

# The cost of diabetes in Latin America and the Caribbean

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**Objective** To measure the economic burden associated with diabetes mellitus in Latin America and the Caribbean.

**Methods** Prevalence estimates of diabetes for the year 2000 were used to calculate direct and indirect costs of diabetes mellitus. Direct costs included costs due to drugs, hospitalizations, consultations and management of complications. The human capital approach was used to calculate indirect costs and included calculations of forgone earnings due to premature mortality and disability attributed to diabetes mellitus. Mortality and disability attributed to causes other than diabetes were subtracted from estimates to consider only the excess burden due to diabetes. A 3% discount rate was used to convert future earnings to current value.

**Findings** The annual number of deaths in 2000 caused by diabetes mellitus was estimated at 339 035. This represented a loss of 757 096 discounted years of productive life among persons younger than 65 years (>US\$ 3 billion). Permanent disability caused a loss of 12 699 087 years and over US\$ 50 billion, and temporary disability caused a loss of 136 701 years in the working population and over US\$ 763 million. Costs associated with insulin and oral medications were US\$ 4720 million, hospitalizations US\$ 1012 million, consultations US\$ 2508 million and care for complications US\$ 2480 million. The total annual cost associated with diabetes was estimated as US\$ 65 216 million (direct US\$ 10 721; indirect US\$ 54 496).

**Conclusion** Despite limitations of the data, diabetes imposes a high economic burden to individuals and society in all countries and to Latin American and the Caribbean as whole.

**Keywords** Diabetes mellitus/economics/complications; Cost of illness; Health care costs; Disabled persons; Value of life/economics; Latin America; Caribbean region (*source: MeSH, NLM*).

**Mots clés** Diabète/économie/complication; Coût maladie; Coût soins médicaux; Handicapé; Valeur de la vie/économie; Amérique latine; Caraïbes (*source: MeSH, INSERM*).

**Palabras clave** Diabetes mellitus/economía/complicaciones; Costo de la enfermedad; Costos de la atención en salud; Personas incapacitadas; Valor de la vida/economía; América Latina; Región del Caribe (*fuentes: DeCS, BIREME*).

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*Voir page 25 le résumé en français. En la página 26 figura un resumen en español.*

## Introduction

Diabetes mellitus presents a high burden for individuals and society. This burden is not only related to health care costs, but also to indirect costs caused by loss of productivity from disability and premature mortality. Medical expenditures for people with diabetes are 2–3 times higher than for those not affected by diabetes (1). In Latin America and the Caribbean, many people with diabetes have limited access to health care, which means that indirect costs may exceed direct health care costs.

The care of diabetes and other noncommunicable diseases presents a challenge for most health care systems in Latin America and the Caribbean. Some countries in the region are facing an increasing prevalence of diabetes and other non-communicable diseases, while still experiencing a high incidence of communicable diseases. Diabetes is a chronic disease that requires lifelong, continuous medical care. Health care services in developing countries are oriented to acute medical care

This cost-of-illness study aimed to estimate the economic burden of diabetes in Latin America and the Caribbean in 2000. This report presents a societal perspective of the cost of

diabetes. Calculations included indirect costs due to premature mortality, absenteeism and disability, as well as direct costs attributed to drugs, consultations and hospitalizations.

## Methods

For all the calculations in this study, we used Amos et al.'s prevalence estimates for 2000 (2). We used the distribution by age from a recent diabetes survey in Bolivia to break down the total population with diabetes into age groups (3). A distribution of countries based on per capita gross national product (GNP) values was used to classify the countries into four groups (Table 1) (4).

Costs for different items related to medical care for people with diabetes were obtained for one or two countries in each group from various sources, such as the government, Pan American Health Organization (PAHO) and diabetes associations. When more than one estimate was available for one item in the same country, we calculated an average of the cost (Table 2). We assumed that costs for different items were similar within each country group. A 3% discount rate was used to convert future earnings to current value.

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Table 1. Classification of countries according to per capita gross national product (GNP)

Group	Per capita GNP (US\$)	Countries
1	≥ 6000	Argentina, Barbados, Bahamas, and Trinidad and Tobago
2	4000–5999	Brazil, Chile, Colombia, Costa Rica, Mexico, Uruguay and Venezuela
3	2500–3999	Cuba, Dominican Republic, Ecuador, Guatemala, Jamaica, Panama, Paraguay and Peru
4	<2499	Bolivia, El Salvador, Haiti, Honduras, Nicaragua and Guyana

Table 2. Annual cost per person of diabetes care<sup>a</sup> by country groups (2000)

Group	Countries	Average cost (US\$) per person
1	Trinidad and Tobago, and Barbados	577
2	Chile and Mexico	607
3	Ecuador, Guatemala and Jamaica	491
4	Bolivia	550

<sup>a</sup> The estimates include three visits to a general practitioner, one visit to an ophthalmologist, one HbA<sub>1c</sub> test, one lipid profile, one electrocardiogram, one proteinuria test and an average of the cost of insulin and oral drugs.

## Direct costs

### Drugs

**Insulin.** The total number of persons taking insulin was calculated as the estimated number of people with type 1 diabetes plus 5% of people with type 2 diabetes. We assumed an annual use of 10 000 IU (27 IU per day) for each person taking insulin (5). The commercial cost of insulin was obtained from two or three countries in each group.

**Oral drugs.** We assumed that 80% of the total population with type 2 diabetes used oral drugs. We estimated the number of tablets taken as 1500 per year per person (5).

### Consultations and hospitalizations

Research from Costa Rica showed that people with diabetes made 1.55 times more medical visits and had 1.98 times more hospitalizations than people without diabetes (6). The numbers of medical visits and hospitalization per inhabitants in each country were multiplied by factors of 0.55 and 0.98, respectively, which represented the fractions of excess visits and hospitalizations due to diabetes (6, 7). The estimated number of people with diabetes was then multiplied by these products. In the case of hospitalizations, we obtained the total number of hospital days by multiplying the number by the average of length of stay in each country (7). The study in Costa Rica also reported an increased length of stay for people with diabetes; the reported length of stay from each country was increased accordingly. The costs of consultations and per-day hospitalization were obtained from the group of countries.

