Mediterranean Journal of Nutrition and Metabolism 7 (2014) 21–32
DOI:10.3233/MNM-140002
IOS Press

Estimation of the direct cost of diabetes in the Arab region

Abdesslam Boutayeb[a,*], Wiam Boutayeb[a], Mohamed E.N. Lamlili[a] and Saber Boutayeb[b]
[a]*LaMSD, Faculty of Sciences, University Mohamed Ier, Boulevard Mohamed VI, Oujda, Morocco*
[b]*Department of Medical Oncology, National Institute of Oncology, Rabat, Morocco*

Received 27 October 2013; accepted 26 November 2013

Abstract.
BACKGROUND: Diabetes needs costly prolonged treatment and care. Its burden affects the whole society. Six of the top 10 countries with the highest prevalence of diabetes are in the Middle East. Following the studies carried out in Latin America and the Caribbean countries, and in the WHO African region, an estimation of the direct cost of diabetes in the Arab region is proposed.
METHOD: Arab countries were classified into three income groups. The prevalence of diabetes was estimated in each country. The direct cost of diabetes included the cost of insulin, oral drugs, reagent strips, urine strips, lancets, glucose meters, laboratory tests, outpatient consultation and hospitalization. To overcome the problem of disparity in prices, three scenarios were used (Low, Medium and High price).
RESULTS: The annual average per capita direct cost of diabetes is estimated in US dollars at USD 351, USD 529 and USD 860 according to the low, medium and high cost scenarios, respectively. The cost varies also according to the income group. The annual total direct cost of diabetes in the 21 countries of the Arab world is estimated to be between USD 9 billion and USD 22 billion. The annual average per capita direct cost of diabetes in the Arab region is 1.4 to 3.5 times higher than the average per capita health expenditure of the region (USD 250). The direct cost of diabetes in the third income group is 4.8 to 11.4 higher than the average per capita health expenditure of the group (USD 66.5) whereas, in the first group, the ratio is 0.4 to 1.14. Although indirect cost is not considered in this paper, it is stressed that diabetes also incurs indirect costs due to loss of productivity caused by premature death and disability, and intangible and non-quantifiable costs.
CONCLUSION: This study shows that the direct cost of diabetes is high compared to health expenditure in Arab countries. A sincere call is sent to health decision makers to give more importance to sensitisation, early diagnosis and treatment of diabetes.

Keywords: Diabetes, prevalence, Arab countries, income group, direct cost

1. Introduction

The World Economic Forum Report 2010 enumerated five sets of risks that share a potential for wider systematic impact and are strongly linked to a number of significant, long-term trends: Economic, Geopolitical, Environmental, Societal and Technological risks. Out of the 36 global risks considered, chronic diseases were classified in the first group with the highest economic severity (more than 1 trillion US dollars) [1]. Once associated with economic development and considered as diseases of the rich, non-communicable diseases (NCDs) now affect countries worldwide, threatening particularly economic and human development of low and middle-income countries.

*Corresponding author: Abdesslam Boutayeb, LaMSD, URAC04, Faculty of Sciences, University Mohamed Ier, Boulevard Mohamed VI, BP: 717, Oujda, Morocco. E-mail: x.boutayeb@menara.ma.

ISSN 1973-798X/14/$27.50

Diabetes is one of these diseases having a high prevalence and consequently a substantial socio-economic burden in the Arab region. According to the International Diabetes Federation Report 2011, six of the top 10 countries with the highest prevalence of diabetes (in adults aged 20 to 79 years) are in the Middle East: Kuwait (21.1%), Lebanon (20.2%), Qatar (20.2%), Saudi Arabia (20.0%), Bahrain (19.9%) and UAE (19.2%) [2]. It should, however, be stressed that in the absence of national registries, the estimated prevalence of diabetes varies considerably in the Arab region and even in the same country according to different published studies. For instance, in Saudi Arabia the following estimates are given: 9.5% in 1996 [3], 17% in 1997 [4] and 23.7% in 2004 [5]. Studies in Algeria give a prevalence of 14.2% in Tlemcen-Ouest Algerian region in 2007 [6], 8.2% in the South-East in 2001 [7] and 7.3% in 2003 [8]. Similar differences are found in other Arab countries. Although some variations can be explained by the fact that studies may be carried out in different regions, at different times and in populations with different age structures, the gaps remain too large.

Due to its chronic nature with severe complications, diabetes needs costly prolonged treatment and care. Consequently, its economical burden affects individuals, households and the whole society. Diabetes raises the equity problem between and within countries [9]. In India, a low-income family with an adult diabetic spends about 25% of its family income on diabetes care [10].

The American Diabetes Association estimates that the yearly cost for treating a person with diabetes is over five times more than for a person without diabetes (USD 13,243 versus USD 2,560). In 2002, an amount of USD 132 billion was spent on diabetes and by 2007 the value grew to USD 174 billion (USD 116 billion for medical expenditures (direct costs) and USD 58 billion (indirect costs) in reduced national productivity. It is estimated that the value will be more than USD 350 billion by 2025 and USD 2.6 trillion in the next 30 years [11].

According to the Canadian Diabetes Association [12], the economic burden (in Canadian dollars) of diabetes nearly doubled between the years 2000 (CAD 6.3 billion) and 2010 (CAD 12.2). It was also predicted that this cost will rise by another CAD 4.7 billion in 2020. The direct cost of diabetes now accounts for about 3.5% of public healthcare spending in Canada. People with diabetes incur medical costs that are up to three times higher than those without diabetes and a person with diabetes can face direct costs for medication and diabetes supplies ranging from CAD 1,000 to CAD 15,000 per year.

