

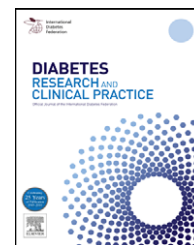


Contents lists available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

International
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Diabetes Atlas

Global healthcare expenditure on diabetes for 2010 and 2030

Ping Zhang^{a,*}, Xinzhi Zhang^a, Jonathan Brown^b, Dorte Vistisen^c,
Richard Sicree^d, Jonathan Shaw^d, Gregory Nichols^b

^a Division of Diabetes Translation, Centers for Disease Control and Prevention, Atlanta, GA, USA

^b Center for Health Research, Kaiser Permanente, Northwest in Portland, Oregon, Portland, OR, USA

^c Steno Diabetes Center NS, Niels Steensens Vej 2, DK-2820 Gentofte, Denmark

^d Baker IDI Heart and Diabetes Institute, 250 Kooyong Road, Caulfield, Victoria 3162, Australia

ARTICLE INFO

Article history:

Received 17 December 2009

Accepted 25 January 2010

Keywords:

Diabetes

Health expenditure

Economic burden

ABSTRACT

Aims: To estimate the global health expenditure on diabetes among people aged 20–79 years for the years 2010 and 2030.

Methods: Country-by-country expenditures for 193 countries, expressed in United States Dollars (USD) and in International Dollars (ID), were estimated based on the country's age-sex specific diabetes prevalence and population estimates, per capita health expenditures, and health expenditure ratios per person with and without diabetes. Diabetes prevalence was estimated from studies in 91 countries. Population estimates and health expenditures were from the United Nations and the World Health Organization. The health expenditure ratios were estimated based on utilization and cost data of a large health plan in the U.S. Diabetes expenditures for the year 2030 were projected by considering future changes in demographics and urbanization.

Results: The global health expenditure on diabetes is expected to total at least USD 376 billion or ID 418 billion in 2010 and USD 490 billion or ID 561 billion in 2030. Globally, 12% of the health expenditures and USD 1330 (ID 1478) per person are anticipated to be spent on diabetes in 2010. The expenditure varies by region, age group, gender, and country's income level.

Conclusions: Diabetes imposes an increasing economic burden on national health care systems worldwide. More prevention efforts are needed to reduce this burden. Meanwhile, the very low expenditures per capita in poor countries indicate that more resources are required to provide basic diabetes care in such settings.

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* Corresponding author at: Division of Diabetes Translation, Centers for Disease Control and Prevention, Mailstop K-10, 4770 Buford Highway NE, Atlanta, GA, USA. Tel.: +1 770 488 5842; fax: +1 770 488 1148.

E-mail addresses: Pzhang@cdc.gov, Paz2@cdc.gov (P. Zhang).

0168-8227/\$ – see front matter. Published by Elsevier Ireland Ltd.

doi:10.1016/j.diabres.2010.01.026

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1. Introduction

Diabetes is a common chronic disease in nearly all countries. There are an estimated 285 billion adults with diabetes in 2010; this number will continue to increase globally due to an aging population, growth of population size, urbanization and high prevalences of obesity and sedentary lifestyle [1]. Diabetes leads to both premature death and complications such as blindness, amputations, renal disease, and cardiovascular diseases.

Diabetes is also costly to health care systems. People with diabetes have more outpatient visits, use more medications, have a higher probability of being hospitalized, and are more likely to require emergency and long-term care than people without the disease. In the United States, people with diabetes, on average, spent 2.5 times more on medical care than people without the condition [2]. Estimates of the current and future economic burden on the health care system can assist decision-makers understand the magnitude of the problem, prioritize research efforts, and plan resource allocation to properly manage the condition. Disease cost estimates also help prioritize interventions, which must be done in the face of limited health care resources.

The global health care expenditure attributable to diabetes has been estimated in 2003 and 2006 by the International Diabetes Federation (IDF) and reported in the second and third editions of the Diabetes Atlas [3,4]. While the basic approach used to derive such estimates in the current study and the two previous studies are the same, we improved the previous estimates in two ways. Compared with the analysis in the second edition of the Diabetes Atlas, which used a single health expenditure ratio (a critical input parameter for the expenditure model) per person with and without diabetes, we used age–sex specific expenditure ratios. Using age–sex specific expenditure ratios can account for differences in the age–sex structures of the populations across countries. Compared with the analysis in the third edition of the Diabetes Atlas, we update the expenditure estimates using the improved diabetes prevalence data and the latest available estimates on each country’s demographics, and health expenditure. The purpose of our study was to provide estimates on health expenditures attributable to diabetes for all countries of the United Nations for the years 2010 and 2030.

2. Methods and data

The global health expenditure attributable to diabetes is the sum of the expenditure of 193 individual countries. The expenditures of 23 countries or regions that were members of United Nations but with no appropriate health expenditure data available were not accounted to in the sum; these 23

countries or regions account for less than 2% of the world population. We also grouped the expenditure for diabetes into regions using two different definitions: the IDF membership regions (Sub-Saharan African Region (AFR); Eastern Mediterranean and Middle East Region (EMME); European Region (EUR); North American Region (NA); South American and Central American Region (SACA); South East Asian Region (SEA); and Western Pacific Region (WPR)) [4]; and all developing versus all developed countries [5]. We considered all countries or regions outside Europe, except Australia, Canada, Japan, New Zealand, the United States of America, Singapore, Hong Kong and Taiwan, to be developing [5].

