Estimation of direct and indirect cost of diabetes in Morocco

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ABSTRACT

Due to its chronic nature with severe complications, diabetes needs costly prolonged treatment and care. The high economic burden of diabetes is particularly threatening low and middle income countries. Worldwide, studies have shown that the cost of diabetes per person is much higher than the per capita health expenditure. This study is the first to estimate the direct and indirect cost of diabetes in Morocco. The direct cost of diabetes was computed by assuming three scenarios of prices (low, medium and high) due to different prices of insulin, oral drugs and other items used in diabetes treatment and care. Indirect costs of diabetes were estimated by the lifetime forgone earnings caused by premature death and disability due to diabetes. The direct cost of diabetes in Morocco was estimated to be between US $0.47 and US $1.5 billion whereas the indirect cost was estimated to be around US $2 billion accounting for 57% of the total cost of diabetes under the high cost scenario, 69% under the medium scenario and 81% under the low cost scenario. The average per capita indirect cost was estimated to be US $1113, relatively higher than the direct cost of diabetes which was seen to vary from US$ 259 to US $830. The results yielded by this study were compared to those obtained by similar studies in different regions and countries of the world. As a conclusion, the findings of this study indicate a high economic burden of diabetes and stress the importance that Moroccan health decision makers should give to sensitisation, early diagnosis and treatment of diabetes especially with the crucial growing trend of diabetes prevalence.

Keywords: Diabetes; Direct Cost; Indirect Cost; Prevalence; Productive Life Years; Disability

1. INTRODUCTION

Once associated with economic development and considered as diseases of the rich, noncommunicable diseases (NCDs) are now affecting countries worldwide, threatening particularly economic and human development of low and middle-income countries. Diabetes is one of these diseases having a high prevalence and consequently a substantial socio-economic burden. 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 and raises the equity problem between and within countries [1]. In India, a low-income family with an adult diabetic spends about 25% of its family income on diabetes care [2]. In the Eastern District of Abu Dhabi emirate (Al-Ain region), Al-Maskari estimated that the annual direct treatment cost of a diabetic patient without complications (US $1605) was 3.2 times higher than the per capita expenditure for health care in the UAE (US $497). The cost increased notably with the presence of micro-vascular complications (2.2 times) and macro-vascular complications (6.4 times) [3].

In 2003, Barcelo et al. carried out a study on the cost of diabetes in Latin America and the Caribbean Region (LACR). The direct cost of diabetes in the 26 countries of LACR was estimated at US $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 indirect cost of diabetes (US $54.5 billion) accounted for US $83.5% of the total cost [4].

In the WHO African region, Kirigia et al. found that the average cost per person with diabetes in income groups 1, 2 and 3 was around Int$ 11430, Int$ 4770 and Int$ 2144 respectively. The total economic loss for the

whole region was Int$ 25.51 billion (PPP). Direct cost accounted for 32%, with one third devoted to cost of insulin while the remaining 68% for indirect cost of diabetes was dominantly caused by permanent disability (88.5%) [5].

Recent Korean studies estimate the cost of Type2 diabetes without complications is approximately US $1184 per patient per year. In contrast, diabetes with microvascular complications costs up to 4.7 times that amount, and diabetes with macrovascular complications incur up to 10.7 times [6].

The American Diabetes Association estimates that the yearly cost for treating a person with diabetes is over 5 times more than for a person without diabetes [7]. According to the Canadian Diabetes Association, the economic burden of diabetes nearly doubled between the years 2000 (CA $6.3 billion) and 2010 (CA $12.2). The direct cost of diabetes now accounts for about 3.5% of public healthcare spending in Canada [8].

The report published by Diabetes UK in 2010 indicated that up to 10% of hospital budgets were spent on treating diabetes and its complications, and beside the cost covered by NHS, people with diabetes were spending over £500 million of their own money on coping with the condition in 2004. Diabetes is the leading cause of blindness in people of working age in UK, the rate of lower limb amputation in people with diabetes is 15 times higher than in people without diabetes and 80% of people with diabetes will die from CVDs [9].

2. METHODS

As in many developing countries, accurate estimation of diabetes prevalence is lacking in Morocco, and reliable data on diabetes constitute 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···).

3. PREVALENCE OF DIABETES

For the number of people with Type 2 diabetes, our study was based on values provided by the International Diabetes Federation (IDF) [10], World Health Organization (WHO) [11], Moroccan ministry of Health [12] and studies published in reviewed journals [13-15]. All computations of costs were based on the assumption that prevalence of Type 2 diabetes among adult people was 9% and that prevalence of Type 1 diabetes was 70/100,000 among the whole population.

4. DIRECT COST OF DIABETES

Large variability of prices between NGOs, 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). Prices of different types of insulin and anti-diabetic oral drugs can be found in the Website of the National Agency of Health Insurance [16]. To overcome the problem of disparity in prices, three scenarios were used (Low, Medium and High price).