The report published by Diabetes UK in 2010, indicated that diabetes was the leading cause of blindness in people of working age in the UK, the rate of lower limb amputation in people with diabetes was 15 times higher than in people without diabetes and 80% of people with diabetes will die from CVDs. More generally, it was estimated that up to 10% of hospital budgets was spent on treating diabetes and its complications, and beside the cost covered by NHS, people with diabetes were spending (pounds sterling – GBP) over GBP 500 million of their own money on coping with the condition in 2004. The cost of treating diabetes and its complications was estimated to rise from 5% of the NHS budget (GBP 3.5 billion) in 2004 to 10% of the NHS budget in 2011 [13].

In 2003, Barcelo et al. carried out a study on the cost of diabetes in Latin America and the Caribbean (LAC). The 26 countries of the LAC region were classified into four groups on the basis of per capita gross national product (GNP). The direct cost of diabetes in LAC was estimated at USD 10.72 billion with medication (insulin and oral drugs) accounting for 44%, hospitalization (9.4%), consultations (23.4%) and treatment of complications (23.2%).

The loss of productivity due to permanent and non-permanent disability, and mortality related to diabetes was responsible for an indirect cost of USD 54.5 billion, representing 83.56% of the total cost of diabetes in LAC. The average per capita direct cost of diabetes (USD 703) was 3.2 times higher than the per capita health expenditure (USD 220) [14].

Following the study in LAC, Kirigia et al. proposed in 2009 a similar study in the WHO African region. Evaluated in International dollars (PPP), the annual average cost per person with diabetes in groups 1, 2 and 3 was estimated at PPP 11,431.6, PPP 4,770.6 and PPP 2,144.3, respectively. The total economic loss for the whole region was PPP 25.51 billion. Direct cost accounted for 57%, with one-third devoted to cost of insulin while the remaining 43% for indirect cost of diabetes, were dominantly caused by permanent disability (88.5%) [15].

Recent Korean studies estimate that cost of Type 2 diabetes without complications is approximately USD 1,184 per patient per year. In contrast, diabetes with micro-vascular complications costs up to 4.7 times that amount, and diabetes with macro-vascular complications incur up to 10.7 times that amount [16].

In the Arab region, despite the high prevalence of diabetes, there is a striking lack of studies on the socio-economic cost of diabetes. A recent study was carried out on the direct medical cost of diabetes and its complications in the

Table 1
Arab countries classified according to per capita gross domestic product (GDP, USD) [18]

Income group (2010)	Per capita GNP (USD)	Countries
1	>8000 Average: 22232	Bahrain(17379), Kuwait(46537), Lebanon(9262), Libya(12461), Oman(20764), Qatar(82248), Saudi Arabia(15836), UAE(39619)
2	2000–8000 Average: 3109	Algeria(4272), Egypt(2646), Iraq(2932), Jordan(4445), Morocco(2848), Syria(2835), Tunisia(3831)
3	<2000 Average: 1181	Comoros(736), Djibouti(1266), Mauritania(967), Somalia(500), Sudan(1328), Yemen(1219)

Eastern District of Abu Dhabi Emirate (Al-Ain region). The authors estimated that the annual cost of direct treatment of a diabetic patient without complications (USD 1,605) was 3.2 times higher than the per capita expenditure for health care in the UAE (USD 497). The cost increased notably with the presence of micro-vascular complications (2.2 times) and macro-vascular complications (6.4 times). In patients with both micro- and macro-vascular complications, the treatment cost was 9.4 times higher. The mean annual cost of treatment was higher for patients treated with insulin (USD 6,778) compared to patients not treated with insulin (USD 3,995). The authors also considered the variation of cost according to various characteristics (age, gender, education level, nationality, occupation) [17].

In this paper, an estimation of the direct cost of diabetes in the Arab region is given. The prices of all items used in treatment and care showed a high variability between and within Arab countries. Consequently, costs are computed according to three scenarios (low, medium and high price).

2. Methods

Accurate estimation of diabetes prevalence is lacking in most Arab countries and the absence of reliable data on diabetes constitutes a real problem either for the prevalence and number of people with diabetes or for the cost related to treatment of diabetes and its complications (cost of drugs, hospitalizations, biological tests, visits to physicians, etc.).

In the absence of registries and precise data collected in each Arab country, extrapolations are often used by organizations like the World Health Organization (WHO) and the International Diabetes Federation (IDF).

In this study, following Bercelo et al. [14] and Kirigia et al. [15], the Arab region was divided into three income groups according to the WHO Global Health Expenditure Atlas 2010 [18] (Table 1) and the cost related to the treatment of diabetes was estimated in each group, using all available data in each country and extrapolating for countries where data are not available by assuming that the costs are similar for different countries in the same income group.

2.1. Prevalence of diabetes

For the number of people with Type2 diabetes, our study was based on a bibliographic research on recent studies carried out in different Arab countries in order to estimate the prevalence of diabetes mainly among adult people (20 years and over). Our database was limited to published works based on surveys respecting the standards of statistical sampling techniques (population size, age, gender, selection criteria, etc.). As indicated earlier and shown in Table 2, two or three surveys in the same country, at nearly the same period of time and for the same age population, may end up with different values for the prevalence of diabetes. Consequently, in countries with multiple studies on the prevalence of diabetes, the value retained was the average of values found in different published studies. In countries for which no prevalence was available, the value considered was the mean of the income group to which the country belongs.

For the number of people with Type 1 diabetes, lack and scarcity of reliable data were more crucial but the previous procedure was followed.