We used the approach developed by Jonsson [6] to derive the estimate of health care expenditures for diabetes for each individual country in 2010. Specifically, we used the formula:

$$D = \sum_{s=1}^2 \sum_{a=1}^6 \left\langle \frac{N_{as} C_{as} P_{as} (R_{as} - 1)}{P_{as} (R_{as} - 1) + 1} \right\rangle,$$

where D = the total health expenditure for diabetes in a country, N_{as} = the total population, in each age and sex subgroup, projected for a country in 2010, C_{as} = the annual health expenditure per person including persons with and without diabetes, in each age and sex subgroup, in the country in 2005, P_{as} = the prevalence of diabetes in the country, by age and sex, projected for a country in 2010, R_{as} = the ratios of health care expenditure for persons with diabetes to persons without diabetes, by age and sex, a is an indicator for ten year age span (20–29, 30–39, . . . , 70–79), and s is an indicator for sex (men, women).

Data on population size by age and sex were obtained from United Nations Population estimates [5]. Country-by-country estimates of diabetes prevalence by age and sex were from Shaw et al. [1]. The country’s total health expenditures by age and sex group were estimated based on per capita health expenditure data from the World Health Organization (WHO) *World Health Report for 2008* [7] and population estimates from the United Nations [5]. WHO defines “total health expenditure” to include all expenditures for medical care regardless of who paid for them. The WHO definition also includes expenditures for public health programmes and medical research but excludes the unpaid care-giving of family members, relatives and others. We applied the same procedures as those used in the third edition of the Diabetes Atlas. [4] to allocate the total expenditure in a country into age–sex specific total expenditures; the WHO reported only the average per capita expenditure or total health expenditure for a country (per capita expenditure times the country’s population).

Our analysis requires age- and sex-specific ratios of health care expenditure for persons with diabetes to persons without diabetes, called R , in each individual country. Data on R were not available for most countries. In countries where such

estimates are available, the average value of R falls between 2 and 3. Therefore, we estimated the health expenditure for diabetes with two alternative average R values, R = 2 and R = 3. Since R is sensitive to age and sex, applying age- and sex-specific R should improve the health expenditure estimates. We used a set of age- and sex-specific R values estimated by Brown et al. [4]. They derived these R values from a large diabetes registry data used by Kaiser Permanente Northwest Region, a large not-for-profit pre-paid medical care system in the United States. The procedure used to derive those estimates was described elsewhere [4]. We applied the same set of age- and sex-specific R values to all countries included in this study.

We also estimated the proportion of the national health expenditure spent on diabetes and the average level of health expenditure for diabetes per person with diabetes for the year 2010. The former is calculated as the country's health expenditure for diabetes divided by the total national health expenditure. The latter is estimated as the expenditure on diabetes divided by the total number of people with diabetes.

Data used to derive the 2030 estimates on health expenditure for diabetes were the same except we used the 2030 predicted country's age- and sex-estimates on population and the number of people with diabetes. Estimates of a country's population for year 2030 were obtained from the United Nations [5].

Estimates are shown in both United States Dollars (USD) and in International Dollars (ID). The ID is a USD that has been adjusted to account for differences in purchasing power, as estimated from surveys of how much the USD buys of a standard basket of goods and services in different countries. Because some aspects of medical care are priced through global markets (drugs and supplies, for example) while others are priced locally (salaries of medical workers, for example), neither USD nor ID provides an unbiased estimate of expenditures for medical care. Nevertheless, US dollars are best used to compare currency prices or expenditures for diabetes care. IDs are best used to compare the amount of diabetes care that countries produce. Amounts in both USD and ID are expressed as their value in 2005, the most recent year for which national health expenditure estimates have been published [7]. In reporting our study results, we will refer to the estimates in USD with R = 2, unless otherwise stated.

3. Results

3.1. Health expenditures for diabetes in 2010

The total annual global health expenditure for diabetes in 2010 is estimated to fall between USD 376.0 billion (R = 2) and USD 672.2 billion (R = 3), or between ID 417.8 billion and ID 745.7 billion (Table 1). Expenditure on diabetes is expected to account for 12% (R = 2) of the world's total health expenditure (Table 1). On average, USD 1330 (R = 2) is expected to be spent on each person with diabetes (Table 1).

Spending on diabetes varies by IDF region. The NA region will spend USD 214.2 billion, or 57% of the total global health expenditure. The EUR and WP regions will spend USD 105.5 billion and USD 38.2 billion, respectively, or 28% and 10% of the

Table 1 – Global health expenditure for diabetes, 2010 and 2030.

Region	Health expenditure for diabetes in 2010 ('000)			Spending on diabetes as a % of total health expenditure in 2010, R = 2			Mean health expenditure per person with diabetes in 2010, R = 2			Health expenditure for diabetes in 2030 ('000)					
	US dollars (USD)			International dollars (ID)			USD	ID	US dollars (USD)			International dollars (ID)			
	R = 2	R = 3	R = 2	R = 3	R = 2	R = 3			R = 2	R = 3	R = 2	R = 3			
AFR	1,360,001	2,428,829	2,760,601	4,933,394	7	112	227	2,038,596	3,666,401	4,312,818	7,748,206				
EMME	5,575,419	9,254,580	11,255,720	19,019,468	14	210	424	11,382,670	19,008,939	22,421,595	38,053,579				
EUR	105,466,358	196,048,243	106,347,710	197,115,798	10	1911	1927	124,613,549	234,815,304	126,042,567	236,642,012				
NA	214,225,151	373,276,922	216,859,501	377,783,710	14	5751	5822	288,682,344	517,281,497	293,310,969	525,265,583				
SACA	8,051,822	14,384,661	17,273,767	30,924,764	9	458	982	13,208,022	23,946,087	28,202,408	51,189,469				
SEA	3,099,199	5,413,277	8,955,615	15,639,475	11	53	153	5,311,322	9,346,234	15,362,678	27,030,663				
WP	38,205,994	71,428,989	54,365,057	100,288,354	8	508	723	44,828,062	84,947,205	71,681,417	134,480,914				
Global total	375,983,944	672,235,502	417,817,971	745,704,963	12	1330	1478	490,064,566	893,011,667	561,334,452	1,020,410,426				

