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ARTICLE

The economic costs of diabetes: a population-based study in Tehran, Iran

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Abstract
Aim/hypothesis The aim of the study was to determine the annual healthcare expenditures of an individual with diabetes in Tehran, between March 2004 and March 2005.
Methods This prevalence-based 'cost-of-illness' study was conducted in two phases. In the first phase, 23,707 randomly selected individuals were interviewed to gather a cohort of participants with diabetes. In the second phase, 710 diabetic patients and 904 age- and sex-matched controls were followed up for 1 year at intervals of 3 months and the direct (physician services, medications and devices, hospitalisation, laboratory, paraclinical and transport) and indirect (loss of productivity) expenditures were recorded. The excess costs of a person with diabetes were estimated through comparison with matched controls. The estimates were also extrapolated to the total population of Tehran and Iran. The costs were converted from the Iranian rial to the US dollar (exchange rate September 2004).
Results Total annual direct costs of diabetic and control participants were $152.3±14.5 and $52.0±5.8, respectively, which is indicative of 2.92 times higher costs in diabetic patients. The most expensive components of direct costs were medications and devices, and hospitalisation in diabetic patients (28.7% and 28.6%, respectively). Total indirect costs were $39.6±2.4 and $16.7±1.1 in diabetic and non-diabetic individuals. The aggregate annual direct costs of diabetes were estimated to be $112.424±10.732 million and $590.676±65.985 million in Tehran and Iran, respectively. Diabetes complications contributed 53% of the aggregate excess direct costs of diabetes.
Conclusions/interpretation Diabetes is an expensive medical problem in Iran and planning of national programmes for its control and prevention is necessary.

Keywords Complication · Cost of illness · Diabetes · Direct costs · Indirect costs · Iran · Medical care

Abbreviations
IDF International Diabetes Federation
I$ International dollar
IRR Iranian rial
PPP Purchasing power parity

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Introduction

Diabetes mellitus is a public-health issue of significant epidemiological and economic importance in developing countries, including Iran, because of its chronic nature, high and rapidly increasing prevalence, serious complications, and the need for patients to receive long-term care [1]. The economic burden of diabetes in high-income nations, such

as the USA [2, 3] and those of western Europe [4], is well recognised and researched. Less attention has been given to the economic burden of diabetes in low- and middle-income countries, but in this context diabetes represents one of the most important non-communicable diseases with the potential to significantly impact upon economic growth in such countries [1, 5]. Recently, it has been reported that Iran has a 7.7% rate of prevalence of diabetes within the 25- to 64-year-old age group, which equates to approximately 2 million Iranian adults [6]. This rather high prevalence is seemingly rising [7], and is likely to be a significant social and economic burden. Despite this, to date, no study has attempted to robustly quantify the economic, and specifically healthcare, cost burden of diabetes in a middle-income Middle Eastern country such as Iran.

There are various methods for estimating costs of an illness [8]. Most estimations, especially in the developed countries, have been based on existing aggregate population healthcare data of the country. This method is not completely practicable for countries such as Iran, because of the lack of documented data on healthcare uses of the whole country. In this study, we performed a prospective survey of diabetic and non-diabetic individuals to directly estimate the excess annual healthcare uses and expenditures of an individual with diabetes through comparison with age- and sex-matched non-diabetic controls during 1 year of follow-up. This method is reported as a precise cost estimation method but because of its expensive and time-consuming process has been little used before [8]. This study, as the first cost-of-illness study in Iran, was conducted in the province of Tehran, the capital of Iran, between March 2004 and March 2005.

Methods

Population sample and data collection methods The study was conducted in two phases of data collection: a cross-sectional baseline phase to gather random cohorts of diabetic patients and a prospective expenditure/lost productivity data collection phase running for 12 months from March 2004 to March 2005. A multi-stage cluster-sampling scheme was used to randomly gather a representative sample of residents of Tehran. One hundred and sixty clusters were randomly selected based on postal addresses. Sampling began at the selected address and advanced clockwise from the first stage to upper stages to include at least the residents of 40 households. In the first cross-sectional phase of the study, demographic data of participants were collected through interviewer-administered questionnaires. Overall, data on 23,707 participants, aged 0–104 years, were obtained, from which 738 people were identified as having diabetes. Participants were designated as having diabetes if a healthcare professional had ever told them that they had diabetes. The diabetic participants were further asked about diabetes complications in heart, eye, kidney and limbs, as well as stroke or other complications.