Table 2
Bibliographic review on prevalence of diabetes in Arab countries

Author	Country	Year	Population	Sample	Prevalence
[7] Malek	Algeria/Setif	2001			8.2%
[6] Zaoui	Algeria/Tlemcen	2007	20 years+	7656	14.2%
[7] Malek	Algeria/Setif	2001			8.2%
[8] WHO-STEPS	Algeria	2005	25–64	4000	7.3
[19] Novonordisk	Algeria/ Oran ElOued-Blida	2010	20 years+	49000	13%
[20] WHO-STEPS	Bahrain	2007	20–64	1769	14.3%
[21] Al-Mahroos	Bahrain	1998	40–70	2000	29.8%
[22] Ellabany	Egypt	2006	15–65	10000	15.8%
[23] Mansour	Iraq/Basrah	2008	20 years+	3176	7.43%
[24] WHO-STEPS	Iraq	2006	20 years+	1000	13.5%
[25] Ajlouni	Jordan	2008	25 years+		17.1%
[26] Ajlouni	Jordan	1998			3.69%
[27] Zindah	Jordan	2008	18 years+	3334	16.9%
[28] Abdella	Kuwait	1998	20 years+	3003	14.8%
[29] Kadiki	Libya	2001	20 years+	868	14.1%
[30] Tazi	Morocco	2000	20 years+		6.6%
[31] Ramdani	Morocco/Oujda	2011	40 years+	1628	10.2%
[32] Asfour	Oman	1995		5096	10%
[33] Al-Lawati	Oman	2002	20 years+	5838	11.5%
[34] Al-Moosa	Oman	2006	20 years+	7179	U:17.7; R:10.5
[35] Bener	Qatar	2009	20 years+	1117	16.7%
[3] El-Hazmi	Saudi Arabia	1998	2–77 years	25337	M:5.63 F:4.53
[4] Al-Nuaim	Saudi Arabia	1997	15 years+	13177	UM12; UF14 RM7; RF8
[5] Al-Nozha	Saudi Arabia	2004	30–70 years	16917	23.7
[36] WHO-STEPS	Saudi Arabia	2005	25–64	1768	19.2%
[37] WHO-STEPS	Syria	2006	20–65	4774	19.8%
[38] Bouguerra	Tunisia	2008	20 years+	3729	9.9%
[39] Saadi	UAE/Al Ain	2007	20 years+	2455	17.1%
[40] Malik	UAE	2005	20 years+	5844	20%
[41] WHO-MOH	UAE	1998–2000	21 years+	6609	19.6%
[42] AlHabori	Yemen	2004	25 years+	498	4.6%

2.2. *Direct cost of diabetes*

Large variability of prices between and within countries and especially between public and private health sectors was found for the cost related to treatment of diabetes (insulin, oral drugs, syringes, reagent strips, glucose meters, lancets, biological tests and hospitalization) [43, 44].

In each country, public procurement prices are usually obtained centrally and the price of medicines depends on the type of medicine as originator brand or generic, and the place where patients get their needed medicine (public sector, private retail pharmacies and religious or nongovernmental organizations). The World Health Organisation (WHO) and Health Action International (HAI) undertake regular surveys to compare the price of medicines in different countries [44]. Local prices are compared to an International Reference Price (IRP) [45]. Dividing the local unit price by the IRP provides a price ratio giving an indication of how many times more expensive (or cheaper) the medicine is than the reference price. When there is more than one price for the same medicine in a country, the median price ratio (MPR) is used as summary measure.

According to the synthesis report of medicine price surveys undertaken by WHO and HAI in selected countries of the WHO Eastern Mediterranean region (WHO-EMR), the price of the originator brand is higher than the price

of the lowest priced generic equivalent (LPG) for all medicines considered. For instance, Glibenclamide (Daonil), Metformin (Glucophage) and Gliclazide (Diamicron) are the anti-diabetic oral drugs used by the majority of Arab diabetic patients. In the case of Glibenclamide, comparing the private sector MPR of its originator brand (OB) and its lowest priced generic equivalent (LPG) shows a ratio of 1.1 in Kuwait (66.3/60.7), 2.1 in Jordan (38.4/18.5), 2.4 in Morocco (39.6/16.6), 4.1 in Tunisia (27.7/6.9), 4.9 in Lebanon (34.8/7.1) and nearly 6 in Yemen (46.2/7.8). The private sector MPR of the LPG varies from low values in Egypt (2.44), Syria (3.1), Tunisia (6.9), Lebanon (7.1) and Sudan (7.3) to high values in UAE (32.01) and Kuwait (60.7), passing through medium values in Morocco (16.6) and Jordan (18.5). More generally, in developing and middle-income countries of the WHO-EMR, the MPRs were found to be: 59.85 for OB, 25.06 for Private LPG and 17.97 for public LPG [46].

Comparing the price of a 10 ml traditional vial of 100 IU/ml soluble human insulin injection in Morocco shows a high cost of USD 23.5 in private pharmacies, a medium cost of 15.5 in hospitals, whereas the equivalent generic, has a low-medium cost of USD10.15 in private pharmacies and a low cost of USD 6.7 in hospitals. More generally, the Moroccan Agency of Health Insurance indicates the different prices of many other types of insulin and oral drugs [47]. Similar relative differences in prices are found in all Arab countries.

In all Arab countries and for all medicines and care facilities, there are different prices that can be classified as low, medium or high. Consequently, the number of diabetics in each country could be divided into three subpopulations according to the use of medicine or care corresponding to low, medium or high cost. But it is impossible to get this precise information for each health item and in each country. Consequently, we contented ourselves by simply adopting the three low, medium and high scenarios.