AFR = Sub-Saharan African Region; EMME = Eastern Mediterranean and Middle East Region; EUR = European Region; NA = North American Region; SACA = South American and Central American Region; SEA = South East Asian Region; WP = West Pacific Region.

Table 2 – Health expenditures for diabetes among adults aged 20–79 years for years 2010 and 2030: 80 most populous countries.

Country	Health expenditure for diabetes in 2010 ('000)				% of health expenditure	Mean health expenditure per person with diabetes in 2010		Health expenditure for diabetes in 2030 ('000)			
	US dollars (USD)		International dollars (ID)			Expenditure		US dollars (USD)		International dollars (ID)	
	R = 2	R = 3	R = 2	R = 3		USD	ID	R = 2	R = 3	R = 2	R = 3
Africa: Sub-Saharan											
Angola	14,740.44	26,332.43	16,787.73	29,989.71	5	65.91	75.06	32,980.12	58,367.42	37,560.70	66,474.00
Burkina Faso	10,276.54	18,398.84	32,732.68	58,603.71	5	49.11	156.42	22,998.84	40,889.57	73,255.56	130,240.84
Cameroon	34,457.20	61,321.41	54,850.23	97,613.68	7	82.96	132.06	61,468.58	108,870.67	97,847.95	173,304.34
Côte d'Ivoire	23,098.04	41,107.32	42,799.31	76,169.45	7	9.37	31.84	41,566.71	73,689.37	77,020.67	136,542.06
Dem. Rep. of Congo	6962.70	12,477.31	23,673.17	42,422.85	5	58.64	108.66	16,303.88	28,821.10	55,433.18	97,991.76
Ethiopia	8945.82	16,270.33	29,819.41	54,234.43	4	10.83	36.10	21,787.44	39,199.19	72,624.81	130,663.97
Ghana	23,073.09	41,475.67	71,526.57	128,574.59	6	50.34	156.07	44,750.96	80,316.80	138,727.97	248,982.09
Kenya	22,334.37	39,720.46	88,406.87	157,226.84	5	43.03	170.31	52,152.72	92,176.54	206,437.84	364,865.45
Madagascar	4290.16	7745.00	15,730.59	28,398.32	5	15.90	58.32	10,090.87	18,111.89	36,999.87	66,410.27
Malawi	4011.96	7366.27	13,513.98	24,812.69	3	34.80	117.21	9195.86	16,534.07	30,975.53	55,693.70
Mozambique	8079.68	14,453.19	27,124.63	48,521.42	6	24.56	82.44	14,180.11	25,019.30	47,604.66	83,993.36
Niger	3791.13	6836.88	10,530.91	18,991.32	6	16.93	47.02	8405.75	15,214.93	23,349.31	42,263.71
Nigeria	133,439.31	237,861.55	222,398.85	396,435.92	7	47.33	78.89	249,599.09	443,274.21	415,998.48	738,790.35
Senegal	16,924.80	30,553.30	30,731.88	55,478.36	7	66.22	120.24	33,224.91	59,346.10	60,329.45	107,760.02
South Africa	865,095.13	1,545,032.66	1,605,474.03	2,867,326.06	7	674.06	1250.95	1,086,147.59	1,972,975.69	2,015,710.97	3,661,517.81
Uganda	9503.33	17,317.93	56,156.06	102,333.21	3	42.41	250.61	25,984.96	46,522.86	153,547.48	274,907.82
UR Tanzania	15,492.12	27,879.93	36,452.04	65,599.84	5	30.73	72.30	35,055.43	62,319.82	82,483.37	146,634.88
Zimbabwe	8903.81	15,971.52	61,902.71	111,040.10	6	37.84	263.09	14,549.20	25,987.35	101,151.57	180,673.94
Asia											
Bangladesh	116,472.49	202,764.06	553,244.33	963,129.28	10	20.50	97.38	216,056.73	378,009.43	1,026,269.48	1,795,544.81
Cambodia	18,670.87	32,809.26	107,518.47	188,936.08	8	52.74	303.70	37,778.24	66,836.35	217,550.54	384,885.21
China	4,968,697.48	9,049,213.38	19,322,712.43	35,191,385.36	6	115.13	447.73	7,469,708.48	13,994,489.75	29,048,866.33	54,423,015.70
Dem. Rep. of Korea	1321.44	2400.42	62,107.89	112,819.75	8	1.40	65.87	1779.97	3233.06	83,658.64	151,953.75
India	2,815,149.48	4,927,972.44	7,819,859.68	13,688,812.33	11	55.45	154.03	4,841,521.26	8,531,713.05	13,448,670.16	23,699,202.91
Indonesia	287,345.37	519,208.65	862,036.11	1,557,625.95	7	41.26	123.79	501,593.25	913,943.02	1,504,779.76	2,741,829.06
Japan	22,150,915.53	42,310,281.37	18,846,385.22	35,998,325.23	8	3124.59	2658.46	21,442,994.40	41,361,937.41	18,244,073.58	35,191,457.65
Malaysia	600,407.75	1,005,095.05	1,227,860.90	2,055,464.66	16	325.24	665.14	1,073,139.02	1,828,693.40	2,194,617.64	3,739,760.38
Myanmar	6243.16	11,771.98	59,310.03	111,833.84	5	6.77	64.34	11,964.65	22,909.94	113,664.17	217,644.43
Nepal	15,152.56	27,608.90	71,974.66	131,142.26	6	29.67	140.94	31,538.71	57,255.37	149,808.89	271,963.03
Philippines	208,944.86	360,976.75	1,123,784.53	1,941,469.54	11	61.49	330.70	384,634.26	670,570.18	2,068,708.57	3,606,580.18
Republic of Korea	4,130,466.97	7,324,294.27	5,361,541.40	9,507,280.22	12	1254.53	1628.44	5,598,024.75	10,262,524.45	7,266,500.78	13,321,241.92
Sri Lanka	106,801.72	180,754.51	395,794.60	669,854.94	16	69.85	258.84	149,932.89	259,756.07	555,633.66	962,625.44
Thailand	509,784.39	906,374.25	1,680,207.73	2,987,335.54	11	144.09	474.91	720,238.41	1,315,096.08	2,373,847.01	4,334,449.33
Viet Nam	101,809.75	195,379.03	608,106.90	1,166,993.65	5	61.83	369.31	216,262.64	419,160.40	1,291,730.93	2,503,633.75
Europe/North America/Oceania											
Australia	4,105,051.93	7,701,169.16	3,872,763.55	7,265,390.96	9	3780.52	3566.59	5,649,982.74	10,895,824.56	5,330,272.93	10,279,273.66
Austria	2,838,538.04	5,112,748.29	2,611,484.97	4,703,782.41	12	4006.97	3686.46	3,382,733.75	6,205,428.90	3,112,150.77	5,709,060.11
Belarus	157,262.40	284,568.37	397,010.46	718,395.65	11	237.88	600.53	172,921.87	315,348.70	436,542.94	796,100.87