In the second phase of the study, the participants were prospectively followed up over a 1 year period at intervals of 3 months, and healthcare costs and resource use were recorded. From the 738 known diabetic patients identified in the first phase, 710 diabetic patients participated in the second phase. A control group of 904 non-diabetic participants was then selected to match the diabetic patients for age and sex. In the follow-up steps, 675, 646, 612 and 586 diabetic and 854, 811, 764 and 725 non-diabetic participants attended. Of the non-participants, changing address, no response after three consecutive calls, unwillingness to participate, absence because of travelling with no defined return date, death and transfer to a nursing home were the most common causes of loss of follow-up. In the second phase, data on medical-care expenditures were collected using four forms, designated forms A to D. The participants were followed up with household visits to administer the forms at baseline and at months 3, 6 and 9, and to obtain the filled forms of the previous 3 months at months3, 6, 9 and 12, correspondingly. At the baseline visit of the second phase, a form related to the identity, lifestyle, current medication use, physical activity, habits, history of hypertension and dyslipidaemia and another form concerning socioeconomic status and income of the family was also filled out by the interviewer. Form A was completed by patients or their next of kin, to obtain outpatient physician services use and expenditures. Form B collected healthcare expenditures for inpatient conditions and was to be completed by the patients or their next of kin and the responsible physician or health professional. Form C was given to the participants to obtain data on outpatient use of prescribed medications and devices (e.g. self-monitoring blood glucose meters and test tapes) and Form D for outpatient paraclinical imaging examinations and laboratory uses and expenditures. In addition, the participants provided information on their transportation expenditures, and lost hours and days off work caused by their medical condition in these forms. For incomplete or uncertain responses by either participants or health professionals the interviewer rechecked the medical records of participants or contacted the relevant medical institute or healthcare provider to verify or obtain the data required. This study was approved by the Local Ethics Review Committee of Tehran University of Medical Sciences. Informed consent was obtained from each individual before participation.

Costing methods Direct and indirect healthcare costs of participants were calculated from the questionnaires. Direct

medical costs comprised medical care expenditures (hospital care, physician services, paraclinical and laboratory evaluations, medications and medical devices) and non-medical costs (transportation costs). The financing of the healthcare system in Iran consists of a combination of government and private healthcare insurance coverage for the majority of the population, but with many patients also incurring out-of-pocket expenditures [9]. The share of insurance and out-of-pocket payments was directly calculated from the data-collection forms. Indirect healthcare costs were calculated using the human capital approach [10]. Indirect costs were defined as lost work days because of time spent travelling to receive care, waiting in clinics and days spent in hospital, according to each person's average daily incomes. Indirect costs were estimated in workers only.

Both direct and indirect costs were recorded in Iranian rials (IRR), and then, to express costs in terms of an international currency, converted into US$ at a currency exchange rate of 8,740 IRR/1 US$ (September 2004) [11]. By the individual cost-estimation approach [8] that we used in this survey, the medical expenditures of an individual with diabetes during the 1 year of follow-up was estimated and the excess costs were calculated through comparison with those of non-diabetic controls. Furthermore, we calculated the aggregate total and excess costs of diabetes in the Tehran population (12,794,893 in 2004 [12]) and in the next step we extrapolated our results to the total population of Iran (68,344,730 in 2004 [12]) by adjusting the study data according to age- and sex-specific diabetes prevalence rates in different provinces of Iran in 2004. The adjustment was based on data from an epidemiological study conducted by the Ministry of Health in Iran in 2005 [13]. Since our sample was representative of the Tehran population, extrapolation to the whole country can potentially introduce bias. However, it was useful to have an approximation of the aggregate costs of diabetes in the country, as this study was the first empirical evaluation on diabetes expenditures in Iran. Estimates of the aggregate cost of diabetes in Iran could provide useful data for healthcare policy makers to evaluate the overall impact of diabetes on the economy of the whole country and to compare it with national estimates of other countries.