2.3. Insulin and syringes

The annual cost of insulin and syringes per person was calculated by assuming that all Type 1 diabetics (N1) and 25% of Type 2 diabetics (0.25*N2) use insulin and syringes. Assuming that 13000 UI is the annual average number of insulin units needed per patient (corresponding to around 35 UI per day) and 200 syringes are needed by each patient per year, the annual cost of insulin and syringes per patient was calculated for three price values per UI and syringe in each country (pl: low price, pm: medium price and ph: high price) when prices are available, leading to the final cost values:

Annual low cost per patient = (N1 + 0.25*N2)*(13000*pl(i) + 200*pl(s))

Annual medium cost per patient = (N1 + 0.25*N2)*(13000*pm(i) + 200*pm(s))

Annual high cost per patient = (N1 + 0.25*N2)*(13000*ph(i) + 200*ph(s))

In case of non-availability of prices in a country, an estimated value is obtained by the mean of the income group to which the country belongs.

2.4. Oral drugs

To estimate the annual cost of oral drugs, it was assumed that 3% of Type 1 (0.03*N1) and 65% of Type 2 diabetics (0.65*N2) use oral drugs at a level of 1,000 tablets per year per patient. Again the total cost of oral drugs was calculated for three values per tablet in each country (low, medium, high) when prices are available and estimating the price value by the mean of the income group in case of non availability of prices in a country. Metformin (Daonil) and Glibenclamide (Glucophage) were the oral drugs most used in the Arab region.

Annual low cost per patient = (0.03*N1 + 0.65*N2)*1000*pl

Annual medium cost per patient = (0.03*N1 + 0.65*N2)*1000*pm

Annual high cost per patient = (0.03*N1 + 0.65*N2)*1000*ph

2.5. Reagent strips, urine strips, lancets, glucose meters

Following the previous procedure for insulin and oral drugs, the annual cost of lancets (la), reagent strips (rs), urine strips (us) and glucose meters (gm) was calculated according to low-medium-high scenarios of prices. The number of people with diabetes using these four items was assumed to be equal to all Type 1 diabetics plus 33% of Type 2 diabetics (N1 + 0.33*N2). Assuming that each patient uses 100 lancets, 300 reagent strips and 100 urine strips per

year and a glucose meter with an eight-year useful life, the annual cost of lancets + reagent strips + glucose meter per patient per year can be expressed, according to the low-medium-high scenarios, by the following formulae:

Annual low cost = (N1 + 0.33*N2)*(pl(la) + pl(rs) + pl(us) + pl(gm)/8)

Annual medium cost = (N1 + 0.33*N2)*(pm(la) + pm(rs) + pm(us) + pm(gm)/8)

Annual high cost = (N1 + 0.33*N2)*(ph(la) + ph(rs) + ph(us) + ph(gm)/8)

2.6. Laboratory tests

People with diabetes usually need some regular tests in order to control their disease and to avoid delayed diagnosis of complications that may affect eyes, kidneys, feet, and others. It is assumed that, on average, 75% of Type 1 and 25% of Type 2 diabetics will require one HbA_{1C} test (t1), one lipid profile (t2), one proteinuria (t3), one electrocardiogram (t4), one eye examination (t5) per year. The annual cost is obtained according to the three scenarios of low-medium-high prices.

Annual low cost = (0.75*N1 + 0.25*N2)*[pl(t1) + pl(t2) + pl(t3) + pl(t4) + pl(t5)]

Annual medium cost = (0.75*N1 + 0.25*N2)*[pm(t1) + pm(t2) + pm(t3) + pm(t4) + pm(t5)]

Annual high cost = (0.75*N1 + 0.25*N2)*[pl(t1) + ph(t2) + ph(t3) + ph(t4) + ph(t5)]

2.7. Outpatient consultation

Estimation of the outpatient consultation cost was calculated according to the low-medium-high scenarios by assuming that each patient with diabetes needs four visits per year. In each country, the low, medium and high prices are related to the kind of health service (public, private, NGO) and the type of visit (to general practitioner or specialist). In case of non-availability of prices in a country, the value was estimated by the mean of the income group to which the country belongs.

Annual low cost = 4*(N1 + N2)*pl

Annual medium cost = 4*(N1 + N2)*pm

Annual high cost = 4*(N1 + N2)*ph

2.8. Inpatient consultation and hospitalization

In addition to the four outpatient visits per year assumed for all people with diabetes, it is assumed that, on average, 75% of Type 1 and 25% of Type 2 diabetics will require a seven days hospitalisation per year. Again, the price of hospitalisation was evaluated according to a low-medium-high price, depending of the kind of hospitalisation service.

Annual low cost = 7*(0.75*N1 + 0.25*N2)*pl

Annual medium cost = 7*(0.75*N1 + 0.25*N2)*pm

Annual high cost = 7*(0.75*N1 + 0.25*N2)*ph

3. Results

As indicated in Table 3, the annual average per capita direct cost of diabetes is estimated at USD 351, USD 529 and USD 860 according to the low, medium and high cost scenarios respectively. Obviously, the cost varies also according to the income group.

Our study shows that the total direct cost of diabetes in the 21 countries of the Arab world (Occupied Palestinian Territories not included for lack of data) is estimated at USD 9 billion, USD 13.5 billion and USD 22 billion following the low, medium and high cost scenarios respectively (Table 4). Although per capita cost in the first group is higher than per capita cost in the second group, the total cost in the second income group is higher than that of the first income group due to the number of diabetics in each group.