Table 3. Estimated weighted probabilities and annual costs of main chronic complications of diabetes in Chile

Complication	Probability	Annual cost (US\$)	Ratio <sup>a</sup>
Retinopathy	12.53	146	0.24
Cardiovascular disease	12.28	134	0.22
Nephropathy	5.53	2365	3.89
Neuropathy	7.79	71	0.12
Peripheral vascular disease	5.07	86	0.14

<sup>a</sup> Relative to the annual cost of diabetes care in Chile.

### Complications

The prevalences of major complications were estimated from a survey that included 8100 people with diabetes who attended clinics and hospitals in Chile (8). The survey was an audit of clinical records that reproduced previous evaluations of care conducted in various institutions in Latin American and Europe (9, 10). We identified amputation, retinopathy, cardiovascular disease, nephropathy, neuropathy and peripheral vascular disease as complications. For each of these, we obtained the cumulative probability as a function of the duration of diabetes in years (1–55 years or more) and estimated the distribution of diabetes duration — a weighted probability — for each complication (Table 3). Prevalence of complications was estimated by applying the mean probability of each complication in this data to Amos et al.'s estimated population with diabetes (2).

White et al. estimated the average cost of treating retinopathy, heart disease, nephropathy and neuropathy in Chile (11). We obtained the cost of standard diabetes care (three physician visits, one visit to an ophthalmologist, one HbA<sub>1c</sub> test, one lipid profile, one electrocardiogram, one proteinuria test and the average cost of one year's supply of insulin and oral hypoglycaemic drugs) in Chile and calculated a ratio with the increase of cost for each complication. The ratio was then applied to the cost of care in each group of countries in order to estimate the cost of treatment of each complication. The cost of each complication was then multiplied by its estimated prevalence.

### Indirect cost

We used the human capital approach to calculate the indirect cost of diabetes in Latin America and the Caribbean in 2000.

### Mortality cost

Estimates of the indirect cost of diabetes included the calculation of lifetime, forgone earnings due to premature mortality and disability attributed to diabetes. To estimate the number of deaths, we applied the known increased risk of dying for people with diabetes (3.5 times for those with type 2 diabetes and 7.5 times for those with type 1 diabetes (12, 13)) to the general mortality rate (14) and then multiplied the result by the estimated number of people with diabetes. The number of deaths corresponding to the general mortality rate was then subtracted, so that we included only those deaths attributed to diabetes. Deaths in each age group were estimated using official data on mortality from diabetes as an underlying cause of death in the region (14, 15). Discounted future lifetime

earnings were calculated for the estimated deaths in those aged <65 years using the most recent figure for per GNP as a proxy for estimated potential annual earnings (4).

### Disability cost

**Permanent disability.** We used results of surveys conducted in Chile (8) and Costa Rica (6) to estimate the prevalence of permanent disability due to diabetes. We estimated that 8% of the total population with diabetes was permanently disabled (different estimates by age group were derived from the Chilean study) (8). The disability rate reported in the population without diabetes in the Costa Rica survey was then subtracted, so that we included only the proportion of disability attributed directly to diabetes (5). We used this estimate and the prevalence rates by age to calculate the number of discounted years of productive life lost (YPLL). The cost of permanent disability was then estimated by multiplying the per capita GNP by the number of YPLL.

**Temporary disability.** We used the proportion of people with diabetes without complications from a study in Chile (8). The numbers of disability days related and unrelated to diabetes were obtained from a research report from Argentina (16). We assumed that 40% of the population with diabetes aged <65 years (after excluding those assumed to have permanent disability mentioned before) were economically active. Forgone earnings for 2000 were calculated by applying the corresponding per capita GNP.

Appendix 1 (web version only, available at: <http://www.who.int/bulletin/>) provides an overview of each cost component as well as the methodology used in their calculations.

## Results

The numbers of people with type 1 and type 2 diabetes were estimated at 377 500 and 14 863 700, respectively (Table 4).

Overall, in the region, type 2 diabetes accounted for 97.5% of cases of diabetes mellitus, with a prevalence of 3.2%; this compared with a prevalence of 0.1% for type 1 diabetes. The total number of deaths among people with diabetes was estimated at 339 035. A total of 96 867 deaths were estimated to be related to the risk of dying from general causes, while 242 168 deaths were related to the increased risk attributed to diabetes. Diabetes caused an estimated 83 090 deaths among those with diabetes aged <65 years in 2000. The corresponding number of YPLL was 757 096; this represented a cost of US\$ 3 099 000.

The total number of people with diabetes and permanent disability was estimated at 726 575. This represented 12 699 087 YPLL or a loss of US\$ 50.6 billion. The number of people with diabetes who were temporarily disabled was estimated at >6 million. With our assumption that 40% of patients with diabetes (> 2.4 million) were economically active, diabetes caused the loss of 136 700 discounted years of productivity, costing over US\$ 763 million from loss of days at work. The total indirect cost was estimated at almost US\$ 54.5 billion; mortality, permanent disability and temporary disability accounted for 6%, 92% and 2% of this amount, respectively.

Table 5 shows the estimated direct costs of diabetes. The number of people taking insulin was estimated at more than 1 million. This included all people with type 1 diabetes and an assumed 5% of people with type 2 diabetes. With our assumption that 80% of people had type 2 diabetes, we calculated that almost 12 million people with diabetes used oral drugs to control their blood glucose levels. The attributed cost was estimated at US\$ 1.9 billion for insulin and US\$ 2.8 billion for oral drugs. The overall estimated cost of drugs for people with diabetes was over US\$ 4.7 billion.

