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Assessment of the Direct Medical Costs of Type 2 Diabetes Mellitus and its Complications in Turkey

Türkiye'de Tip 2 Diabetes Mellitus ve Komplikasyonlarının Doğrudan Tıbbi Maliyetine İlişkin Değerlendirme

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Abstract

Purpose: To estimate the direct annual medical costs of Type 2 diabetes and its complications in diagnosed patients in Turkey.
Material and Method: A cost-of-illness model was developed. The prevalence of Type 2 diabetes was derived from the Turkish Diabetes Epidemiology Study, estimated as 13.7% in adults, with one-third of patients previously undiagnosed. Complication costs were extracted from the records of 7095 patients at a Turkish tertiary care hospital in 2009. For each modelled complication, acute phase costs were applied to globally derived incidence rates, and one-year follow-up costs were applied to globally derived prevalence rates. Costs and frequencies of ongoing antihyperglycaemic treatment and disease management were derived from treatment guidelines and Turkish hospital records. Parameter variation was performed.
Results: The cost of Type 2 diabetes in diagnosed patients was estimated at between 11.4 to 12.9 billion Turkish Lira, 1% of Gross Domestic Product. Cardiovascular complications comprised the largest share of total medical costs (between 24.3% and 32.6%), followed by renal complications-related costs (between 25% and 28.3%) and concomitant cardiovascular and antihypertensive medication costs (between 14.2% and 16%). Antihyperglycaemic medications and screening costs comprised between 10.9% to 12.3% and between 4.4% to 5% of total costs, respectively.
Discussion: Type 2 diabetes is a disease burden and economic burden in Turkey; the complications cost is higher than the cost of disease control. For preventing complications, any activities effect positively limited resources and also quality of life. *Turk Jem 2014; 2: 39-43*

Key words: Turkey, cost of illness, modelling, Type 2 diabetes, complications

Özet

Amaç: Türkiye'de tanı alan hastalarda Tip 2 diyabet ve komplikasyonlarının doğrudan yıllık tıbbi maliyetini hesaplamak çalışmanın amacıdır .
Gereç ve Yöntemler: Hastalık maliyeti modeli çalışmanın metodolojisini oluşturmaktadır. Tip 2 diyabet prevalansı Türkiye Diyabet Epidemiyoloji Çalışmasından elde edilmiş olup, yetişkinlerde %13,7 olarak tahmin edilmiş, hastaların üçte biri daha önce tanı konulmayan hastalar olarak belirlenmiştir. Komplikasyon maliyeti 2009 yılında Türkiye'deki bir üçüncü basamak hastanede 7095 hastanın kayıtlarından alınmıştır. Modellenen her komplikasyon için global olarak belirlenen insidans hızı akut faz maliyeti ve global olarak belirlenen prevalans hızlarına bir yıllık takip maliyeti eklenmiştir. Devam eden antihiperglisemik tedavi ve hastalık yönetimine ilişkin maliyet ve sıklık verileri tedavi kılavuzları ve Türkiye'deki hastane kayıtlarından elde edilmiştir.
Bulgular: Tanı konulan hastalarda Tip 2 diyabet maliyeti Gayri Safi Yurt İçi Hasılanın yüzde birine karşılık gelen, 11,4 ile 12,9 milyar TL olarak hesaplanmıştır. Toplam tıbbi maliyetin en büyük kısmını kardiyovasküler komplikasyonlar oluştururken (%24,3 ila %32,6 aralığında), bunu böbrekle ilgili komplikasyon maliyeti (%25,0 ila %28,3 aralığında) ve eş zamanlı kardiyovasküler ve antihipertansif ilaç maliyeti (%14,2 ila %16,0 aralığında) izlemektedir. Antihiperglisemik ilaç ve tarama maliyeti, toplam maliyetin sırasıyla %10,9 ila %12,3 aralığında ve %4,4 ila %5,0 aralığında seyretmektedir.
Tartışma: Türkiye'de Tip 2 diyabet hastalığı önemli bir hastalık yükü olmakla beraber aynı zamanda önemli bir ekonomik yüktür. Hastalığın komplikasyonlara harcanan maliyetinin yüksekliği, hastalığın kontrolüne harcanan miktardan çok daha fazladır. Komplikasyonları önlemek için alınacak önlemler kaynakların atıl kullanılmasının önüne geçecek olup, yaşam kalitesinin de korunmasında önemli rol alacaktır. *Turk Jem 2014; 2: 39-43*