Table 5 shows the cost incurred by the use of insulin and oral drugs. In the first income group, insulin represents around 12% of the total cost while the percentage of oral drugs varies from 13.64% to 17.28%. For the second income

Table 3
Per capita cost of diabetes per group per year

Income group	Direct cost (USD)		
	Low cost	Medium cost	High cost
Group1	404	588	945
Group2	336	516	844
Group3	317	469	756
Average	351	529	860

Table 4
Total cost of diabetes per group per year

Income group	Direct cost (USD billion)		
	Low cost	Medium cost	High cost
Group1	2.66	3.82	6.10
Group2	5.54	8.38	13.84
Group3	0.87	1.27	2.06
Total of 3 groups	9.07	13.47	22.00

Table 5
Cost and percentage incurred by the use of insulin and oral drugs (USD)

Groups	Scenario cost	Cost of insulin and syringes per year (USD)	%	Cost of oral drugs per year (USD)	%
Group1	Low	334,471,572	12.58	362,656,801	13.64
	Medium	461,621,406	12.08	660,346,660	17.28
	High	715,583,329	11.73	958,036,519	15.71
Group2	Low	212,256,139	7.83	671,126,665	12.11
	Medium	686,516,879	8.19	1,150,967,369	13.74
	High	1,274,448,985	9.21	1,630,808,072	11.78
Group3	Low	70,380,053	8.08	90,252,538	10.37
	Medium	120,715,283	9.47	134,343,053	10.54
	High	142,238,986	6.89	178,433,569	8.65

group, insulin accounts for 8% to 9% and oral drugs account for 12% to 14%. Finally, in the third income group, insulin represents 7% to 9.5% and oral drugs account for 8.65% to 10.54%.

The total direct cost in each Arab country and the related per capita cost are given in Table Annex 1 and Table Annex 2.

Our study estimates that the annual average per capita direct cost of diabetes in the Arab region is between USD 351 (low cost) and USD 860 (high cost). Being 1.4 to 3.5 times higher than the average per capita health expenditure of the region (USD 250), this estimated cost is comparable to that given by Baecelo et al. [14] who estimated that the average per capita direct cost of diabetes (USD 703) was 3.2 times higher than the per capita health expenditure (USD 220) in the 26 countries of Latin America and the Caribbean. The study on the direct medical cost of diabetes and its complications in the Eastern District of Abu Dhabi Emirate (Al-Ain region) provided a similar estimate of the cost, indicating that the annual cost of direct treatment of a diabetic patient without complications (USD 1,605) was 3.2 times higher than the per capita expenditure for health care in the UAE (USD 497) [17]. It should, however, be stressed that the direct cost of diabetes in the third income group is 4.8 to 11.4 higher than the average per capita health expenditure of the group (USD 66.5) whereas, in the the first group, the ratio is 0.4 to 1.14.

According to IDF estimates in 2011, an average of USD 1274 per person with diabetes was spent globally on treating and managing the disease. In Arab countries, the average spending per person was estimated (by IDF) at USD 428 per person with diabetes.

Table Annex 1
Per capita cost of diabetes compared to per capita health expenditure in each Arab country [18]

Group	Countries	Direct cost (USD)			Health expenditure (USD)
		Low	Medium	High	
G1	Bahrain	406.81	586.62	941.47	864
	Kuwait	418.86	600.93	959.59	1223
	The Lebanon	408.00	585.46	965.36	651
	Libya	408.62	589.16	946.07	484
	Oman	407.65	587.66	943.02	574
	Qatar	406.87	585.96	940.58	1489
	Saudi Arabia	425.70	583.07	926.45	680
	UAE	351.01	589.04	933.03	1450
	Average cost per person	404.19	588.49	944.45	827.5
G2	Algeria	336.42	516.73	849.20	178
	Egypt	331.03	483.48	815.09	123
	Iraq	336.16	516.14	847.96	247
	Jordan	335.93	515.61	846.85	357
	Morocco	341.11	569.24	891.90	148
	Syria	336.15	509.38	832.11	97
	Tunisia	337.11	501.60	825.32	238
	Average cost per person	336.27	516.03	844.06	164.5
G3	Comoros	316.55	467.54	753.27	33
	Djibouti	316.43	467.30	752.83	123
	Mauritania	317.34	468.94	755.86	43
	Somalia	316.50	467.35	752.85	30
	Sudan	325.36	471.03	766.36	84
	The Yemen	311.61	470.98	753.48	63
	Average cost per person	317.30	468.86	755.78	66.5
	Average cost for G1,G2,G3	351.45	529.39	860.16	250.3

In the USA, the yearly cost for treating a person with diabetes is over five times more than for a person without diabetes (USD 13,243 versus USD 2,560) [11].

Korean studies estimate that the cost of Type 2 diabetes without complications is approximately USD 1,184 per patient per year. In contrast, diabetes with micro-vascular complications costs up to 4.7 times that amount, and diabetes with macro-vascular complications incur up to 10.7 times (Kim et al., 2012) [16].

In Pakistan, the annual mean direct cost for each person with diabetes was estimated at USD 197 [48].

Our study shows also that the total direct cost of diabetes varies from USD 9.1 billion (low cost) to USD 22 billion (high cost). Our lower estimation is comparable to that given by the International Diabetes Federation in 2011 (USD 8.7 billion) [2]. According to IDF, however, the total healthcare expenditures due to diabetes in the Arab region accounted for less than 2% of the total global figure whereas the number of diabetics in the region (20.5 million) represented 5.6% of the world total number of diabetes (366 million) [49]. For the 26 countries of Latin America and the Caribbean, the direct cost of diabetes estimated by Barceol et al. [14] was USD 10.72 billion.

In the United States of America, it was estimated that USD 174 billion was spent on diabetes in 2007. The direct cost (USD 116 billion) accounted for two-thirds of the total cost incurred by diabetes [11].