Overall, the number of hospitalizations was estimated at 1 954 066; 988 528 of these were assumed to be the result of

Table 4. Data on people with diabetes and estimated indirect costs of diabetes in Latin America and the Caribbean in 2000

Item	Mexico	Spanish Caribbean	English Caribbean	Central America	South America	Total
<b>Population (× 10<sup>3</sup>)</b>	91 145	25 911	5150	32 115	316 070	470 391
No. of people with type 1 diabetes mellitus	12.6	19.2	5.5	6.8	33.4	377.5
No. of people with type 2 diabetes mellitus	3725.4	906.8	311.7	1185.8	8734.0	14 863.7
Total no. of people with diabetes mellitus	3738.0	926.0	317.2	1192.6	9067.4	15 241.2
<b>Mortality</b>						
No. of deaths	66 985	21 965	7776	26 278	216 031	339 035
Deaths from general causes	47 846	6276	2221	7508	61 723	96 867
Deaths related to diabetes	19 139	15 689	5555	18 770	154 308	242 168
People aged <65 years						
No. of deaths in those <65 years?	16 416	5383	1906	6440	52 944	83 090
Years of productive life lost	149 584	49 050	17 366	58 680	482 416	757 096
Cost (US\$ × 10 <sup>6</sup> )	593.8	58.5	50.9	93.6	2 302.2	3099.0
<b>Disability</b>						
No. of permanently disabled patients	178 187	44 142	15 064	56 870	432 312	726 575
Years of productive life lost	3 114 367	771 510	263 281	993 965	7 555 964	12 699 087
Cost (US\$ × 10 <sup>6</sup> )	12 364.0	981.5	750.2	1669.4	34 868.8	50 633.9
No. of temporarily disabled patients <sup>a</sup>	598.1	148.2	50.8	190.8	97.7	2438.6
Years of productive life lost	33 527	8,305	2845	10 697	5,478	136 701
Cost (US\$ × 10 <sup>6</sup> )	186.3	14.8	11.3	25.1	26.8	763.1
<b>Total indirect cost (US\$ × 10<sup>6</sup>)<sup>a</sup></b>	<b>13 144.1</b>	<b>1054.8</b>	<b>812.4</b>	<b>1788.1</b>	<b>37 696.5</b>	<b>54 495.9</b>

<sup>a</sup> Economically active.

Table 5. Estimated direct cost of diabetes in Latin America and the Caribbean, 2000

Item	Mexico	Spanish Caribbean	English Caribbean	Central America	South America	Total
<b>Medication</b>						
No. of patients taking insulin ( $\times 10^3$ )	189.9	64.5	21.1	66.1	770.1	1120.7
No. of patients taking oral drugs ( $\times 10^3$ )	2980.3	725.4	249.4	948.6	6987.2	11 890.9
Cost of insulin (US\$ $\times 10^6$ )	318.2	159.5	30.0	147.2	1285.5	1940.3
Cost of oral drugs (US\$ $\times 10^6$ )	447.0	416.4	122.9	383.0	1410.6	2779.9
Total cost of drugs	765.2	575.8	152.9	530.2	2696.1	4720.3
<b>Hospitalization</b>						
Related to general causes ( $\times 10^3$ )	220.1	95.4	22.7	61.0	589.4	988.5
Related to diabetes mellitus ( $\times 10^3$ )	215.0	93.2	22.1	59.5	575.7	965.5
Total no. of hospitalization ( $\times 10^3$ )	435.1	188.6	44.8	120.5	165.1	1954.1
No. of hospital days for general causes	1 342 717	581 912	127 672	365 367	4 117 461	6 535 129
No. of hospital days for diabetes mellitus-related causes)	655 746	248 189	62 352	178 435	2 010 853	3 191 574
Total no. of hospital days	1 998 463	866 101	190 024	543 801	6 128 313	9 726 702
Costs related to general causes (US\$ $\times 10^6$ )	154.4	36.1	5.7	27.4	456.3	680.0
Costs related to diabetes mellitus (US\$ $\times 10^6$ )	75.4	17.6	2.8	13.4	222.9	332.1
Total cost	229.8	53.7	8.5	40.8	679.2	1012.0
<b>Consultations</b>						
Related to general causes ( $\times 10^3$ )	8876.1	6140.1	281.0	2045.2	47 439.3	64 781.8
Related to diabetes ( $\times 10^3$ )	4871.2	3369.7	154.2	1122.4	26 034.7	35 552.2
Total no. of consultations ( $\times 10^3$ )	13 747.3	9509.8	435.2	3167.6	73 474.0	100 334.0
Costs related to general causes (US\$ $\times 10^6$ )	221.9	153.5	7.0	51.1	1186.0	1619.5
Costs related to diabetes mellitus (US\$ $\times 10^6$ )	121.8	84.2	3.9	28.1	650.9	888.8
Total cost	343.7	237.7	10.9	79.2	1836.9	2508.4
<b>Complications</b>						
No. of patients with retinopathy ( $\times 10^3$ )	468.4	116.0	39.7	149.4	1136.1	1870.0
No. of patients with cardiovascular disease ( $\times 10^3$ )	459.0	113.7	39.0	146.5	1113.5	1832.7
No. of patients with nephropathy ( $\times 10^3$ )	198.1	49.1	16.8	63.2	480.6	791.0
No. of patients with neuropathy ( $\times 10^3$ )	291.2	72.1	24.7	92.9	706.4	1162.6
No. of patients with peripheral vascular disease ( $\times 10^3$ )	189.5	46.9	16.1	60.5	459.7	756.7
Costs of retinopathy (US\$ $\times 10^6$ )	68.4	13.8	4.9	19.2	160.6	267.0
Costs of cardiovascular disease (US\$ $\times 10^6$ )	61.5	12.5	4.4	17.2	144.5	240.1
Costs of nephropathy (US\$ $\times 10^6$ )	468.5	94.9	33.8	131.1	1100.6	1829.1
Costs of neuropathy (US\$ $\times 10^6$ )	20.7	4.2	1.5	5.8	48.6	80.7
Costs of peripheral vascular disease (US\$ $\times 10^6$ )	16.3	3.3	1.1	4.6	38.3	63.5
Total cost (US\$ $\times 10^6$ )	635.4	128.6	45.8	178.1	1492.5	2480.4
<b>Total direct cost (US\$ <math>\times 10^6</math>)</b>	<b>1974.1</b>	<b>995.8</b>	<b>218.1</b>	<b>828.3</b>	<b>6704.7</b>	<b>10 721</b>

general causes and 965 538 directly related to diabetes. Diabetes caused a total of 3 191 574 days in hospital, representing a lost of about US\$ 332 million.