Anahtar kelimeler: Türkiye, hastalık maliyeti, modelleme, Tip 2 diyabet, komplikasyonlar

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Introduction

The prevalence of diabetes mellitus continues to increase, straining healthcare budgets and leading to increased population morbidity and mortality. The global prevalence of the disease was estimated as 6.4% in 2010, and is projected to increase to 7.7% by 2030 (1). Higher disease prevalence values have been estimated for countries of the Eastern Mediterranean and Middle East. The Turkish Diabetes Epidemiology Study I (TURDEP I) has reported that the prevalence of diabetes mellitus was 7.2% in 1997-1998 in Turkey, with one-third of patients previously undiagnosed (2). Recent findings from the TURDEP 2 study indicate that the prevalence has increased to 13.7% in 2010 (3).

Patients with diabetes mellitus consume a disproportionate share of health system resources. Globally, 12% of healthcare expenditures are estimated to be attributable to diabetes and its complications (4). Diabetes is costly due to the extensive complications that may be experienced by patients with the disease. More financial resources are directed at treating the costly complications of diabetes rather than preventing them. The Cost of Diabetes in Europe-Type 2 (CODE-2) study, reported that 55% of total medical costs in European patients with Type 2 diabetes were attributable to hospitalisations, with 7% of costs attributable to antihyperglycaemic drugs (5).

Diabetes is a progressive disease characterized by the development of degenerative complications associated with the duration of the disease and the level of glycemic control (6,7). Lower than optimal awareness of the disease by policy makers may result in less strict disease management by physicians, which in turn may increase the risk of late-stage diabetes complications (8), and associated higher healthcare costs (5). More intensive management of the disease, while costly in short term, can be highly cost-effective or lead to long-term cost savings due to reduced incidence of the expensive late-stage complications, based on extensive analyses performed internationally (9,10,11). In middle-income settings, the need to assess the size of the economic burden of diabetes and identify cost-effective or cost-saving interventions is more pressing, as diabetes represents a large share of healthcare expenditure and is an opportunity cost for education and infrastructure investment, which are fundamental for further national development.

The health of the Turkish population has improved greatly over the past 50 years, reflecting health system reforms and the expansion of public health insurance coverage. Since 1960, there has been a huge gain in life expectancy in Turkey (25.5 years), so that it is quickly approaching the Organization for Economic Co-operation and Development (OECD) average (73.8 versus 79.5 years) (12). A large reduction in infant mortality was achieved in Turkey between 1970 and 2009, with a 6% annual decline in the infant mortality rate, yet this metric in Turkey is still approximately three times higher than the OECD average (13.1 versus 4.4 deaths per 1000 live births). While excellent progress has been made, there may still be opportunities for general health improvement in Turkey, and substantial opportunity costs of diabetes mellitus expenditures. The aim of the present analysis was to estimate the direct annual medical costs of Type 2 diabetes and its complications in diagnosed patients in Turkey.

Materials and Methods

A cost-of-illness model was developed that incorporated estimates of the size of the diagnosed adult Type 2 diabetes population in Turkey, included incidence and prevalence rates for major diabetes complications, and captured costs of complications and costs of disease treatment and management. The synthesis of evidence in a cost-of-illness model was required, as no datasets could be identified and analysed in Turkey that reported summary national diabetes expenditure.