According to Kirigia et al. [8], the 7.02 million cases of diabetes recorded by countries of the African Region in 2000 resulted in a total economic loss of PPP 25.51 billion with direct cost accounting for PPP 17.4 billion (68%) in the Region. It should, however, be stressed that some assumptions made by these authors are very conservative and should lead to the direct cost of diabetes being underestimated. We have addressed a critical reader's comment to

Table Annex 2
Total cost of diabetes compared to health expenditure in each Arab country (USD)

Group	Countries	Direct cost (million USD)			Health expenditure (million USD)
		Low	Medium	High	
G1	Bahrain	69	99	159	1100
	Kuwait	136	195	312	3300
	The Lebanon	195	279	461	2800
	Libya	192	277	444	3100
	Oman	89	128	206	1600
	Qatar	107	154	247	2600
	Saudi Arabia	1462	2003	3182	19000
	UAE	409	686	1087	11000
	Average	332	478	762	
	total	2659	3822	6098	
G2	Algeria	849	1304	2143	6300
	Egypt	2577	3764	6345	10000
	Iraq	512	788	1294	6900
	Jordan	189	290	476	2200
	Morocco	621	1036	1623	4700
	Syria	553	837	1368	2000
	Tunisia	242	360	592	2500
	Average	792	1197	1977	
	total	5543	8378	13841	
G3	Comoros	5689	8	13	24
	Djibouti	12	18	29	81
	Mauritania	28	41	67	148
	Somalia	68	100	161	
	Sudan	586	848	1380	3700
	The Yemen	170	258	412	1500
	Average	145	212	344	
	total	871	1275	2064	
	Average	423	6290	1028	
	Total	9072	13475	22004	

the Journal which published the paper, indicating among others [50], that 1) Kirigia et al. assumed that only people using insulin (Type 1 + 5% of Type 2) were using reagent strips and glucose meters. This assumption is controversial because the vast majority of articles in the literature on diabetes [2, 51–53] recommends that people with Type 2 diabetes on insulin and/or tablets should regularly control their blood glucose, while the authors have considered only one HBA test per year. 2) Similarly, the authors assumed that only people using insulin (Type 1 + 5% of Type 2) were facing hospitalization. This may be true in the case of hypoglycemic coma but in general, diabetes patients not using insulin are also likely to need hospitalization especially older people and those with bad control.

3.1. Indirect cost of diabetes and intangible costs

The indirect economic cost of a disease is mainly estimated by the cost of premature mortality, and permanent and temporary disability caused by this illness. It should be stressed, however, that these non-medical costs are difficult to measure. Beside the problem raised by what to include in indirect costs and how to measure and value such economic costs, overlapping and double counting that may result from indirect cost estimation, constitute a subject of discussion and debate among researchers [54]. In this paper, indirect cost of diabetes is not considered.

Diabetes is a chronic disease with a high economic burden affecting rich and poor people worldwide; however, its burden goes beyond the limits of economical problems. The disease also incurs costs that are intangible and not quantifiable such as inconvenience, anxiety, pain, and more generally lower quality of life [55]. Indeed, diabetes causes more than half of all non-traumatic lower limb amputations. It is also one of the leading causes of visual impairment and blindness, and the leading cause of renal failure in many developing countries. How can we evaluate financially the loss of vision, kidneys or lower limbs? And how can we estimate the affective care devoted by a family to one of its members affected by diabetes complications? As indicated earlier, the treatment of diabetes appears not only as an economic problem but also as a sustainable development issue. For this reason, health decision makers should consider such a disease in its integrated context, requiring health education and sensitization, early diagnosis and efficient treatment to avoid complications or at least to delay them as far as possible. For instance, the budget required for sensitization, diagnosis and treatment of diabetes without complications is cost-efficient compared to the socio-economic burden imposed by blindness, kidney failure or foot amputation.

3.2. Study limitations

In our study, we were limited by lack and scarcity of reliable data. Other limitations were related to different assumptions concerning the number of people using insulin, oral drugs, glucose meters and those needing outpatient care or hospitalization. It is difficult to give an estimation that takes into account the use of all different types of insulin, oral drugs or other items used in diabetes control. In the absence of national registries, it is impossible to identify the proportions of diabetic patients using one kind of medicine or another.

4. Conclusion

Despite the limitations imposed by lack and paucity of reliable data concerning the number of people with diabetes in the Arab countries and the large variability of prices, our study proposes for the first time an estimation of the economic cost of diabetes incurred directly by the use of insulin, oral drugs and other items needed for diabetes treatment and care. Moreover, we also discuss the intangible and not quantifiable costs such as inconvenience, anxiety, pain, and more generally lower quality of life, and hence we stress the importance that health decision makers should give to sensitization, early diagnosis and treatment of diabetes in the Arab region where the prevalence of diabetes is very high.

Competing interests

The authors declare that they have no competing interest.

Author's contribution

AB: Proposed the idea, carried out bibliographic research, checked available prices and wrote the first version.

SB: Searched papers using Medline, EMBASE and other sources, gathered information on oral drugs and participated in writing the second version.

WB and MENL: Gathered information on insulin and other items used in diabetes control, wrote a computer programme and computed estimated costs.

The four authors discussed and checked together all the figures computed. They read, checked and agreed on the last version submitted.

Acknowledgments

This work is partially supported by URAC04.

The authors are very grateful to Professor E.H Twizell for English editing.

References

[1] World Economic Forum. Global Risks 2010; http://www.weforum.org/reports/global-risks-2010

[2] International Diabetes Federation. IDF DIABETES ATLAS fifth edition. IDF 2011, Bressels, Belgium.

[3] El-Hazmi MA, Warsy A, Al-Swailem A, Al-Swailem A, Sulaimani R. Diabetes mellitus as a health problem in Saudi Arabia. East Mediterr Health J. 1998;4(1):58–67.

[4] Al-Nuaim AR. Prevalence of glucose intolerance in urban and rural communities in Saudi Arabia. Diabet Med. 1997;14:595–602.