Diabetes was responsible for more than 35 million medical visits, priced at more than US\$ 888 million. As many as 1.8 million people were affected with heart disease, and a similar number was affected by retinopathy. Nephropathy affected 0.8 million people with diabetes, neuropathy, 1.1 million and peripheral vascular disease, 0.8 million. Overall, complications of diabetes were responsible for costs of more than US\$ 2.4 billion. Among the diabetic complications we studied, the highest cost was attributed to nephropathy (US\$ 1.8 billion); this was followed by retinopathy (US\$ 267 million) and cardiovascular diseases (more than US\$ 240 million). Medications, hospitalizations, consultations and complications had contributed 43%, 10%, 24% and 23% of these costs, respectively.

Table 6 shows the total cost of diabetes by country, as well as the contributions of direct and indirect costs. The overall contribution of indirect costs was 82% and of direct costs was 18%. The proportion of indirect and direct costs varied somewhat among countries — the lowest proportion of direct costs was found in Argentina (7%) and the highest in Nicaragua (66%). Per capita costs of diabetes care were highest in Cuba (US\$ 1219) and lowest in Colombia (US\$ 442). The average per capita expenditure on health (latest available figures) in the region was US\$ 220, while the average cost of care per person with diabetes was US\$ 703; it was lowest in Haiti (US\$ 24) and highest in Argentina (US\$ 882). In general, the costs of caring for diabetes were more than 300% higher than the average health expenditures in Latin America and the Caribbean — ranging from 68% in Argentina to 2517% in Haiti.

Table 6. Estimated total indirect and direct costs attributed to diabetes, per capita direct cost and per capita health expenditures by country in Latin America and the Caribbean

Country	Costs (US\$ × 10 <sup>6</sup> )			Per capita direct cost (US\$)	Per capita health expenditures (48) (US\$)	Excess cost of diabetes mellitus (%)
	Total	Indirect	Direct			
<b>North America</b>						
Mexico	15 118.3	13 144.1	1974.2	528	221	239
<b>Caribbean (Spanish)</b>						
Cuba	1 346.6	624.4	722.2	1219	139	877
Dominican Republic	625.1	399.4	225.7	888	112	793
Haiti	78.7	30.7	48.0	604	24	2517
Subtotal	2050.7	1054.8	995.9	1076	92	1174
<b>Caribbean (English)</b>						
Bahamas	148.8	138.1	10.7	835	664	126
Barbados	151.2	138.4	12.8	551	506	109
Guyana	36.3	15.9	20.4	719	33	2179
Jamaica	409.5	273.4	136.1	750	146	514
Trinidad/Tobago	284.5	246.5	38.0	533	162	329
Subtotal	1030.5	812.4	218.1	687	302	227
<b>Central America</b>						
Costa Rica	473.2	376.6	96.6	624	285	219
El Salvador	499.5	362.1	137.4	626	161	389
Guatemala	840.8	549.6	291.2	790	94	840
Honduras	239.7	125.9	113.8	590	59	1000
Nicaragua	128.8	43.8	85.0	624	41	1522
Panama	434.7	330.3	104.4	866	354	245
Subtotal	2616.4	1788.1	828.3	695	166	420
<b>South America</b>						
Argentina	10 935.3	10 188.3	747.0	597	882	68
Bolivia	227.8	142.3	85.5	555	53	1047
Brazil	22 603.8	18 651.5	3952.3	872	270	323
Chile	2417.9	2122.9	295.0	594	449	132
Colombia	2586.8	2171.9	414.9	442	209	211
Ecuador	598.5	365.1	233.4	873	65	1343
Paraguay	218.0	146.0	72.0	779	165	472
Peru	1844.1	1341.7	502.4	828	117	708
Uruguay	774.9	680.3	94.6	795	697	114
Venezuela	2139.7	1886.2	307.5	503	304	165
Subtotal	44 400.0	37 696.5	6704.6	739	321	230
<b>Total</b>	<b>65 216.5</b>	<b>54 495.9</b>	<b>10 720.1</b>	<b>703</b>	<b>220</b>	<b>319</b>

## Discussion

A severe lack of data about the economic burden of diabetes mellitus in most countries of Latin America and the Caribbean motivated our complex economic analysis. In view of the increasing global prevalence of diabetes, information from cost-of-illness studies should be used to increase awareness and lobbying for allocation of resources.

Cost estimates provide information that describes used resources (direct costs) and productivity losses (indirect costs) (17). Cost estimates must be reviewed with caution, however, because inaccuracies may occur when costs are estimated in a great number of countries with different economic, health and accounting systems. Estimates in this paper are conservative, and in some cases they intentionally underestimate the true cost of different items.

Comments have been made on the risk of including the undiagnosed portion of diabetes in studies of the costs of diabetes. In this respect, we compared the studied prevalence of diabetes in some countries with Amos et al.'s estimates (2).

Results of the Bolivian survey showed a prevalence of 7.2% in four urban conglomerates, of which 5% had already been diagnosed with diabetes (3). Amos et al.'s prevalence of diabetes for Bolivia was only 2% (2). We think, therefore, that the estimates we used in our calculation are conservative and do not contribute to an overestimation of the cost of diabetes.

It has been said that overestimates of indirect costs may occur when using the human capital approach (18–21), and the frictional cost approach is believed to be more conservative (22–24). The paucity of information needed to apply the frictional cost approach meant that it was not a feasible option for this study.

The number of deaths among people with diabetes was estimated at 339 035 in 2000, although the number of reported deaths with diabetes as the underlying cause of death in Latin America and the Caribbean is approximately 40 000 per year. This means that vital statistics based on the underlying cause of death may have an undercount of up to 60% of diabetes-related deaths. The limitations of death certificates for

measuring diabetes-related deaths are well known (25, 26, 28–30). The undercount of diabetes-related deaths in vital statistics is also supported by medical literature from Brazil (31), Cuba (32, 33), Costa Rica (34) and Jamaica (35). Murray & Lopez estimated diabetes mortality for Latin America and the Caribbean as 263 700 in 1995 (36). Our estimate of mortality was comparable, although differences in methods can be noted. A recent report estimated the number of deaths related to diabetes in Latin America and the Caribbean to be higher than that reported here (465 828 deaths vs 339 035 in the present study) (37). We believe that the WHO estimates are more precise because they are based on more complex methods to account for the risk of dying at different ages.