Belgium	2,295,388.90	4,385,558.50	2,042,636.71	3,902,651.45	9	3762.66	3348.35	2,810,304.26	5,434,029.78	2,500,853.20	4,835,672.40
Canada	11,217,092.34	19,853,674.02	11,181,119.16	19,790,003.35	13	3913.73	3901.18	15,493,896.28	28,247,408.71	15,444,207.40	28,156,819.36
Czech Republic	663,262.01	1,227,928.47	1,104,163.14	2,044,189.68	10	979.26	1630.21	768,508.08	1,455,465.38	1,279,371.17	2,422,980.96
France	17,242,239.47	32,081,751.90	14,962,236.61	27,839,467.35	10	4140.62	3593.09	21,361,923.06	40,479,164.75	18,537,159.73	35,126,460.33
Georgia	42,266.27	77,158.72	109,273.78	199,483.53	11	147.22	380.61	47,938.90	87,465.83	123,939.60	226,131.16
Germany	28,108,815.37	51,318,714.34	25,180,168.12	45,971,836.17	12	3750.67	3359.89	30,288,414.03	56,013,228.18	27,132,675.19	50,177,230.32
Greece	2,067,277.65	3,941,035.30	2,367,754.06	4,513,860.20	9	2741.76	3140.27	2,403,451.12	4,577,553.82	2,752,789.94	5,242,895.94
Hungary	641,387.74	1,188,031.92	996,964.10	1,846,660.15	10	973.43	1513.08	698,736.70	1,317,478.12	1,086,106.53	2,047,869.49
Italy	11,022,610.96	20,883,103.78	10,129,992.39	19,191,975.76	9	2807.47	2580.12	12,613,637.58	23,933,106.98	11,592,176.59	21,994,987.62
Netherlands	3,793,953.02	7,159,054.81	3,396,440.53	6,408,962.83	9	4113.20	3682.24	4,816,095.59	9,307,548.49	4,311,487.82	8,332,347.48
Poland	1,587,530.84	2,872,479.80	2,703,613.13	4,891,920.15	11	593.56	1010.85	1,868,847.92	3,485,718.73	3,182,704.63	5,936,284.63
Portugal	1,556,895.91	2,853,311.47	1,761,022.27	3,227,412.30	11	1957.29	2213.92	1,791,737.50	3,308,573.77	2,026,654.19	3,742,364.55
Romania	398,017.51	743,759.73	807,179.51	1,508,344.73	10	294.51	597.28	435,144.20	819,960.71	882,472.44	1,662,880.31
Russian Federation	3,123,375.74	5,638,531.23	6,325,681.56	11,419,552.42	11	324.51	657.22	3,354,748.84	6,125,977.38	6,794,274.72	12,406,762.86
Serbia	147,478.15	275,465.90	274,782.40	513,250.15	10	240.43	447.98	165,625.72	312,093.78	308,595.10	581,495.49
Spain	6,694,086.23	12,449,384.34	6,974,043.36	12,970,037.03	9	2277.45	2372.70	8,837,728.28	16,500,546.03	9,207,335.87	17,190,624.63
Sweden	1,986,899.47	3,798,437.03	1,605,726.11	3,069,732.31	8	4101.41	3314.58	2,270,267.40	4,416,821.29	1,834,731.80	3,569,483.70
Ukraine	484,052.20	881,903.57	1,845,449.01	3,362,257.37	11	145.43	554.46	487,322.42	891,991.02	1,857,916.72	3,400,715.78
United Kingdom	7,647,875.05	15,096,949.65	6,482,223.07	12,795,945.90	6	3574.46	3029.66	9,130,774.39	18,281,744.65	7,739,106.10	15,495,329.91
USA	197,956,039.70	344,778,333.26	197,956,039.70	344,778,333.26	14	7382.66	7382.66	264,343,629.36	473,770,569.07	264,343,629.36	473,770,569.07
Latin America/ Caribbean											
Argentina	1,046,138.36	1,902,592.38	3,304,846.18	6,010,462.29	8	671.48	2121.28	1,448,539.16	2,647,415.12	4,576,066.89	8,363,425.03