4.1. 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 ($0.25 \times N2$) use insulin and syringes. Assuming that 13,000 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 (pl: low price, pm: medium price and ph: high price).

Annual average low cost per patient
$$= (N1 + 0.25 \times N2) \times (13000 \times pl(i) + 200 \times pl(s)) \quad (1)$$

Annual average medium cost per patient
$$= (N1 + 0.25 \times N2) \times (13000 \times pm(i) + 200 \times pm(s)) \quad (2)$$

Annual average high cost per patient
$$= (N1 + 0.25 \times N2) \times (13000 \times ph(i) + 200 \times ph(s)) \quad (3)$$

4.2. Oral Drugs

To estimate the annual cost of oral drugs, it was assumed that 3% of Type1 ($0.03 \times N1$) and 65% of Type 2 diabetics ($0.65 \times N2$) use oral drugs at a level of 1000 tablets per year per patient. Again the total cost of oral drugs was calculated for three values per tablet (low, medium, high). Metformin (Daonil) and Glibenclamide (Glucophage) were the oral drugs the most used.

Annual low cost per patient
$$= (0.03 \times N1 + 0.65 \times N2) \times 1000 \times pl \quad (4)$$

Annual medium cost per patient
$$= (0.03 \times N1 + 0.65 \times N2) \times 1000 \times pm \quad (5)$$

Annual high cost per patient
$$= (0.03 \times N1 + 0.65 \times N2) \times 1000 \times ph \quad (6)$$

4.3. 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 Type1 diabetics plus 33% of Type 2 diabetics ($N1 + 0.33 \times N2$). 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 average low cost

$$= (N1 + 0.33 \times N2) \times (\text{pl}(\text{la}) + \text{pl}(\text{rs}) + \text{pl}(\text{us}) + \text{pl}(\text{gm})/8) \quad (7)$$

Annual average medium cost

$$= (N1 + 0.33 \times N2) \times (\text{pm}(\text{la}) + \text{pm}(\text{rs}) + \text{pm}(\text{us}) + \text{pm}(\text{gm})/8) \quad (8)$$

Annual average high cost

$$= (N1 + 0.33 \times N2) \times (\text{ph}(\text{la}) + \text{ph}(\text{rs}) + \text{ph}(\text{us}) + \text{ph}(\text{gm})/8) \quad (9)$$

4.4. 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, in 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.

$$\text{Annual average low cost} = (0.75 \times N1 + 0.25 \times N2)$$
$$\times [\text{pl}(t1) + \text{pl}(t2) + \text{pl}(t3) + \text{pl}(t4) + \text{pl}(t5)] \quad (10)$$

$$\text{Annual average medium cost} = (0.75 \times N1 + 0.25 \times N2)$$
$$\times [\text{pm}(t1) + \text{pm}(t2) + \text{pm}(t3) + \text{pm}(t4) + \text{pm}(t5)] \quad (11)$$

$$\text{Annual average high cost} = (0.75 \times N1 + 0.25 \times N2)$$
$$\times [\text{ph}(t1) + \text{ph}(t2) + \text{ph}(t3) + \text{ph}(t4) + \text{ph}(t5)] \quad (12)$$

4.5. 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 4 visits per year. 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).

$$\text{Annual average low cost} = 4 \times (N1 + N2) \times \text{pl} \quad (13)$$

$$\text{Annual average medium cost} = 4 \times (N1 + N2) \times \text{pm} \quad (14)$$

$$\text{Annual average high cost} = 4 \times (N1 + N2) \times \text{ph} \quad (15)$$

4.6. Inpatient Consultation and Hospitalization

In addition to the 4 outpatient visits per year assumed for all people with diabetes, it is assumed that, in average, 75% of Type 1 and 25% of Type 2 diabetics will require a 7days hospitalisation per year. Again, the price of hospitalisation was evaluated according to a low-medium-high price, depending of the kind of hospitalisation service.

$$\text{Annual average low cost}$$
$$= 7 \times (0.75 \times N1 + 0.25 \times N2) \times \text{pl} \quad (16)$$

$$\text{Annual average medium cost}$$
$$= 7 \times (0.75 \times N1 + 0.25 \times N2) \times \text{pm} \quad (17)$$

$$\text{Annual average high cost}$$
$$= 7 \times (0.75 \times N1 + 0.25 \times N2) \times \text{ph} \quad (18)$$

5. INDIRECT COST OF DIABETES

Indirect economic cost of a disease is mainly estimated by the cost of premature mortality, permanent and temporarily 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 [17]. Usually, three approaches are used to estimate indirect costs of diseases: human capital, willingness-to-pay and friction costs. In this study, following Barcelo *et al.* [4], we use the first approach in which indirect costs of diabetes are estimated by the lifetime forgone earnings caused by premature death and disability due to diabetes.