The diagnosed Type 2 diabetes population of Turkey for inclusion in the cost-of-illness model was based on a total 2009 adult population of 47.467.358 persons as reported by the Turkish Statistical Institute (13), a prevalence rate of the disease estimated as 13.7% in the TURDEP-2 study (3), and the assumption that two-thirds of patients with diabetes were previously diagnosed, in line with the findings of TURDEP-1 (2). Therefore, a diagnosed Type 2 diabetes population of 4.335.352 persons was included in the cost-of-illness model.

The Type 2 diabetes population in the cost-of-illness model was at risk of experiencing incident diabetes complications and having a history of diabetes complications. Diabetes complications included in the cost-of-illness model encompassed the range of microvascular, macrovascular, neurological, and treatment-related complications experienced by patients with Type 2 diabetes. Diabetes complications incidence rates and prevalence rates were derived from the literature (Table 1). Few Turkey-specific publications were identified (Supplementary Appendix 1); therefore, studies performed in a range of country settings were included (Supplementary Appendix 2). Incidence and prevalence rates derived from the literature were validated by clinical experts in Turkey by means of three face-to-face interviews. As cardiovascular-related costs comprise a large share of total diabetes-related complication costs in international settings, a range of incidence and prevalence rates were used for each cardiovascular complication, including myocardial infarction, angina, peripheral vascular disease, stroke, and heart failure. Lower bound rates of cardiovascular complications were derived from the UK Prospective Diabetes Study (UKPDS) (14), which enrolled newly diagnosed patients with Type 2 diabetes, and upper bound rates of cardiovascular complications were derived from studies of higher risk patients with diabetes (15,16). A range of inputs were also used for major hypoglycaemia, with lower bound incidence rates derived from the UKPDS, and upper bound incidence rates derived from a study of insulin-using patients (17). For renal replacement therapies, incidence and prevalence rates from the literature were not applied to the modelled Type 2 diabetes population. Instead, the absolute numbers of patients with Type 2 diabetes treated in Turkey with haemodialysis, peritoneal dialysis, and renal transplant were derived from the Registry of Nephrology, Dialysis, and Transplantation in Turkey from 2009 (18), and were applied directly in the cost-of-illness model. Summary cost-of-illness data are presented as a range, based on the upper and lower bounds of the complications prevalence and incidence rates identified in the literature.

The perspective of a third-party payer in Turkey was used. Direct medical costs were incorporated, comprising hospital inpatient and

outpatient costs, screening and laboratory test costs, and ongoing prescription drugs and medical supplies expenses. Transport, self-care, and child care were not included, as they were not covered by the payer. Indirect costs, including costs of employee absenteeism, disease-related retirement, and death amongst an assumed working age population were excluded from the cost-of-illness analysis. Costs of treating diabetic complications were collected from the records of 7095 patients with Type 2 diabetes treated at a Turkish tertiary care hospital. Patients were enrolled and analysed between 1 January 2009 and 31 December 2009. Relevant patient records were identified from the Patient Registration Scheme based on International Classification of Diseases (ICD)-10 codes relevant to diabetes, cardiovascular, and renal complications (19); (E10-E14, I10-I13, I20-I22, I24-I51, I60-I69, N00-N07, N13-N19). Costs of treating diabetes complications were classified as either acute event costs, defined as the costs relevant to the complication incurred from admission to hospital until discharge, or ongoing annual costs (Table 2). Costs are reported in 2010 Turkish Lira.

The frequencies of eye and foot screening in patients with Type 2 diabetes in Turkey were derived from the records of a Turkish tertiary care hospital. Concomitant cardiovascular medication usage, such as angiotensin-converting enzyme inhibitors, beta blockers, aspirin, and statins, were also derived from the records of a Turkish tertiary care hospital. Government prices in Turkey, set by the Ministry of Health, were used for the cost of all medications captured in the model, including antihyperglycaemic and cardiovascular medications. The proportion of patients treated with different antihyperglycaemic strategies, including oral antihyperglycaemics, insulin, and diet and exercise, were derived from the literature (20).