Statistical analysis Complex survey sample analysis was performed using SPSS 15 (Chicago, IL, USA). Further analyses were performed using STATA ver. 8 (StataCorp; College Station, TX, USA). Data were standardised according to the age and sex distribution of Tehran and Iran in 2004. Prevalence rates are expressed with a 95% CI. Average annual per capita healthcare resource use and expenditures of diabetic patients and control participants were calculated and expressed as means ± SEM. The annual per capita excess resource use and costs of diabetes are presented as an absolute difference between the diabetic patients and control participants, and as a ratio for the two sets of individuals. For those who did not attend all follow-up steps, the annual expenditures were calculated based on the months that they had been followed up. The method of general linear modelling was used to compare the expenditures in patients with and without diabetes complications, after adjustment for age, sex and duration of diabetes. The estimated aggregate total and excess costs of diabetes were calculated for the population of Iran on the basis of age- and sex-specific prevalence rates of diabetes.

Results

Participant characteristics and prevalence estimates Out of 23,707 participants in the first phase, 49.1% were female. The mean age of participants was 31.6 years (range 0–104 years). Approximately 31.1% of participants were unmarried, 64.2% were married and the remainder were widowed or separated. After adjustment for age and sex, the prevalence of known diabetes in Tehran was estimated as 6.0% (95% CI 5.8–6.2) in participants ≥25 years of age in the year 2004. The prevalence rates of complications in heart (12.1%, 95% CI 9.8–14.4), kidney (12.7%, 95% CI 10.3–15.2), eye (25.2%, 95% CI 22.1–28.3) and limbs (31.7%, 95% CI 28.3–35.1) along with cerebral stroke (2.6%, 95% CI 1.5–3.7) and other (10.2%, 95% CI 8.0–12.4) complications were estimated in diabetic patients; approximately 60.0% of diabetic patients reported at least one complication.

From the diabetic patients enrolled in the baseline visit of the second phase (n=710), 388 participants were female and 322 were male. In the non-diabetic controls (n=904), 492 participants were female and 412 were male. The mean age of diabetic and control participants was 53.25±0.35 and 52.69±0.55 years, respectively. The mean age of diabetes diagnosis was 48.2±0.53 years. Age and duration of disease in diabetic patients without complications (n=284) were lower than those with one or more complications (49.11±0.43 vs 56.04±0.64 years and 3.45±0.29 vs 8.21±0.75 years, respectively; p<0.001), while there was no significant difference in sex ratio (male/female: 133/151 vs 189/237; p=0.57). Insurance coverage in diabetic patients and controls was 72% and 62%, respectively. Average monthly income of diabetic and control participants was $247.9±2.9 and $246.1±3.2, respectively. Prevalence of known hypertension (30.1% vs 10.3%, OR 1.84; p<0.001) and dyslipidaemia (28.4% vs 9.5%, OR 1.83; p<0.001) was significantly higher in diabetic patients than the control participants. Smoking was significantly more common in healthy participants than diabetic patients (19.9% vs 12.7%,

OR 1.31; $p<0.001$). Overall, 56.9% of diabetic patients were using sulfonylurea as glucose-lowering medication, 21.3% were using metformin and 13.4% were on insulin. Treatment by insulin was significantly higher in patients with complications than in those without complications (16.6% vs 8.5%, OR 2.15; $p<0.01$).

Healthcare resource use attributable to diabetes The annual per capita results for medical resource use for the diabetic compared with the control participants are reported in Table 1. This shows that across all resource components, the diabetic patients experienced excess resource use with over four times greater levels of hospitalisation, 2.6 times greater numbers of annual physician visits and 2.5 times greater volume of drug prescriptions than the control participants. Similarly, laboratory tests and imaging examinations were higher in diabetic patients. Annual lost work days because of medical problems were also more than double in diabetic compared with non-diabetic participants.