A previous analysis estimated the annual direct cost of diabetes in Latin America and the Caribbean at US\$ 3 billion, or US\$ 353 per person (38). That figure was obtained by assuming that 6% of the health budget of the region was allocated to diabetes. Our estimate showed a higher direct cost of US\$ 10.7 billion, or US\$ 701 per person. We used reported statistics to estimate that number, so countries reporting better access to care — such as higher numbers of medical visits (or hospitalizations) per individual — were estimated to have a higher number of medical visits (or hospitalizations) for people with diabetes. Henry-Lee et al. (39) estimated the health care cost in Jamaica by interviewing people suffering from various diseases in 2000. Their estimate of the annual cost of diabetes care was US\$ 437, while the average cost of the same care in Jamaica in our study was US\$ 491. This seems to further support the validity of our method in accessing direct costs.

An earlier study in Mexico on the cost of diabetes reported a total cost of US\$ 430 million (US\$ 100 million of direct costs and US\$ 330 million of indirect costs) (18). Our calculation for Mexico reported a total cost of US\$ 15.1 billion (US\$ 1.9 billion of direct costs and 13.1 billion of indirect costs). Differences in the estimated costs of diabetes in Mexico between our study and the previous analysis are because of differences in the estimates of the prevalence of diabetes used. Although the previous study assumed that 960 000 people (only 1.2% of the population) had diabetes, our study estimated that 3 738 000 people (4.1% of the population) had diabetes (2). This discrepancy resulted in a significantly higher estimate of the numbers of deaths and disabilities attributed to diabetes, as well as of the direct costs in our study. Higher estimates of the number of people with diabetes in Mexico (such as Amos et al.'s estimate (2), which we used in our study) are supported by two studies that reported a prevalence of diabetes in Mexico City of 13% and 8.7% in 1992 and 1994, respectively (40, 41). A national survey in 1993 showed the prevalence of diabetes was 7.2% and of diagnosed diabetes was 5.1% (42). Villareal-Ríos et al., using a different method, estimated that the total direct cost of diabetes mellitus was US\$ 2.6 billion — this is close to our estimate of US\$ 1.9 billion (43).

A study in Chile (11) in 1995 produced lower estimates than ours. The total cost of diabetes was estimated at US\$ 1 billion, while our estimate for Chile was more than two times higher (US\$ 2.4 billion). The difference in indirect costs (and total costs) was related to the inclusion in our study of the cost of diabetes-related mortality, which was not the case in the Chilean study. Similarities in the methods for calculating direct costs mean that both studies were comparable in this regard. The direct cost in the Chilean study was calculated at

US\$ 300 million, or US\$ 570 per person with diabetes (11) while our estimates of direct costs for Chile were US\$ 294 million, or US\$ 594 per person with diabetes.

In the USA, the most recent published analysis by the American Diabetes Association (ADA) estimated the cost of diabetes at US\$ 98 billion (44). Moreover, the ADA attributed a total of US\$ 44.1 billion costs to direct medical care (US\$ 10 071 per capita); this is extremely high when compared with our estimated US\$ 10.7 billion costs for Latin America and the Caribbean (only US\$ 703 per capita). Our calculations of indirect costs were based on estimates of mortality costs of US\$ 37 000 per life lost; this is also lower than the US estimate of US\$ 106 187 per life lost. This difference accounted for the lower number of forgone earnings for people living in Latin America and the Caribbean. In addition, we only calculated forgone earnings for economically active individuals, and we assumed that 40% of people with diabetes were economically active. Other studies have included loss of unpaid labour, such as the value of homemaking services, housekeeping, caregiver costs and leisure time. We did not include these factors, and therefore our calculation of indirect costs when compared to the ADA study (44) probably, therefore, underestimated the value of lost work because of premature death or disability.

Costs may be underestimated if co-morbidity of the various complications of diabetes is not considered (45). We tried to estimate co-morbidity among the various complications of diabetes, but we did not include this because of unsolved limitations, such as the absence of measurements in the Chilean study which we used as a platform for our study. The prevalence of the major complications used here may not correspond with the actual prevalence of complications in the population with diabetes, with the estimates for the prevalence of some complications, such as retinopathy and nephropathy, being intentionally lower than those reported by a population-based survey in Brazil (46). On the other hand, it seems adequate to calculate medical costs using the prevalence of complications among patients attending clinics.

Studies in the USA (44) and Canada (47) showed that direct costs are higher than indirect costs. In our study, however, indirect costs accounted for 82% of the total costs. We believe this is because of the lack of coverage of continuous care for a significant proportion of the population with diabetes in Latin America and the Caribbean, which may have led us to underestimate the cost of medical care. An increase in access to care would also increase the direct costs related to diabetes, and, if care is effective, this may reduce the mortality and rates of disability related to diabetes. In general, the costs of care of diabetes in the USA (US\$ 10 071 per person, or US\$ 7400 per person if care for conditions other than diabetes is subtracted) were 10–15 times more expensive than in Latin America and the Caribbean (an average of US\$ 703 per person) (44). Although this difference may be real, we did not include a number of items, such as home health care, emergency visits, medical equipment and ambulance services, in our study. This difference contributed to the disparity in relation to direct cost between our results and those of the American cost study.

In our study, the balance between direct and indirect costs was driven mostly by the per capita GNP, which we used to calculate indirect costs. In general, countries in group 1 (Argentina, Barbados, Bahamas, and Trinidad and Tobago) had a very low proportion of direct costs compared

with countries in group 4 (Bolivia, El Salvador, Honduras, Nicaragua, and Haiti), which had a high proportion of direct costs. The cost of per capita diabetes care was comparable among the groups (US\$ 577, US\$ 607, US\$ 491 and US\$ 550 for groups 1–4, respectively). This resulted in a more homogeneous output for the direct cost per capita among studied countries. However, exceptions were found, with extremely high and low estimated direct costs noted in Cuba (US\$ 1219) and Colombia (US\$ 442), respectively. These exceptions were caused by unusually high estimates of consultations (6.3 per 100 population) and hospitalizations (13.5 per 100 population) in the general population of Cuba and by low estimates in Colombia (0.7 consultations per 100 population and 6.1 hospitalizations per 100 population) (7).