Table 1. Incidence and prevalence rates for each complication

	Incidence, %	Prevalence, %
Cardiovascular complications		
Myocardial infarction	1.5-2.3	12.0-18.4
Angina	0.4-0.7	10.9-10.9
Peripheral vascular disease	0.5-0.5	8.4-8.4
Stroke	0.6-1.9	6.4-9.0
Heart failure	0.3-3.6	4.9-13.8
Renal complications		
Microalbuminuria	2.0	23.4
Macroalbuminuria	9.9	6.1
Haemodialysis	N/A	9001[a]
Peritoneal dialysis	N/A	824[a]
Renal transplant	N/A	330[a]
Eye complications		
Background diabetic retinopathy	4.0	N/A
Proliferative diabetic retinopathy	1.5	N/A
Laser treatment	2.2	N/A
Cataract extraction	5.8	5.8
Vitrectomy	0.3	N/A
Maculopathy	3.1	N/A
Macular oedema	3.9	N/A
Blindness	0.02	7.4
Other complications		
Peripheral neuropathy	0.8	21.0
Diabetic foot	N/A	9.0
Gangrene	0.1	N/A
Ulcer	2.0	9.3
Amputation	0.2	1.0
Major hypoglycaemia	1.0-15.0	N/A

N/A: No data applied, a The absolute numbers of patients with Type 2 diabetes treated with haemodialysis, peritoneal dialysis, and renal transplant in 2009, as derived from the Registry of Nephrology, Dialysis, and Transplantation in Turkey

Table 2. Complication costs in Turkey

	Acute event cost (TL)	Ongoing annual cost (TL)
Cardiovascular complications		
Myocardial infarction	2163	1519
Angina	1928	1157
Peripheral vascular disease	4356	1443
Stroke	3799	805
Heart failure	3697	759
Renal complications		
Microalbuminuria	140	383
Macroalbuminuria	1597	2017
Haemodialysis	N/A	21 936
Peritoneal dialysis	N/A	1939
Renal transplant	44 861	N/A
Eye complications		
Background diabetic retinopathy	137	N/A
Proliferative diabetic retinopathy	1606	N/A
Laser treatment	346	N/A
Cataract extraction	390	172
Vitrectomy	902	N/A
Maculopathy	1606	N/A
Macular oedema	1606	N/A
Blindness	379	76
Other complications		
Peripheral neuropathy	497	542
Diabetic foot	N/A	155
Gangrene	1119	N/A
Ulcer	1362	183
Amputation	800	41
Major hypoglycaemia	87	N/A

TL: Turkish Lira, N/A: No data applied, Cost data were derived from Başkent University Hospital patient records

This study followed the Declaration of Helsinki and due to the retrospective nature of the study, it was granted an exemption in writing by the Başkent University.

Results

Based on a diagnosed Type 2 diabetes population in Turkey of 4.335.352 persons, globally derived incidence and prevalence rates for diabetes complications, and complication costs and disease management data collected from a Turkish tertiary care hospital, the total cost of Type 2 diabetes for the year 2010 in Turkey was estimated between 11.366 and 12.859 million Turkish Lira (Table 3). On a per-treated patient basis, the cost of illness was estimated at between 2.622 and 2.966 Turkish Lira, representing the lower and upper limits of summary cost of illness results.

Diabetes complications costs comprised the largest share of total costs: 7.577 to 9.070 million Turkish Lira (or 66.7% to 70.5% of total costs). Cardiovascular costs comprised 24.3% to 32.6% of all costs, and renal costs comprised 25.0% to 28.3% of all costs (Table 3, Figure 1). When incidence rates of cardiovascular complications were derived from the UKPDS, enrolling lower risk patients, cardiovascular costs comprised a smaller share of total costs. Other complications, including foot ulcers, neuropathy, and hypoglycaemia, comprised 12.9% to 14.1% of total diabetes-related costs. Hypoglycaemic event rates derived exclusively from insulin-injecting patients resulted in higher "other" complications costs as a percentage of all costs. Hypothetically, prevention of all myocardial infarctions and stroke events in diagnosed patients with Type 2 diabetes would result in a 48% reduction in cardiovascular disease (CVD) complications costs; prevention of all heart failure in such patients would result in a 7.5% reduction in CVD complications costs; and prevention of all dialysis and renal transplantation cases would result in a 4.4% reduction in all renal-related costs.