Per capita costs of diabetes in Tehran The estimated annual direct, indirect and total costs of a diabetic patient were 2.9, 2.4 and 2.8 times higher, respectively, than those of non-diabetic participants (Table 2), with an absolute excess cost of $100.3 and $22.9 per patient for direct and indirect costs, respectively. In non-diabetic participants the proportion of direct medical costs was highest for drugs and devices at 35%, with the next highest cost represented by laboratory costs (20.7%). In contrast, the highest costs for the diabetic patients were for medications and devices and for hospitalisations (28.7% and 28.6%, respectively). The greatest excess cost was in hospitalisation, with an absolute difference of $35.6 per capita, representing a $5.4 greater expenditure for diabetes patients. Approximately, 43% of total direct costs in both diabetic patients and non-diabetic participants were absorbed by out-of-pocket expenditure; the remaining costs (57%) were covered by insurance systems (Table 2).

Comparison between patients without complications ($n=284$), and those with one or more complications ($n=426$) is presented in Table 3. The estimated direct, indirect and total expenditures were 1.88, 1.96 and 1.90 times higher, respectively, than those without complication. The highest cost ratios were for hospitalisation, paraclinical and laboratory costs (cost ratio=3.27, 1.65 and 1.63, respectively).

Aggregate costs of diabetes in Tehran and Iran Aggregating the per capita estimates, the total direct annual cost of diabetes in Tehran was estimated to be $112.424±10.732 million, of which $74.06 million was excess cost attributable to diabetes. The direct, indirect and total costs attributable to diabetes complications were estimated to be $39.291 million, $10.710 million and $50.010 million, respectively. The direct cost attributable to complications contributed 53.1% of excess direct costs of diabetic patients. Hospitalisation and paraclinical costs of complications had the highest contribution in the excess costs of diabetes (71.1% and 53.2%, respectively; Table 4).

Extrapolating to the national level, the direct, indirect and total annual costs of diabetic patients in Iran were $590.676±65.985 million, $153.506±10.370 million and $744.183±69.595 million, respectively, with aggregate costs attributable to diabetes for direct, indirect and total annual costs of $391.268 million, $88.512 million and $479.781 million, respectively. The direct, indirect and total costs attributable to diabetes complications were estimated to be $207.001 million, $56.295 million and $263.357 million, respectively.

Discussion

In this study, we determined excess direct and indirect medical costs of a person with diabetes by a matched case–control method using a survey of individuals with and without diabetes. The data source was a prospective survey conducted between March 2004 and March 2005 in Tehran, the capital of Iran. The province of Tehran, with a population of about 12.7 million (in 2004) people, is representative of about one fifth of Iran's whole population. Thereby, this study, as the largest cost-of-illness study in the Middle East, has estimated the costs of diabetes in a sub-national level in Iran. The direct healthcare costs of diabetes were about three times

Table 1 Annual per capita healthcare resource use and diabetes excess resource uses in Tehran in 2004–2005

Component	Number per year		Diabetes excess resource use	
	Controls	Diabetic patients	Ratio	Absolute
Physician visit	0.92±0.06	2.43±0.22	2.64	1.51
Drug prescription	0.77±0.05	1.95±0.11	2.53	1.18
Laboratory use	0.44±0.04	1.63±0.12	3.70	1.19
Paraclinical use	0.32±0.06	0.57±0.08	1.78	0.25
Hospitalisation	0.02±0.01	0.07±0.02	4.16	0.05
Lost work days	2.03±0.14	4.79±0.29	2.36	2.76

Variables are means ± SEM

Data are weighted and standardised for sex and age distribution in Tehran

Table 2 Annual per capita healthcare expenditure and diabetes excess costs in Tehran in 2004–2005