Brazil	4,296,701.58	7,721,449.84	8,743,961.45	15,713,462.61	9	562.95	1145.62	7,230,733.29	13,224,137.88	14,714,834.59	26,911,655.25
Chile	399,153.85	716,654.60	671,624.12	1,205,857.11	9	571.22	961.15	584,341.29	1,079,501.88	983,224.14	1,816,391.08
Colombia	464,843.17	832,912.98	1,343,651.16	2,407,574.34	8	325.69	941.43	828,326.75	1,520,600.52	2,394,317.63	4,395,367.68
Cuba	339,322.32	580,310.45	364,497.85	623,365.74	13	375.65	403.52	439,359.41	762,614.83	471,957.04	819,195.93
Ecuador	102,903.69	184,466.52	191,806.89	343,835.55	9	232.06	432.54	175,276.16	318,398.51	326,705.22	593,477.49
Guatemala	105,653.44	181,790.52	195,298.78	336,037.03	12	227.26	420.09	219,976.03	373,057.54	406,622.36	689,591.22
Mexico	4,836,480.08	8,280,355.91	7,397,569.74	12,665,101.33	15	708.46	1083.61	8,513,062.13	14,695,229.29	13,021,033.85	22,476,880.24
Venezuela	412,820.45	737,444.44	543,184.80	970,321.63	10	399.37	525.48	742,708.31	1,353,252.45	977,247.78	1,780,595.33
Middle-East Crescent											
Afghanistan	28,625.01	48,537.01	37,212.51	63,098.11	11	33.42	43.45	57,170.69	96,398.56	74,321.90	125,318.12
Algeria	264,177.99	455,675.29	428,066.19	738,362.75	11	161.86	262.27	461,074.27	803,885.69	747,111.09	1,302,592.56
Egypt	557,078.45	936,606.64	1,992,626.78	3,350,169.90	16	116.37	416.25	993,584.17	1,673,524.58	3,553,974.13	5,986,068.69
Iran, Islamic Republic of	1,048,047.21	1,829,836.94	3,346,829.99	5,843,394.38	11	364.98	1165.52	2,186,953.76	3,827,378.56	6,983,809.87	12,222,336.24
Iraq	112,917.24	189,086.82	248,800.70	416,631.97	13	96.03	211.59	251,459.85	421,711.11	554,064.07	929,193.97
Kazakhstan	124,544.95	221,440.09	257,505.10	457,842.36	8	213.20	440.80	180,564.52	323,799.57	373,329.36	669,477.50
Morocco	206,626.45	358,324.56	598,984.55	1,038,738.60	12	136.59	395.96	356,397.11	623,753.16	1,033,151.18	1,808,183.31
Pakistan	172,512.83	293,537.06	563,541.92	958,887.74	12	24.14	78.86	332,612.23	566,773.86	1,086,533.27	1,851,461.29
Saudi Arabia	1,409,561.98	2,246,478.24	1,793,415.91	2,858,242.41	21	682.50	868.35	2,989,442.48	4,836,078.04	3,803,531.72	6,153,045.73
Sudan	34,794.99	63,104.72	64,790.66	117,505.35	6	51.53	95.95	69,958.46	126,256.32	130,267.47	235,097.97
Syrian Arab Republic	100,497.58	172,057.88	181,225.15	310,268.30	14	103.22	186.13	220,411.08	377,176.42	397,462.61	680,154.20
Tunisia	138,376.55	238,390.34	417,757.05	719,697.41	12	229.94	694.18	245,444.05	424,646.87	740,992.48	1,282,003.51
Turkey	2,104,674.27	3,691,919.32	3,253,177.98	5,706,569.81	11	572.08	884.26	3,681,648.62	6,513,163.95	5,690,694.47	10,067,344.80
Uzbekistan	29,016.08	51,832.05	190,836.56	340,895.41	7	43.06	283.22	61,629.98	110,262.50	405,335.65	725,187.95
Yemen	20,008.71	35,859.62	45,147.85	80,914.01	5	74.11	167.22	46,044.17	82,541.60	103,894.53	186,247.71