[5] Al-Nozha MM, Al-Maatouq MA, Al-Mazrou YY, Al-Harthi SS, Arafah MR, Khalil MZ, et al. Diabetes mellitus in Saudi Arabia. Saudi Med J. 2004;25:1603–10.

[6] Zaoui S, Biémont C, Meguenni K. Approche épidémiologique du diabète en milieux urbain et rural dans la région de Tlemcen (Ouest algérien). Cahiers Santé. 2007;17(1):15–21.

[7] Malek R, Belateche F, Laoumiri FS, et al. Prevalence du diabète de type2 et de l'intolérance au glucose dans la région de Sétif (Algérie). Diabetes Metabolism. 2001;18:229–53.

[8] Ministry of Health Algeria. Algérie Enquête STEPS. Technical Report. Ministry of Health Algeria and World Health Organization 2005. http://www.who.int/chp/steps/STEPS_Report_Algeria.pdf

[9] Boutayeb A, Boutayeb S. The burden of NCDs in developing countries. International Journal for Equity in Health. 2005;4:2

[10] World Health Organisation. The cost of diabetes 2010. http://www.who.int/mediacentre/factsheets/fs236/en/

[11] American Diabetic Association. Economic costs of diabetes in the U.S. in 2007. Diabetes Care. 2008;31(3):596-615.

[12] Canadian Diabetes Association. An economic tsunami: The cost of diabetes in Canada 2010. http://www.diabetes.ca/documents/get-involved/FINAL_Economic_Report.pdf

[13] Diabetes UK. Diabetes in the UK 2010: Key statistics on diabetes. http://www.diabetes.org.uk/Documents/Reports/Diabetes_in_the_UK_2010.pdf

[14] Barcelo A, Aedo C, Rajpathak S, Robles S. The cost of diabetes in Latin America and the Caribbean. Bulletin of the World Health Organization. 2003;81(1):19-27.

[15] Kirigia JM, Sambo HB, Sambo LG, Barry SP. Economic burden of diabetes in the WHO African region. BMC International Health and Human Rights. 2009;9:6. http://www.biomedcentral.com/1472-698X/9/8

[16] Kim TH, Chun KH, Kim HJ. Direct Medical Costs for Patients with Type 2 Diabetes and Related Complications: A Prospective Cohort Study Based on the Korean National Diabetes Program. Journal of Korean Medical Sciences. 2012;27(8):876-82.

[17] Al-Maskari F, El-Sadig M, Nagelkerke N. Assessment of the direct medical costs of diabetes mellitus and its complications in the United Arab Emirates. BMC Public Health. 2010;10:679. http://www.biomedcentral.com/content/pdf/1471-2458-10-679.pdf

[18] World Health Organisation. WHO Global Health expenditure Atlas. World Health Organisation, Geneva 2010. http://www.who.int/nha/atlas.pdf

[19] Novo Nordisk. Novo Nordisk solution for diabetes pandemic in MENA region. www.novonordisk.com

[20] Kingdom of Bahrain Ministry of Health. National Non-communicable Diseases Risk Factors Survey 2007. Ministry of Health, Bahrain 2009. http://www.who.int/chp/steps/2007_STEPS_Survey_Bahrain.pdf

[21] Al-Mahroos F, Mckeigue PM. High prevalence of diabetes in Bahrainis: Association with ethnicity and raised plasma cholesterol. Diabetes Care. 1998;6:936-42.

[22] Ellabany E, Abel-Nasser M. Community based survey study on non-communicable diseases and their risk factors in Egypt, 2005-2006. Technical Report. Ministry of Health and Population, and WHO. Egypt 2006. http://www.who.int/chp/steps/STEPS_Report_Egypt_2005-06.pdf

[23] Mansour AA, Wanoose HL, Hani I, Abed-Alzahrea A, Wanoose HL. Diabetes screening in Basrah, Iraq: A population-based cross-sectional study. Diabetes Research and Clinical Practice. 2008;79:147-50.

[24] Iraq Ministry of Health. 2006. Chronic non-communicable diseases risk factor survey in Iraq. Technical Report. Iraq Ministry of Health and Ministry of planning and Development Cooperation, and World Health Organization 2009. http://www.who.int/chp/steps/IraqNorthernGovernoratesSTEPSReport2003.PDF

[25] Ajlouni K, Khader YS, Batieha A, Ajlouni H, El-Khateeb M. An increase in prevalence of diabetes mellitus in Jordan over 10 years. Journal of Diabetes and Its Complications. 2008;22:317-24.

[26] Ajlouni K, Jaddou H, Batieha A. Diabetes and impaired glucose tolerance in Jordan: Prevalence and associated risk factors. J Intern Med. 1998;244:317-23.

[27] Zindah M, Belbeisi A, Walke H, Mokdad AH. Obesity and diabetes in Jordan: Findings from the behavioural risk factor surveillance system, 2004. Preventing Chronic Diseases. 2008;5(1):A17. http://www.cdc.gov/pcd/issues/2008/jan/06_0172.htm

[28] Abdella N, Al Arouj M, Al Nakhi A, Al Assoussi A, Moussa M. Non-insulin-dependent diabetes in Kuwait: Prevalence rates and associated risk factors. Diabetes Research and Clinical Practice. 1998;42(3):187-96.

[29] Kadiki OA, Roaeid RB. Prevalence of diabetes mellitus and impaired glucose tolerance in Benghazi Libya. Diabetes Metabolism. 2001;27(6):647-54.

[30] Tazi MA, Abir-Khalil S, Chaouki N, Cherqaoui S, Lahmouz F, Srairi SE. Prevalence of the main cardiovascular risk factors in Morocco: Results of a National Survey 2000. J Hypertens. 2000;21:897-903.