Component	Controls		Diabetic patients		Diabetes excess costs	
	Mean cost per capita (US$)	Per cent of direct	Mean cost per capita (US$)	Per cent of direct	Ratio	Absolute
Physician services	9.9±1.1	19.0	22.8±2.0	14.9	2.3	12.9
Out-of-pocket	4.7±0.7		9.3±0.8		1.98	4.6
Insurance	5.2±0.7		13.4±1.2		2.60	8.2
Medications and devices	18.4±2.0	35.2	43.7± 3.6	28.7	2.37	25.3
Out-of-pocket	5.8±0.8		17.1±1.7		2.94	11.3
Insurance	12.5±1.5		26.5±2.4		2.11	13.9
Hospitalisation	8.0±3.4	15.4	43.6±10.9	28.6	5.42	35.6
Out-of-pocket	3.0±1.3		16.7±4.6		5.39	13.9
Insurance	4.9±2.1		27.0±4.2		5.47	22.1
Laboratory cost	10.8±1.3	20.7	31.3±3.7	20.6	2.63	20.6
Out-of-pocket	4.2±0.5		12.0±1.2		2.92	7.8
Insurance	6.6±0.9		19.4±2.4		2.93	12.8
Paraclinical cost	3.8±0.9	7.4	8.2±1.9	5.4	2.14	4.4
Out-of-pocket	3.4±0.9		7.1±1.9		2.10	3.7
Insurance	0.4±0.2		1.1±0.3		2.25	0.7
Transport cost	1.1±0.1	2.1	2.7±0.3	1.8	2.5	1.6
Total direct	52.0±5.8		152.3±14.5		2.92	100.3
Total out-of-pocket	22.3±2.4	42.9	65.0±4.0	42.7	2.91	42.7
Total insurance	29.7±2.5	57.1	87.3±5.1	57.3	2.94	57.6
Indirect (lost work days)	16.7±1.1		39.6±2.4		2.37	22.9
Total	68.8±6.6		191.9±15.3		2.79	123.1

Variables are means ± SEM

Share of each component in total expenditure and share of insurance and out-of-pocket expenses in specific components are also displayed. Data are weighted and standardised for sex and age distribution in Tehran

Table 3 Annual per capita healthcare expenditure of diabetes complications in Tehran in 2004–2005

Component	Without complication		With complication(s)		Complications excess costs	
	Mean cost per capita (US$)	Per cent of direct	Mean cost per capita (US$)	Per cent of direct	Ratio	Absolute
Physician services	17.1±2.1	17.0	27.0±2.5	14.3	1.58	9.9
Medications and devices	33.8±2.8	33.6	50.8±3.9	26.8	1.50	17.0
Hospitalisation	18.6±2.5	18.5	60.8±11.7	32.1	3.27	42.2
Laboratory costs	23.0±3.0	22.9	37.5±4.2	19.8	1.63	14.5
Paraclinical costs	6.0±1.1	6.0	9.9±2.1	5.2	1.65	3.9
Transport costs	2.1±0.3	2.0	3.2±0.4	1.7	1.52	1.1
Total direct	100.5±10.7		189.2±16.3		1.88	88.7
Total out-of-pocket	44.1±5.1	43.9	80.1±6.2	42.3	1.81	35.9
Total insurance	56.4±5.8	56.1	109.2±8.4	57.7	1.93	52.8
Indirect (lost work days)	25.3±1.8		49.5±3.1		1.96	24.2
Total	125.8±12.3		238.7±17.8		1.90	112.9

Variables are means ± SEM

Data are weighted and standardised for sex and age distribution in Tehran. Estimates are calculated after adjustment for age, sex and duration of diabetes

Table 4 Estimated aggregate healthcare expenditures of diabetes in the Tehran population in 2004–2005

Component	Overall mean cost (US$ millions)	Attributable to diabetes		Attributable to complications	
		Mean costs (US$ millions)	Per cent of direct	Mean costs (US$ millions)	Per cent of attributable to diabetes
Physician services	16.834±1.445	9.516	12.8	4.389	46.1
Medications and devices	32.245±2.672	18.655	25.2	7.534	40.4
Hospitalisation	32.155±8.022	26.257	35.4	18.678	71.1
Laboratory cost	23.116±2.544	15.198	20.5	6.422	42.3
Paraclinical cost	6.054±1.388	3.249	4.4	1.728	53.2
Transport cost	2.005±0.252	1.181	1.6	0.531	45.0
Total direct	112.424±10.732	74.059		39.291	53.1
Total out-of-pocket	48.005±2.923	31.513	42.6	15.902	50.5
Total insurance	64.419±3.808	42.546	57.4	23.388	55.0
Indirect (lost work days)	29.217±1.783	16.846		10.710	63.6
Total	141.641±11.301	90.899		50.010	55.0