global total. The remaining IDF regions, including SEA, EMME, SACA, and AFR, will only spend 5% of the global total. Spending on diabetes as a percentage of the total regional health expenditures will vary from 7% in the AFR region to 14% in the EMME and NA regions (Table 1). In terms of health expenditure per person with diabetes, the NA region will spend the most, USD 5751, while the SEA region will spend the least, USD 53, an over 100-fold difference. The EUR region will also spend about USD 2000 per person, and the rest of the regions will spend between USD 112 and USD 508 (Table 1).

Health expenditure for diabetes in 2010 will not be evenly distributed by age group, sex and country's income level. More than three-quarters of the global expenditure will be for people between 50 and 80 years of age and 53% of the total is expected to be spent on women. Ninety-one percent of the world total health expenditure on diabetes will be in developed countries while only 9% of the total will be in the developing countries (data not shown).

Health expenditures on diabetes for the 80 most populous countries appear in Table 2. In 2010, those countries will account for about 95% of the world's population [1]. The health expenditure for diabetes for all 193 countries or regions can be found in the online Appendices 1–7.

A large disparity in total health spending for diabetes among the top 80 most populous countries exists, varying from USD 1.3 million to USD 198.0 billion. The country with the highest total expenditure, the United States of America, will spend 52.7% of the global expenditure. India, the country with the largest population of people living with diabetes, will spend an estimated USD 2.8 billion or less than 1% of the world total. The total diabetes spending in the 18 countries in IDF's African Region will be only USD 1.2 billion, 0.3% of the global total.

By country, health expenditures on diabetes per person with diabetes, in 2010, will vary from less than USD 10 to USD 7383 ($R = 2$). The United States of America is expected to spend the most while the Democratic People's Republic of Korea is expected to spend the least. At the top end, four other countries, Austria, France, Sweden and the Netherlands, will spend more than USD 4000 per person with

diabetes. At the bottom end, five other countries, Myanmar, Côte d'Ivoire, Ethiopia, Niger, and Madagascar, will spend less than USD 20 per persons with diabetes. Nearly all countries with per capita expenditure of USD 2000 or more are developed countries and nearly all countries with per capita spending of USD 1000 or less are developing countries. However, the health expenditure as indicated by USD in the low per capita spending countries may underestimate the health care resources devoted to diabetes because the US Dollar can buy more services in these countries. For example, spending expressed in international dollars are ID 66 for the Democratic People's Republic of Korea and ID 62 for Myanmar, respectively, which are much higher than the less than 20 measured in USD.

Expenditure on diabetes as a percent of a country's total health expenditure varies from 2% to 41%. This variation is primarily driven by the diabetes prevalence of each country, which is driven in turn by the incidence of new diabetes cases and by the rates of survival after diabetes onset. About 95% of the countries covered in this report will spend 5% or more of their total health expenditure on diabetes, and about 80% of the countries will spend between 5% and 13% (Fig. 1).

The top 10 countries for expenditure on diabetes, as measured by total health expenditures for diabetes, per capita health expenditures for diabetes, and percent of health expenditures spent on diabetes are presented in Table 3. Only two of the ten countries with the highest total health expenditures for diabetes are developing countries. The top 10 countries with the highest per capita health expenditure on diabetes are all developed countries. The top 10 countries with the highest percent of the health expenditure spent on diabetes are all countries where the prevalence of diabetes is high.

We observed a striking discrepancy between countries with the largest number of people with diabetes and countries with the highest expenditures for diabetes care. Fig. 2 displays the health expenditure for diabetes in international dollars and the number of people with diabetes for the 25 countries with the largest numbers of people with diabetes in 2010. In general, developing countries have more people with diabetes but less

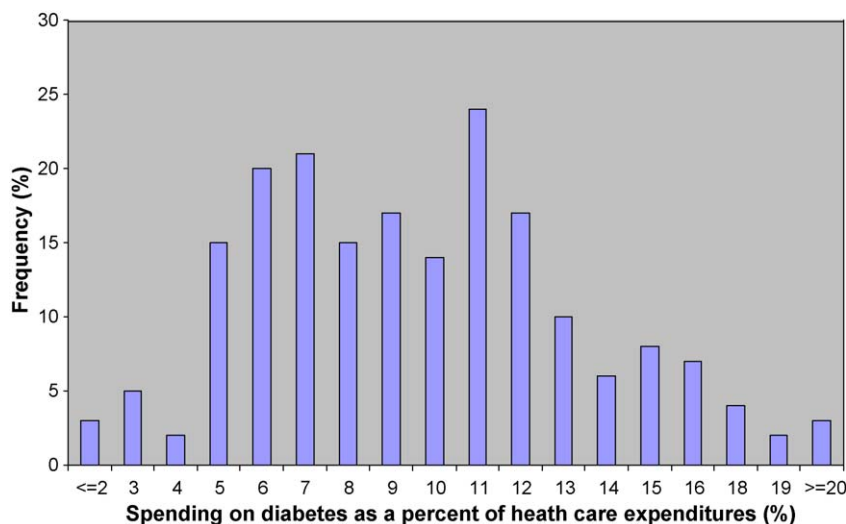


Fig. 1 – Frequency distribution of spending on diabetes as a percent of a country's healthcare expenditure in the world, 2010.

Table 3 – Top 10 countries with the highest health expenditures for diabetes as measured by the national total, per person with diabetes, and percentage of the national health expenditure on diabetes in 2010.