Although direct per capita costs in most countries (except Cuba and Colombia) were comparable, a large gap was seen in the excess of costs of diabetes care when compared with governments' per capita expenditures on health. This suggests that, in most countries, health expenditures were much lower than the cost of health care for people with diabetes. The disparity between the cost of care and health expenditures varied somewhat in the region, and it was highest among countries from groups 3 and 4. Only Argentina had per capita direct costs lower than per capita health expenditures.

Another important aspect not included in our analysis was the calculation of out-of-pocket expenses. A recent cost study from Jamaica reported that 57% of interviewed people with diabetes experienced financial difficulties because of illness and that 50% of those admitting economic difficulties reportedly avoided some medical treatment because of economic constraints (39).

## Conclusion

Our data show that research into the health economics of diabetes is still insufficient and should be prioritized. Despite the limitations of our data, the results show that diabetes imposes a very high economic burden on the individuals and society of each country and on the region of Latin America and the Caribbean as a whole. Although we may have underestimated the direct costs of diabetes, our results show a gap between health expenditures in the region and the cost of diabetes care. This gap may promote adverse outcomes, such as a high frequency of complications, disabilities and premature mortality notably discouraging patients from seeking health care. ■

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## Résumé

### Coût du diabète en Amérique latine et dans les Caraïbes

**Objectif** Mesurer la charge économique associée au diabète sucré en Amérique latine et dans les Caraïbes.

**Méthodes** Des estimations de la prévalence du diabète pour l'année 2000 ont été utilisées pour calculer les coûts directs et indirects du diabète sucré. Les coûts directs comprenaient le coût des médicaments, des hospitalisations, des consultations et de la prise en charge des complications. L'approche basée sur le capital humain a été utilisée pour calculer les coûts indirects et tenait compte de la perte de revenus due à la mortalité et à l'incapacité prématurées attribuées au diabète sucré. La mortalité et l'incapacité attribuées à d'autres causes ont été déduites des estimations afin d'examiner uniquement le surcroît de charge économique imputable au diabète. Un taux de réduction de 3 % a été appliqué pour rapporter les revenus futurs à leur valeur actuelle.

**Résultats** Le nombre annuel de décès dus au diabète en 2000 a été estimé à 339 035. Ce chiffre représente une perte de

757 096 années de vie productive perdues parmi les personnes de moins de 65 ans (>US \$3 milliards). Les incapacités permanentes ont entraîné une perte de 12 699 087 ans et un coût de plus de US \$50 milliards, et les incapacités temporaires une perte de 136 701 ans dans la population active et un coût de plus de US \$763 millions. Les coûts associés à l'insuline et aux traitements par voie orale ont été de US \$4720 millions, ceux de l'hospitalisation de US \$1012 millions, ceux des consultations de US \$2508 millions et ceux de la prise en charge des complications de US \$2480 millions. Le coût total annuel associé au diabète a été estimé à US \$65 216 millions (coût direct US \$10 721 millions et coût indirect US \$54 496 millions).

**Conclusion** Malgré des données limitées, on peut estimer que le diabète impose une lourde charge économique aux individus et à la société dans tous les pays comme dans l'ensemble de l'Amérique latine et des Caraïbes.

## Resumen

**El costo de la diabetes en América Latina y el Caribe**

**Objetivo** Medir la carga económica asociada a la diabetes mellitus en América Latina y el Caribe.

**Métodos** A partir de las prevalencias estimadas de la diabetes para el año 2000 se calcularon los costos directos e indirectos de la enfermedad. Los costos directos incluían los gastos en medicamentos, las hospitalizaciones, las consultas y el tratamiento de las complicaciones. Para estimar los costos indirectos se utilizó un criterio basado en el capital humano, que incluía el cálculo de los ingresos no percibidos como consecuencia de la mortalidad prematura y la discapacidad atribuidas a la diabetes mellitus. La mortalidad y la discapacidad atribuidas a otras causas distintas de la diabetes se restaron de las cifras estimadas para considerar así únicamente el exceso de carga debido a la diabetes. Se aplicó una tasa de descuento del 3% para convertir al valor actual los ingresos futuros.

**Resultados** El número anual de defunciones causadas por la diabetes mellitus en 2000 se estimó en 339 035. Ello representa

una pérdida de 757 096 años descontados de vida productiva entre las personas menores de 65 años (> US\$ 3000 millones). La discapacidad permanente causó una pérdida de 12 699 087 años y de más de US\$ 50 000 millones, y la discapacidad temporal entrañó una pérdida de 136 701 años en la población activa y de más de US\$ 763 millones. La insulina y la medicación oral supusieron un gasto de US\$ 4720 millones, las hospitalizaciones US\$ 1012 millones, las consultas US\$ 2508 millones, y la atención requerida por las complicaciones US\$ 2480 millones. El costo anual total asociado a la diabetes, según las estimaciones, sería de US\$ 65 216 millones (directos: US\$ 10 721 millones; indirectos: US\$ 54 496 millones).

**Conclusión** Pese a las limitaciones de los datos, cabe concluir que la diabetes impone una alta carga económica a los individuos y la sociedad en todos los países y en el conjunto de América Latina y el Caribe.