Variables are means ± SEM

Data are weighted and standardised for sex and age distribution in Tehran

higher in diabetic patients than non-diabetic controls, and there was a 2.4 times greater value of lost work days in diabetic patients. Our study found that while 57% of total direct costs were covered by health insurance, the remaining 43% was out-of-pocket expenditure. This represents a significant burden for the individual diabetic patient. Annual per capita healthcare expenditures in patients with diabetes complications were approximately 90% higher than those without. Diabetes complications substantially contributed to diabetes expenditure, comprising approximately half of the aggregate costs attributable to diabetes.

In order to assess the magnitude of the economic burden of diabetes, it is useful to compare the cost estimates of diabetes in Iran with other countries. However, cost comparisons between different national healthcare systems is difficult because of differences in the infrastructure and financing of healthcare, and the different methodologies that studies use to capture resource use and costs. The government in Iran subsidises many drugs, in particular generics which are locally produced. The generalisability of the results to other middle-income countries is therefore highly uncertain. Taken together, it seems that the costs of diabetes generally increase in relation to a country's degree of economic development and gross domestic product. In our neighbouring country, in a recent study of outpatient clinics in Karachi (Pakistan) [14], with a sample of 345 randomly selected diabetic patients, annual mean direct costs for a person with diabetes were estimated to be $197. This study did not consider excess costs attributable to diabetes, and hospitalisation costs were also not included. Furthermore, in Pakistan all estimates are 'out-of-pocket' and there is no insurance system. In Latin America and the Caribbean, one study in the year 2000 indicated that the annual per capita direct cost of treatment for a diabetic person was $703 and the excess cost of diabetes in that region was estimated to be $483 [15]. To give an example from a developed country, the annual direct cost of a diabetic patient in Germany was €5,262 (US$4,713), while indirect costs were estimated to be €5,019 (US$4,495). The direct and indirect excess cost ratios between diabetic and non-diabetic patients were 1.9 and 1.4, which is less than found from our study results (ratios of 2.87 and 2.37, respectively) [16]. In the USA in 2007 [2], annual per capita direct medical costs were $11,744 for a diabetic patient and $2,935 for a non-diabetic individual. After age and sex adjustment, the annual per capita costs of diabetic patients were 2.3 times higher than those of non-diabetic controls.

The aggregate excess direct cost of diabetes was estimated to be $74 million in Tehran. Given that a match on age and sex is scientifically sound, the figure for Iran was estimated to be $391 million. Comparison of our results with those from other countries is more feasible by using the concept of the international dollar (I$). The I$ is a hypothetical unit of currency that has the same purchasing power in every country. Conversion from local currencies to I$ is based on purchasing power parities (PPP), which is a method of measuring the relative purchasing power of the currencies of different countries over the same types of goods and services, by eliminating the differences in price levels between countries [17]. When we recalculate our estimates in terms of I$, the aggregate direct diabetes

expenditures are estimated to be I$1,439 million in Iran (the ratio of the official exchange rate [US$] to the PPP conversion factor [I$] in 2004 was 3.678 [18]). The International Diabetes Federation (IDF) has compared the direct costs of diabetes (in terms of I$) in different countries [19], using a formula described by Jönsson in 1998 [20]. The estimates are calculated based on total healthcare budget and prevalence of diabetes in different countries, by assuming a ratio of two or three for the cost of healthcare in diabetic patients compared with people without diabetes [19]. This method calculates the costs of diabetes as a fraction of healthcare budget of the country and needs to be validated by empirically derived estimates. Considering the approximation of 3.6% for prevalence of diabetes in the Iranian 20- to 74-year-old population, and the cost ratio of three (for the cost of care in diabetic vs non-diabetic individuals), the IDF has estimated the cost of diabetes in Iran as I$871.535 million in 2003. This estimate would be approximately doubled if they had considered the prevalence of diabetes in Iran, as recently documented in a very large national survey (7.7% in the 25- to 64-year-old population of Iran in 2005 [6]). Nonetheless, the report of the IDF shows that Saudi Arabia, Iraq, Egypt, Iran and Pakistan are the five countries with the highest aggregate costs of diabetes in the eastern Mediterranean and Middle East region.