Country	Total (USD in 000s)	Country	Per person with diabetes (USD)	Country	Percent (%)
United States	197,956,040	United States	7383	Nauru	41
Germany	28,108,815	Luxembourg	7268	Saudi Arabia	21
Japan	22,150,916	Monaco	5866	Mauritius	20
France	17,242,239	Slovenia	1626	Tuvalu	19
Canada	11,217,092	Norway	6933	Bahrain	19
Italy	11,022,611	Iceland	7001	Tonga	18
United Kingdom	7,647,875	Switzerland	5995	Oman	18
Spain	6,694,086	Ireland	5035	Qatar	18
China	4,968,697	Canada	3914	Seychelles	18
Mexico	4,836,480	Austria	4007	Malaysia	16

total diabetes spending. In contrast, developed countries have much higher national diabetes expenditures but much smaller numbers of people with diabetes.

3.2. Projections to 2030

We project that annual global health expenditure for diabetes for 2030 falls between USD 490.1 billion ($R = 2$) and USD 893.0 billion ($R = 3$). Measured in international dollars, this expenditure will range from ID 561.3 billion ($R = 2$) to ID 1020.4 billion ($R = 3$).

The global health expenditures for diabetes in 2030 will be 30–34% larger than those of 2010 (Table 1). However, the rate of growth in diabetes expenditure will vary by region. The developing countries will have a twenty-year growth rate of 67% while the developed countries will have a rate of 27%. Corresponding to this higher growth rate in the developing countries, the developing countries' share of the total global diabetes expenditure will increase from 9% (2010) to 12% (2030). By IDF region, EMME will have the fastest growth rate with a 100% increase while the European region will have the smallest increase, with a growth rate of about 20%.

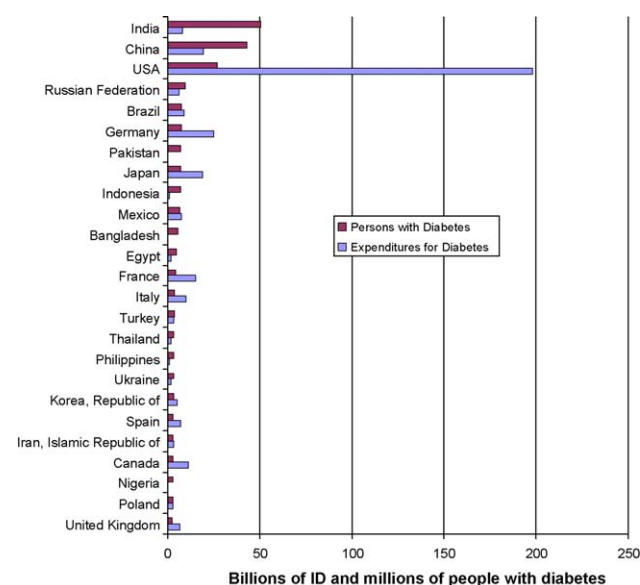


Fig. 2 – Health expenditure for diabetes and the number of persons with diabetes in the 25 countries with the largest numbers of persons with diabetes in 2010.

Table 2 also shows projected health expenditures for diabetes in 2005 dollars for the year 2030 for the top 80 most populous countries. The total expenditure for diabetes will be higher in 2030 than in 2010 in all countries except Japan, for which the expenditure will fall slightly because of the decrease in total population. The increase varies from 101% to 271%. In general, the growth rate in the developed countries is lower than that in the developing countries. Nine of the top 10 countries with the highest growth rate are African. However, the ten countries with the highest expenditure will remain the same as in 2030 and as in 2010. The United States will spend the most, with USD 264.3 billion ($R = 2$) or 54% of the world total.

4. Discussion

We estimated that the global health expenditure on diabetes is expected to total at least USD 376 billion or ID 418 billion or 12% of the total health expenditure in 2010. On average, USD 1330 is being spent on each person with diabetes. About 80% of the countries will spend 5–13% of their national health expenditures on diabetes. These results suggest diabetes imposes a large economic burden on the national health care system worldwide, thus more prevention efforts are needed to reduce this burden.

Considerable disparity in total health expenditures for diabetes exists across regions, countries and by age group. More than 90% of the global expenditure on diabetes is made in the world's economically richest countries. The United States of America alone will spend more than half of the global expenditure on diabetes. In comparison, less than 10% of the global expenditure will be spent in the low- and middle-income countries where some 70% of people with diabetes will live in 2010. India, which has the largest population of people with diabetes, will account for less than 1% of the world total. Differences in the size and composition of the population, prevalence of diabetes, and, most importantly, the level of health expenditure contributed to these region- and country-differences. The discrepancy between regions or countries with the largest number of people with diabetes and regions or countries with the highest health diabetes expenditure also indicates that the need for medical care is not the primary determinant of health spending for medical care.

A disproportionate amount of the global health expenditure for diabetes will be spent on older adults because of higher prevalence of diabetes and higher rates of diabetes-related

complications in older age-groups. In addition, countries with the most per capita spending for diabetes, such as the United States and Japan, tend to have an older population, which also contributes to higher spending for the older population.

The absolute level of health expenditure in developing countries appears to be quite low. The lowest 20 spending countries in the top 80 most populated countries will spend less than USD 50 per person per year for managing diabetes and diabetes-related complications. Expenditure at this level cannot even cover the annual wholesale cost of a generic oral agent capable of preventing acute, life-threatening hyperglycaemia. Considering the health services and therapeutic treatments needed to manage diabetes and diabetes-related complications, more health care resources are required to provide adequate diabetes care in the poor countries.