## References

- Rubin RJ, Altman WM, Mendelson DN. Health care expenditures for people with diabetes mellitus, 1992. *Journal of Clinical Endocrinology and Metabolism* 1994;78:809A-F.
- Amos AF, McCarty DJ, Zimmet P. The rising global burden of diabetes and its complications: estimates and projections to the year 2010. *Diabetes Medicine* 1997;14 Suppl 5:S1-85.
- Barcelo A, Daroca MC, Ribera R, Duarte E, Zapata A, Vohra M. Diabetes in Bolivia. *Pan American Journal of Public Health* 2001;10:318-23.
- World Bank Data. Available from: URL: <http://www.worldbank.org/data/countrydata/countrydata.html>
- Phillips M, Salmerón J. Diabetes in Mexico — a serious and growing problem. *World Health Statistics Quarterly* 1992;45:338-46.
- Morice A, Roselló M, Araújo AG, Sánchez G, Padilla G. *Diabetes mellitus en Costa Rica: un análisis interdisciplinario*. [Diabetes mellitus in Costa Rica: an interdisciplinary analysis] Costa Rica: Instituto de Investigación y Enseñanza en Nutrición y Salud; 1999. In Spanish.
- Pan American Health Organization. *Health conditions in the Americas. 1994 edition*. Volume I. Washington (DC): Pan American Health Organization; 1994.
- Escobar MC, Delgado I. *Diabetes y calidad de la atención en el sistema nacional de servicios de salud*. [Diabetes and quality of care in the national health service system] Santiago: Republica de Chile. Ministerio de Salud; 1999. In Spanish.
- Grupo de Investigación de la Red QUALIDIAB. Evaluación de la calidad de atención al paciente con diabetes en Latino America. [Evaluation of the quality of care for diabetic patients in Latin America] *Pan American Journal of Public Health* 2001;10:309-17. In Spanish.
- Piwernetz K, Home PD, Staehr Johansen K, Kleinebreil L, Vermeij D, Storms GEMG, et al. DIABCARE Quality Network in Europe. TELEMATICS project within the St. Vincent declaration. Consensus meeting. *Diabetes Nutrition and Metabolism* 1995;8:243-9.
- White F, Vega J, Aedo C, Jadue L, Robles S, Salazar R, et al. *Proyecto de demostración en educación en diabetes. Informe Final*. [Demonstration project on diabetes education. Final report] Washington (DC): Pan American Health Organization; 1998. In Spanish.
- Collado-Mesa F, Díaz-Díaz O, Melián-Torres R, Suárez-Pérez R, Vera-González M, Aldana-Padilla D. Mortality of childhood-onset IDDM patients. A cohort study in Havana City Province, Cuba. *Diabetes Care* 1997;20:1237-41.
- Wang SL, Head J, Stevens L, Fuller JH. Excess mortality and its relation to hypertension and proteinuria in diabetic patients. The World Health Organization Multinational Study of Vascular Disease in Diabetes. *Diabetes Care* 1996;19:305-12.
- World health statistics annual*. Geneva: World Health Organization; 1996.
- Health statistics in the Americas*. Washington (DC): Pan American Health Organization; 1998.
- Olivera E, Duhalde E, Gagliardino JJ. Costs of temporary and permanent disability induced by diabetes. *Diabetes Care* 1999;14:593-6.
- Songer TJ. Assessing direct and indirect cost of diabetes. In: Williams R, Tuomilehto J, Bjork S, editors. *The economics of diabetes care. An international perspective*. Wellingborough: Blackwell Science; 2000.
- Cooper BS, Rice DP. The economic cost of illness revisited. *Social Security Bulletin* 1976;39:21-36.
- Rice DP, Hodgson TA, Kopstein AN. The economic costs of illness: a replication and update. *Health Care Financing Review* 1985;7:61-80.
- Rice DP. *Estimating the cost of illness*. Health Economics Series No. 6, PHS No. 947-6. US Government Printing Office, Washington (DC); 1966.
- Hodgson TA. The state of the art in cost-of-illness estimates. *Advances in Health Economics and Health Services Research* 1983;4:129-64.
- Koopmanschap MA, Ineveld BMV. Towards a new approach for estimating indirect costs of disease. *Social Science and Medicine* 1992;9:1005-10.
- Gold MR, Siegel JE, Russell LB, Weinstein MC, editors. *Cost-effectiveness in health and medicine*. New York: Oxford University Press; 1996.
- Drummond MF, O'Brien B, Greg GL, Torrance GW. *Methods for the economic evaluation of health care programmes*. New York: Oxford University Press; 1997.
- Fuller JH, Elford J, Golblatt P. Diabetes mortality: new light on an underestimated public health problem. *Diabetologia* 1983;24:336-41.
- Fuller JH. Mortality trends and causes of death in diabetic patients. *Diabetes Metabolism* 1993;19:96-9.
- Jouglu E, Papoz L, Balkau B. Death certificate coding practices related to diabetes in European countries — the EURODIAB Subarea C study. *International Journal of Epidemiology* 1992;21:343-51.
- Whittall DE, Glatthar C, Knuiiman MW. Deaths from diabetes are under-reported in national mortality statistics. *Medical Journal of Australia* 1990;152:598-600.
- Andersen EM, Lee JAH, Percoraro RE. Underreporting of diabetes on death certificates, King County, Washington. *American Journal of Public Health* 1993;83:1021-4.
- Centers for Disease Control and Prevention. Sensitivity of death certificate data for monitoring diabetes mortality. Diabetes eye disease follow-up study, 1985–1990. *Morbidity and Mortality Weekly Report* 1991;40:739-41.
- Franco LJ, Mameri C, Pagliaro H, Iochida LC, Goldenberg P. Diabetes como causa básica ou associada de morte no Estado de São Paulo, Brasil, 1992. [Diabetes as underlying or associated cause of death in the State of S. Paulo, 1992.] *Revista de Saude Publica* 1998;32:237-45. In Portuguese.
- Hernández Yero A, Díaz Díaz O, Gómez Suárez E. Machado Chaviano M. Utilidad de la certificación de defunción en la valoración de la mortalidad por diabetes mellitus. Programa/Resúmenes. [Use of death certificates to evaluate diabetes mellitus mortality] *III Congreso Nacional de Endocrinología, La Habana, 1992*. In Spanish.