Many socioeconomic factors and healthcare system-related factors influence the outcome of diabetes and consequently its costs. In this context, diabetes care in developing countries is accompanied by certain societal issues [21]. As diabetes initially presents with few symptoms and is not life-threatening, many people, particularly in developing countries, often do not seek medical attention until other incapacitating symptoms or complications develop [22]. Delay in diagnosis, inadequate awareness of disease complications, disparity in earning and access to medical care, as well as heterogeneous quality of care, are among the other societal issues influencing care of diabetes in developing countries [22]. Delay in diagnosis can directly increase complications and then lead to higher costs. Being a chronic disease, diabetes requires support service infrastructure and a team approach for care. Generally, the level of clinical care in developing countries is lower than in developed societies. Additionally, because of scant resources and the attitude of policy makers to seek easily achievable prosperities, monitoring the disease to assess response to treatment and to detect complications does not receive adequate attention, while most resources are consumed for acute care (where effort and success are easily measurable) [23]. The need for health-system reform for continuous management of diabetes in the primary-care setting is recommended as a cost–benefit policy to reduce the long-term economic burden of this growing epidemic [23, 24]. Policy makers who focus on diabetes care need to be aware of what drives cost. Prevention plans are the most effective interventions. Based on IDF recommendations, the national prevention plans should target life-style modification in the entire population as well as for people at higher risk of diabetes [25]. Indeed, both primary (health promotion and awareness) and secondary prevention (reducing the burden of complications by early diagnosis and effective care) should be considered.

This study has some limitations: it was not possible to distinguish costs between type 1 and type 2 diabetes, although the majority of diabetic patients in the study had type 2 diabetes. Moreover, the extrapolation of results from Tehran to Iran should be interpreted with caution. Tehran is rather more urbanised than other provinces of Iran and there may be lower costs outside Tehran because of poorer access to diabetes care and services. On the other hand, in Iran most healthcare services, including medications, laboratory and paraclinical evaluations, public sector hospitals and physician services in governmental clinics, have equal governmental fees and this indicates that our projected cost of diabetes in Iran is not too far from reality. The presence of diabetes-related complications were questioned subjectively; thus the estimates on the costs attributable to complications could potentially introduce information bias. Finally, cost-of-illness studies do not provide information on the efficiency of resource use, hence higher cost does not necessarily mean better services or value for money. Assessment of value for money requires formal economic evaluations of the cost-effectiveness of drug and other interventions for diabetes, of which cost is an essential component, but this needs to be set against evidence of clinical effectiveness. The strength of our cost-of-illness study is based on its individual-based perspective, with participants recruited by robust matched case–control methods. This has enabled an estimate of not just the absolute costs of diabetes but more importantly the excess costs associated with diabetes. Meanwhile, the major limitation to this methodology is the low number of participants in subgroups, which makes the subgroup analysis of our result to some extent difficult (for instance, separating the cost of various diabetes complications occurring during the follow-ups) [8].

Our study suggests that the direct cost of diabetes was about 5.5% of total Iranian healthcare expenditure ($10,627 million) in 2004 [26]. The high growth rate of medical expenditures in Iran, and the increasing prevalence of diabetes in the developing world, including Iran [7], are likely to cause significant financial strain on the Iranian healthcare system and the resources available for the care of diabetic patients in the near future. It seems that while the excess cost of diabetes in Iran already represents a burden on society, there is potential for further increases in the aggregate economic burden as Iran develops in gross domestic product and health-system sophistication.

In conclusion, diabetes is a chronic condition with a high economic burden in Iran, and is a major public-health issue. Planning national programmes to better control and, if possible, prevent diabetes will increase costs in the short-term, but may prevent long-term complications and the costs associated with secondary-care treatment and lost economic productivity.

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