The increase in global health expenditure on diabetes from 2010 to 2030 exceeds the assumed global population growth (28.6%) among people aged 20–79 years over the same period. Expenditures will grow more quickly than population because the global prevalence of diabetes is expected to increase, because of aging and increasing urbanization. Our estimate of global health expenditure on diabetes for the year 2030 may be negatively biased because we used the same values for per capita health expenditure in both 2010 and 2030. It is almost certain that per capita health expenditure in both developed and developing worlds will increase in the next 20 years.

Both global and country specific estimates of health expenditure for diabetes were reported in the third edition of the Diabetes Atlas [4]. We updated the estimates in the third edition of the Diabetes Atlas, from the years 2007 and 2025 to the years 2010 and 2030, using the same method. Our estimates are higher because the world population, diabetes prevalence and per capita health expenditures have increased over time. However, for some countries, different estimates between our study and the third edition of the Diabetes Atlas may merely reflect the use of different data sets. Better data have become available since the third edition of the Diabetes Atlas was prepared; the change in estimates is, at least in part, a result of improved data. This is particularly true for those countries where health expenditures on diabetes showed a decrease when no turmoil or natural disasters led to a worse national economy.

We used a relatively simple formula to derive our estimates of health expenditure for diabetes for 193 countries in the world. The advantage of this approach is its simplicity and its ability to use available data, which are quite limited for most countries. However, we are uncertain of the validity/accuracy of estimates obtained from this simple approach. To check the validity and accuracy of our estimates, we compared our estimated expenditure on diabetes with independent estimates obtained from industrialized countries where direct studies of diabetes costs have been conducted. We compared health expenditures per person with diabetes instead of total national expenditures on diabetes to control for the influence of using different national populations and diabetes prevalences between our study and the comparison study. Because the estimates from the comparison studies tend to be several years old and are reported in non-USD currencies, we also adjusted all estimates into the same year and same currency (USD) using annual average exchange rates and the rate of growth in health expenditure.

Koster et al. [8] estimated the medical cost of diabetes in Germany (CoDiM) and reported per capita costs of USD 2795 (converted from Euro into USD using the average exchange rate in 2001) in 2001, which is quite similar to our estimate of USD 2484 (adjusting our estimate into spending in year 2001). CODE-2 estimated the expenditures attributable to diabetes in 1999 ranging from USD 1270 in Spain to 3361 in Germany [9]. After the adjustment, our estimates were similar for Spain (USD 1198) and somewhat lower for Germany (USD 2700), assuming $R = 2$. In Australia, the DiabCo\$t Study [10] estimated a direct medical care cost per person with diabetes (including costs for treating both diabetes and other health conditions) at USD 2230 in 2001 compared with our adjusted estimate of USD 1939. However, our estimate omits expenditures not caused by diabetes. The latest estimate for the direct cost of medical care was USD 6649 in the United States in 2007 [2]. Our adjusted estimate is USD 8409. However, our estimate covered a broader scope of expenditures than the independent US study by including all expenditures on diabetes, including medical research.

Confirmation of estimates for developing countries remains uncertain because few studies have estimated the cost of diabetes in these countries. Our adjusted per-capita health expenditure for diabetes is similar to a published estimate for the publicly supported medical care systems in Mexico [11]. In China, a study of patients of endocrinologists from four different provincial capitals, including Beijing and Shanghai, estimated that the median direct medical cost per person with type 2 diabetes was USD 686 per year in 2007 [12]. Our adjusted estimate is USD 149 for China. However, our estimates encompass nearly a billion rural Chinese who have no health insurance, and tens of millions of urban residents who cannot afford treatment by the endocrine specialists who contributed the Chinese data. Similarly, our estimates for India and Iran are also lower than estimates reported from studies conducted in various cities in India and Iran [13–15].

Our study has several other limitations. First, the input data for population size, diabetes prevalence, aggregate health expenditures and rates of mortality are subject to errors. Assumptions or approximations were used to derive these input data for countries where direct surveys were not available. Second, the ratios of health care expenditure for people with diabetes to people without diabetes by age and sex, R , used in our estimation, came from a single medical care system within one country. Almost nothing is yet known about R or about general medical expenditure patterns by age and sex in poor and middle-income countries. We applied the same R values derived from people with diagnosed diabetes to people with undiagnosed diabetes, which could inflate our estimates because expenditure on a person with undiagnosed diabetes tends to be less than on a person with diagnosed diabetes. We also assumed that estimates of R derived from data on medical care can be generalized to apply to all money expended for health purposes. This may be especially inaccurate in low-income countries because they often receive large portions of their health budgets from external donors, who generally want to focus their giving on public health initiatives and infectious disease, not on diabetes, cardiovascular and renal disease. Finally, purchasing power parities estimated for general baskets of goods and services may not describe purchasing power for

medicines and medical care, increasing the uncertainty of the estimates in international dollars.

In summary, diabetes imposes an enormous economic burden on the national health care system worldwide in 2010. This burden will continue to increase in the next two decades. More prevention efforts are needed to reduce this burden. Meanwhile, wealthy countries do almost all the spending while low- and middle-income countries bear most of the suffering as measured by the share of total global diabetic population. More resources are required to provide basic diabetes care in the low- and middle-income countries.

Disclaimer

The contents of this paper are solely the responsibility of the authors and do not necessarily represent the official positions of the Centers for Disease Control and Prevention.

Conflict of interest

There are no conflicts of interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.diabres.2010.01.026](https://doi.org/10.1016/j.diabres.2010.01.026).

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