33. Crespo Valdes N, Sainz Ballesteros J, Alonso Chil OB, Suárez Pérez R. Causas de muerte y hallazgos necropsicos en 423 pacientes diabético. Programa/ Resúmenes. [Causes of deaths and necropsy findings in 423 diabetic patients] *III Congreso Nacional de Endocrinología, La Habana, 1992*. In Spanish.
34. Rodríguez L, Castro M, Zúñiga N. Diabetes mellitus mortality in Costa Rica. *Revista Costarricense Ciencias Médicas* 1988;9:139-44.
35. Alleyne SJ, Cruickshank JK, Golding AL, Morrison EY. Estimación de la mortalidad por diabetes mellitus basada en los certificados de defunción. Jamaica, 1970-1990. [Mortality trends for diabetes mellitus in Jamaica, 1970-1990] *Boletín de la Oficina Sanitaria Panamericana* 1989;106:277-86. In Spanish.
36. Murray CJL, Lopez AD. The global burden of disease in 1990: final results and their sensitivity to alternative epidemiological perspective, discount rates, age-weights and disability weights. In: Murray CJL, Lopez AD, editors. *The global burden of disease*. Harvard School of Public Health on behalf of the World Health Organization and the World Bank; 1996.
37. King H, Roglic G, Lozano R, Boshi-Pinto C. Global burden of diabetes: estimates of mortality for the year 2000 (forthcoming).
38. Gagliardino J, Oliviera E. Latin America. In Gruber W, Lander T, Leese B, Songer T, Williams R editors. *The economics of diabetes and diabetes care. A report of the diabetes health economics study group*. International Diabetes Federation and World Health Organization, Brussels, Belgium; 1998.
39. Henry-Lee A, Yearwood A. *Protecting the poor and the medically indigent under health insurance: a case study in Jamaica. Small applied research No. 6*. Bethesda: Partnership for Health Reform Project and Abi Associates; 1999.
40. Posadas-Romero C, Yamamoto-Kimura L, Lerman-Garber I, Zamora-Gonzalez J, Fajardo-Gutierrez A, Velazquez L, et al. The prevalence of NIDDM and associated coronary risk factors in Mexico City. *Diabetes Care* 1994;17:1441-8.
41. Stern MP, González C, Mitchell BD, Villapando E, Haffner SM, Hazuda HP. Genetic and environmental determinants of type II diabetes in Mexico City and San Antonio. *Diabetes* 1992;41:484-92.
42. Secretaría de Salud de Mexico. *Encuesta Nacional de Enfermedades Crónicas, 1993. [Ministry of Health of Mexico: National Survey on Chronic Diseases]* Mexico City: Secretaría de Salud de Mexico; 1996. In Spanish.
43. Villareal-Ríos E, Salinas-Martínez AM, Medina-Jáuregui A, Garza-Elizondo ME, Nuñez-Rocha G, Chuy-Díaz ER. The cost of diabetes mellitus and its impact on the health spending in Mexico. *Archives of Medical Research* 2000;31:511-4.
44. American Diabetes Association. Economic consequences of diabetes mellitus in the U.S. in 1997. *Diabetes Care* 1998;21:296-309.
45. Norlund A, Apelqist J, Bitzen PO, Schersten B. Cost of illness of adult diabetes mellitus underestimated if comorbidity is not considered. *Journal of Internal Medicine* 2001;250:57-65.
46. Foss MC, Paccola MGF, Souza NV, Iazigi N. Estudo analítico de uma amostra populacional de diabéticos tipo II da região de Reberão Preto (SP). [Analytic study of a population based sample of type 2 diabetics from the region of Reberao Preto] *Revista Associação Médica Brasileira* 1989;35:179-83. In Portuguese.
47. Dawson KG, Gomes D, Gerstein H, Blanchard JF, Kahler KH. The economic cost of diabetes in Canada, 1998. *Diabetes Care* 2000;25:1303-7
48. *Special program for health analysis. Health situation in the Americas. Basic indicators 2001*. Washington (DC): Pan American Health Organization; 2002.

## Appendix 1. Summary of costs

Costs	Source	Cost (US\$ × 10 <sup>6</sup> )
<b>Indirect</b>		
Permanent disability	Number of persons with diabetes with permanent disability: 726 575. Estimated by applying the proportion of people permanently disabled due to diabetes, which was assumed to be approximately 8% of the total population with diabetes. Number of years lost due to permanent disability: before age 65 years with a 3% discount rate is 126 999 087. Cost calculated by multiplying years lost to disability by annual per capita GNP.	50 633.9
Temporary disability	Estimated number of people with diabetes who are economically active (assumption: 40% of all people with diabetes) is 2 438 600.	
Mortality	Number of sick days per year among people with diabetes and major complications and who are economically active (60%): 94 441 253. Applying result of research from Argentina (6). Estimated number of deaths: 339 035. Estimated number of deaths due to diabetes and its complications among those younger than 65 years of age: 83 090. Estimated number of years lost due to premature mortality: 757 096. Years lost before age 65 years with a 5% discount rate. Cost calculated by multiplying years lost to disability in each country by annual per capita GNP.	763.0   3099.0
Subtotal		54 495.9
<b>Direct</b>		
Insulin	Assumption: proportion of people with diabetes using insulin = all people with type 1 and 4% of those with type 2 diabetes.	
Oral medication	Insulin consumption per year: 10 000 units per person (5). Number of insulin users: 1 120 685. Assumption: Oral medication consumption per year: 1500 per person per year. Oral drug users: 80% of the total population with diabetes. Oral medication users: 11 890 960.	1940.3  2780.0
Consultations	Estimated number of consultations per year for people with diabetes: 100 334 046. Number of consultations per inhabitant from health condition in the Americas multiplied by the estimated number of persons with diabetes. Assumption: people with diabetes have 1.55 more medical visits (6). Due to general causes: 64 781 796. Related to diabetes: 35 552 250. Number of extra consultations related to diabetes 1.55% from a survey in Costa Rica (6).	2508.4
Hospitalizations	Total number of hospitalizations per year for people with diabetes: 1 954 066. Number of hospital discharges per inhabitant from health conditions in the Americas (7) multiplied by the estimated number of people with diabetes. Assumption: people with diabetes have 1.98 more hospitalizations (6). Due to general causes: 988 528. Related to diabetes: 965 538. Number of extra hospitalizations related to diabetes from a survey in Costa Rica (6).	1012.0
Complications	Cost of treatment of complications. A ratio of the cost of diabetes care and the cost of complications (retinopathy, cardiovascular diseases, nephropathy, neuropathy and peripheral vascular disease) from research in Chile (11) was applied to the prevalence of complication taken from the Chilean database (8).	2480.4
Subtotal		10 721
<b>Combined indirect and direct costs (US\$ × 10<sup>6</sup>)</b>		<b>65 216</b>