5.1. Mortality Cost

Following the method used by Kirigia *et al.* [5] and using the probabilities of diabetes associated deaths in different age groups given by Murray and Lopez [18], the number of productive years lost by people aged 15 to 60 years was estimated by subtracting the averages of age of onset and duration of diabetes from life expectancy of the country. For children and adolescents, productive years lost was calculated by subtracting the averages of age of onset and duration of diabetes plus 14 years from life expectancy of the country.

5.2. Cost of Permanent Disability Caused by Diabetes

Following Barcelo *et al.* [4], we assumed that 5% of the total population with diabetes was permanently disabled.

The estimated cost of permanent disability was calculated by multiplying the number of productive years lost to disability by the per capita GDP.

5.3. Cost of Temporarily Disability Caused by Diabetes

The cost of diabetes-related disability was estimated for people with diabetes aged 15 to 60 years. The cost of disability in young people (0 - 14) and those retired (above 60 years) was ignored. It should be stressed that, following Barcelo *et al.* [4] and Kirigia *et al.* [5], we assumed that 40% of the population with diabetes aged <60 years were economically active and that 60 years is the age of retirement for the quasi-totality of Moroccan citizens in 2011.

A computer program was written, using Excel to compute all the economic costs.

6. INTANGIBLE COSTS

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 incurs also costs that are intangible and not quantifiable such as inconvenience, anxiety, pain, and more generally lower quality of life [2]. 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 limb? 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.

7. RESULTS

As indicated in **Table 1**, the direct cost of diabetes in Morocco is estimated to be US $0.47 billion, US $0.9 billion and US $1.5 billion respectively following the low, medium and high scenarios of cost. Insulin and oral drugs account for 18% to 35%. The average per capita direct cost of diabetes is estimated at US $259 (low cost), US $495 (medium cost) and US $830 (high cost).

Table 1. Direct cost of diabetes in Morocco.

Direct cost of diabetes in Morocco			
Total population Nt × 1000	31,950		
Adult population Na × 1000	19,965		
Prevalence of Type 1 diabetes (per 100,000)	70		
Prevalence of Type 2 diabetes (%)	9		
Number of people with Type 1 diabetes	22,365		
Number of people with Type 2 diabetes	1,796,850		
Total number of people with diabetes mellitus	1,819,215		
Direct cost of diabetes according to different scenarios cost	Low	Medium	High
Number of diabetics using Insulin ($N1 + 0.25N2$)		471,577	
Price of insulin (US $)	33	325	390
Price of 200 syringes (US $)	5	20	40
Total cost of insulin and syringes/year	17,919,945	162,694,238	202,778,325
Price of oral drugs	0.08	0.13	0.19
Total cost of oral drugs/year	90,685,180	154,024,571	217,363,962
Diabetics who require Hospitalization ($0.75 \times N1 + 0.25 \times N2$)		465,986	
Cost of hospitalisation	25	50	100
Total cost of hospitalization	81,547,594	163,095,188	326,190,375
Price of 100 lancets (US $)	10	20	30
Price of one glucose meter (US $)	25	100	300
Price of 100 urine strips (US $)	4	10	18
Price of 300 reagent strips (US $)	90	120	300
Number of diabetics using lancets, glucose meters, reagent strips and urine strips: ($N1 + 0.33N2$)		621,255	
Cost of lancets, glucose meters, reagent strips and urine strips	66,551,953	100,953,955	239,493,843
Test (HbA1c, lipids, eye, blood test, electrocardiogram)	70	100	150
Diabetics who require tests ($0.75 \times N1 + 0.25 \times N2$)		465,986	
Total cost of tests	32,619,037	46,598,625	69,897,937
Outpatient consultation	25	37	62
Outpatient consultation per year (*4)	181,921,500	272,882,250	454,803,750
Total direct cost of diabetes in Morocco per year (US $)	471,245,209	900,48,825	1,510,528,192
Direct cost per patient per year (US $)	259	495	830

The indirect cost was estimated to be around US $2 billion accounting for 57% of the total cost of diabetes under the high cost scenario, 69% under the medium scenario and 81% under the low cost scenario (**Table 2**). The average per capita indirect cost was estimated to be US $1113.

8. DISCUSSION

The per capita direct cost of diabetes in Morocco is between US $259 and US $830 per year, representing 1.75 to 5.6 times the per capita health expenditure (US $148). This result may be compared to different estimations published worldwide.

According to IDF estimates in 2011, an average of US $1274 per person with diabetes was spent globally on treating and managing the disease. In Arab countries, the average spending per person was estimated at US $428 per person with diabetes and the estimation for Morocco was US $235 [10].

