with complications *AR$* Argentine pesos, *CI* confidence interval, *NS* not significant

[a] Based on ND

[b] Household Income ND > T2DM w/o C > T2DM w/C (Elgart et al. 2014)

* Significant compared with T2DM w/o C ($P < 0.05$)

† Significant compared with ND ($P < 0.05$)

et al. 2013). In the US, people with diagnosed diabetes, on average, have medical expenditures approximately 2.3 times higher than people without the disease. The largest component of medical expenditures was hospital inpatient care, accounting for 43 % of the total medical cost (American Diabetes Association 2013a). Comparable data regarding the percentage impact of hospitalization on medical costs were recorded in Europe in the CODE-2 study (Williams et al. 2002; Jönsson and CODE-2 Advisory Board 2002). Similarly, in our study hospitalization represented the main cost related to people with T2DM w/C (Table 3), while comparable and lower figures were recorded in the T2DM w/C and ND groups. Additionally, we have previously reported that the per capita hospitalization cost for people with diabetes was significantly higher than that for people without the disease (US$ 1,628 versus US$ 833 in 2004) (Caporale et al. 2013).

Diabetes does not only affect direct medical costs, but it also impacts negatively on working productivity as shown by our data, indicating that indirect costs were larger than direct ones. Such negative impact of diabetes and its complications on productivity has been also shown in other countries with different social and productivity settings; in Brazil, diabetes was estimated to be responsible for 278,778 years of potential life lost for every 100,000 people. Also, the total annual cost for outpatient care was US$ 2,108 per patient, out of which 63.3 % corresponded to direct costs and 36.7 % to indirect costs (Bahia et al. 2011; Bertoldi et al. 2013). In Mexico, indirect costs represented 56 % of the total $7.7 billion (in 2011 US dollars) spent on diabetes care (Arredondo and Reyes 2013). Indirect costs represented 59 % of diabetes costs in the UK in the 2010/2011 period (Hex et al. 2012). In the US, indirect costs include increased absenteeism ($5 billion) and reduced productivity while at work ($20.8 billion) for the employed population, reduced productivity for those not in the labor force ($2.7 billion), inability to work as a result of disease-related disability ($21.6 billion), and lost productive capacity due to early mortality ($18.5 billion) (American Diabetes Association 2013a). Thus, with a different magnitude and economic figures, diabetes consistently increases indirect cost and significantly decreases working productivity everywhere.

Despite the current data consistently reproduced those previously reported in other studies performed either in our as well as in other countries, they should be considered with caution, because (a) the list of complications is broad, so that the expenditure difference between those with complications and those without is rather low; additionally, some complications such as end-stage renal disease and major cardiovascular events would have a much larger impact; and (b) although the Social Security System of Cordoba is a good example of the national system, the data analyzed could differ from others collected all over the country. Consequently, our study should mainly raise awareness on the need for careful policies and the opportunity to prevent expenditures and costs to government, businesses and families rather than a provision of data on recommended health policies.

As the prevalence of diabetes continues to increase, its financial burden will increasingly weigh heavily on social security resources and government budgets. Additionally, in middle-income countries such as Argentina, health disparities generated by the economic burden of diabetes are one of the main reasons for catastrophic health expenditures (Arredondo and Reyes 2013). For this reason, some

authors suggest that it is necessary to move from biomedical models and curative health care to preventive and socio-medical models to cope with diabetes challenges (Arredondo and Reyes 2013). Since education strategies implemented at every level were effective to decrease the cost of diabetes and optimize the use of economic resources (Gagliardino et al. 2001, 2006, 2012, 2013; Trento et al. 2010), their worldwide implementation could decrease the burden that diabetes imposes on people, the health care system and society overall.

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Conflict of interest The authors have no conflicts of interest.

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