[31] Ramdani N, Vanderpas J, Boutayeb A, Meziane A, Hassani B, Zoheir J, Legssyer A, Aziz M, Mekhfi H, Bnouham M, Ziyyat A. Diabetes and obesity in the Eastern Morocco. Mediterranean Journal of Nutrition and Metabolism. 2012;5:149-55.

[32] Asfour MG, Lambourne A, Soliman A, Al-Behlani S, Al-Asfoor D, Bold A, Mahtab H, King H. High Prevalence of Diabetes Mellitus and Impaired Glucose Tolerance in the Sultanate of Oman: Results of the 1991 National Survey. Diabet Med. 1995; 12:112-25.

[33] Al-Lawati JA, Al Riyami AM, Mohammed AJ, Jousilahti P. Increasing prevalence of diabetes mellitus in Oman. Diabetic Medicine. 2002;19(11):954-57.

[34] Al-Moosa S, Allin S, Jemiai N, Al-Lawati J, Mossialos E. Diabetes and urbanization in the Omani population: An analysis of national survey data. Population Health Metrics. 2006;4:5.

[35] Bener A, Zirie M, Janahi IM, Al-Hamag A, Musallam M, et al. Prevalence of diagnosed and undiagnosed diabetes mellitus and its risk factors in a population based study of Qatar. Diabetes Research and Clinical Practice. 2009;84:99-106.

[36] Ministry of Health KSA and WHO-EMRO. Non Communicable Diseases Risk Factors. Technical Report. Saudi Arabia 2005. http://www.who.int/chp/steps/2005_SaudiArabia_STEPS_Report_EN.pdf

[37] Ministry of Health of Syria and WHO. Non communicable Diseases Risk Factors Survey in Syria http://www.who.int/chp/steps/Syrian ArabRepublicSTEPSReport.PDF

[38] Bouguerra R, Alberti H, Salem LB, Rayana CB, Atti JE, Gaigi S, Slama CB, Zouari B, Alberti K. The global diabetes pandemic: The Tunisian experience. European Journal of Clinical Nutrition. 2007;61(2):160-5.

[39] Saadi HS, Carruthers G, Nagelkerke N, Al-Maskari F, Afandi B, Reed R, et al. Prevalence of diabetes mellitus and its complications in a population-based sample in Al-Ain, United Arab Emirates. Diabetes Research and Clinical Practice. 2007; 78:369-77.

[40] Malik M, Bakir A, Abi Saab B, Roglic G, King H. Glucose intolerance and associated factors in the multi-ethnic population of the United Arab Emirates. Diabetes Research and Clinical Practice. 2005;69:188-95.

[41] WHO and UAE Ministry of Health. The Emirates National Diabetes Study & Screening for Coronary Artery Disease Risk Factors. United Arab Emirates 2009. http://www.unitedhealthgroup.com/news/rel2010/UNH_WorkingPaperDiabetesUAE.pdf

[42] Al-Habori M, Al-Mamari M, Al-Meeri A. Type II diabetes Mellitus and impaired tolerance in Yemen: Prevalence, associated with metabolic changes and risk factors. Diabetes Research and Clinical Practice. 2004;65:275-81.

[43] International Diabetes Federation. Report on the International Insulin and Diabetes Supplies Survey on cost and Availability, Bressels, 2006.

[44] WHO and HAI. Measuring medicine prices, availability, affordability and price components 2d Edition. World Health Organization and Health Action International 2008. http://www.who.int/medicines/areas/access/OMS_Medicine_prices.pdf

[45] International drug price indicator guide. Management Sciences for Health, Washigton DC, 2006.

[46] Cameron A, Ewen M, Ross-Degnan D, Boll D, Laining R. Medicine prices, availability, and affordability in 36 developing and middle-income countries: A secondary analysis. Lancet. 2009;373:240-49

[47] Agence Nationale d'Assurance Maladie. Médicaments et prix. Available at http://www.assurancemaladie.ma/anam.php?id_espace=6&id_srub=19&ir=2]

[48] Khowaja LA, Khuwaja AK, Cosgrove P. Cost of diabetes care in out-patient clinics of Karachi, Pakistan. BMC Health Services Research. 2007;7:189.

[49] Boutayeb A, Lamlili M, Boutayeb W, Maamri A, Ziyyat A, Ramdani N. The rise of diabetes prevalence in the Arab region. Open Journal of Epidemiology. 2012;2:55-60.

[50] Boutayeb A. Reader's comments: Discussion of estimation parameters. BMC International Health and Human Rights 2012 http://www.biomedcentral.com/1472-698X/9/6/comments

[51] UKPDS (U.K. Prospective Diabetes Study) Group. Intensive Blood-Glucose Control with Sulphonylureas or Insulin Compared with Conventional Treatment and Risk of Complications in Patients with Type 2 Diabetes (UKPDS 33). Lancet. 1998;352(9131):837-53.

[52] Venkat KM, Zhang NP, Kanaya AM, Williams DE, Engelgau MM, Imperatore G, Ramachandran A. Diabetes: The Pandemic and Potential Solutions. In Disease Control Priorities in Developing Countries, chapter 30. Jamison DT et al editors. Washington (DC): World Bank, 2006.

[53] Boutayeb A. The Double burden of communicable and non-communicable diseases in developing countries. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2006;100(3):191-9.

[54] Bjork S. The cost of diabetes and diabetes care. Diabetes Research and Clinical Practice. 2001;54:S13-8.

[55] World Health Organisation. The cost of diabetes. World Health Organisation, Geneva, 2012. http://www.who.int/mediacentre/factsheets/fs236/en/