In Latin America and the Caribbean Region (LACR), Barcelo et al estimated that the average per capita direct cost of diabetes (US $703) was 3.2 times higher than the per capita health expenditure (US $220) in the 26 countries of the LACR [4].

In the Eastern District of Abu Dhabi emirate (Al-Ain region), Al-Maskari estimated that the annual direct treatment costs of a diabetic patient without complications (US $1605) was 3.2 times higher than the per capita expenditure for health care in the UAE (US $497). The cost increased notably with the presence of microvascular complications (2.2 times) and macro-vascular complications (6.4 times) [3].

In USA, the yearly cost for treating a person with diabetes is over 5 times more than for a person without diabetes (US $13243 vs US $2560) [7].

Korean studies estimate that cost of Type 2 diabetes without complications is approximately US $1184 per patient per year. In contrast, diabetes with microvascular complications costs up to 4.7 times that amount, and diabetes with macrovascular complications incur up to 10.7 times [6].

In Pakistan, the annual mean direct cost for each person with diabetes was estimated at US $197 [19].

The total economic cost of diabetes in Morocco was estimated to be between US $2.5 billion and US $3.5 billion with indirect cost accounting for 57% to 81%. Our study shows a dominance of indirect cost comparable to that obtained by Kirigia *et al.* in the WHO African region (indirect cost 68%) [4]. Similarly, for the 26 countries of Latin America and the Caribbean Region, the loss of productivity due to permanent and non permanent disability, and mortality related to diabetes was responsible for an indirect cost of US $54.5 billion, representing 83.5% of the total cost of diabetes in LACR.

Table 2. Indirect cost of diabetes in Morocco.

Indirect cost of diabetes in Morocco	
Permanent Disability	
Number of people permanently disabled by diabetes (4.5%)	81,865
Number of permanently disabled aged 0 - 4 years	41
Number of permanently disabled aged 5 - 14 years	41
Number of permanently disabled aged 15 - 44 years	8186
Number of permanently disabled aged 45 - 59 years	25,296
Number of permanently disabled aged 60+ years	48,300
Discounted years of permanent disability: 0 - 4 years per person	0.6
Discounted years of permanent disability: 5 - 14 years per person	2.8
Discounted years of permanent disability: 15 - 44 years per person	19.6
Discounted years of permanent disability: 45 - 59 years per person	12.6
Discounted years of permanent disability: 60+ years per person	0.0
Average GDP income per capita (US $)	3109
Total cost of permanent disability (US $)	**1,486,940,942**
Temporary Disability	
Number of people temporary disabled by diabetes (40%)	582,149
Number of 60+ temporarily disabled patients (50%)	343,468
Days of temporary disablement per person per year (4)	4
Daily GDP per capita (US $)	8.5
Total cost of temporary disability (US $)	**19,832,628**
Mortality caused by diabetes	
Number of deaths in 0 - 4 years (8%)	2343
Number of deaths in 5 - 14 years (8%)	2343
Number of deaths in 15 - 44 years (8%)	2343
Number of deaths in 45 - 59 years (16%)	4686
Number of deaths in 60+ years (60%)	17,574
Discounted future potential life years lost in 0 - 4 per person	27
Discounted future potential life years lost in 5 - 14 per person	24.5
Discounted future potential life years lost in 15 - 44 per person	11
Discounted future potential life years lost in 45 - 59 per person	5
Total cost of potential life years lost (US $)	**517,757,550**
Total indirect cost of diabetes(US $)	**2,024,531,120**
Indirect cost per patient per year (US $)	**1113**

In contrast, for the United States of America, it was estimated that US $174 billion was spent on diabetes in 2007. The direct cost (US $116 billion) accounted for 2/3

of the total cost incurred by diabetes [7].

In absence of registries and reliable data, it is difficult to know accurately the number of people using insulin, oral drugs, biological tests, glucose meters and hospitalization. For instance, we think that some assumptions made by Kirigia *et al.* [5] are very conservative and should lead to an underestimated direct cost of diabetes. We have addressed a critical reader's comment to the Journal which published the paper, indicating among others [20], 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 the literature on diabetes [10,17,21-23] 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 susceptible to need hospitalizations especially with age and bad control.

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 inpatient hospitalization.

9. CONCLUSION

In this paper, we provided an estimation of the economic cost of diabetes in Morocco, incurred directly by the use of insulin, oral drugs and other items needed for diabetes treatment and care; and the loss of productivity caused by disability and premature mortality due to diabetes. Our results were compared to similar estimations provided by published studies carried out in different countries and regions of the world. We also indicated the intangible and not quantifiable costs such as inconvenience, anxiety, pain, and more generally lower quality of life. The findings of this study indicate the high socio-economic burden of diabetes and stress the importance that Moroccan health decision makers should give to sensitisation, early diagnosis and treatment of diabetes especially with the crucial growing trend of diabetes prevalence.

10. ACKNOWLEDGEMENTS

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