It was estimated that more resources were spent in Turkey on non-diabetes drugs compared to diabetes drugs in patients with Type 2 diabetes (1821 versus 1396 million Turkish Lira). Non-diabetes drugs consisted of angiotensin-converting enzyme inhibitors, beta blockers, aspirin, and statins, which are chiefly used to manage cardiovascular risk. These and other non-diabetes drugs comprised 14.2% to 16% of the total cost of illness. Diabetes drugs, including oral antihyperglycaemics and insulin, comprised 10.9% to 12.3% of the total cost of illness. Screening for diabetes complications costs, including annual eye and foot examinations, comprised 572 million Turkish Lira, or 4.4% to 5% of the total cost of illness.

When it was assumed that all patients in Turkey with Type 2 diabetes were diagnosed, versus two-thirds of patients in the reference case based on the findings of the TURDEP-I study, the cost of illness increased to between 17.049 and 19.289 million Turkish Lira. However, the costs of screening and detecting these undiagnosed patients in Turkey were not examined.

Table 3. Costs of Type 2 diabetes in Turkey

	Total cost (million TL)	Share of costs
Total Costs	11 366-12 859[a]	100.0%-100.0%
Diabetes drugs	1396	10.9%-12.3%
Non-diabetes drugs	1821	14.2%-16.0%
Complications screening	572	4.4%-5.0%
Complications costs	7577-9070[a]	66.7%-70.5%
Cardiovascular	2760-4195[a]	24.3%-32.6%
Renal	3219	25.0%-28.3%
Other	1599-1656[a]	12.9%-14.1%

TL= Turkish Lira, a Upper and lower bounds estimates of costs based on prevalence and incidence rates for cardiovascular and major hypoglycaemia complications

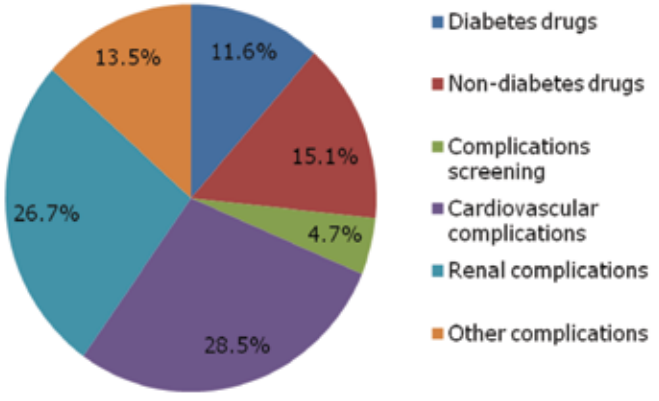

Figure 1. Components of total cost of Type 2 diabetes
Percentages represent the mid-point of the ranges presented in Table 3

Discussion

The cost of Type 2 diabetes in diagnosed patients in Turkey is high, representing approximately 1% of Gross Domestic Product (GDP). Given that total healthcare spending as a percentage of GDP in Turkey has been estimated as 5% (21), the present modelling analysis indicates that diabetes may comprise a large share of the health care cost burden in Turkey. As population health outcomes such as life expectancy and infant mortality are less favorable in Turkey compared to that in other OECD countries, diabetes-related expenditures may be diverting funds from overall health status improvement and economic development.

In line with cost-of-illness studies performed in international settings, including the CODE-2 study in Europe, diabetes-related complications comprised a larger share of total costs when compared with disease management costs in Turkey. Better management and treatment of the disease could reduce the incidence of costly diabetes complications, reduce patient morbidity and mortality, and lessen the burden on the healthcare system in Turkey. Results of a systematic review of interventions to prevent and control diabetes indicate that many diabetes management practices and pharmacy interventions are either cost saving or highly cost-effective across a range of country settings (22).

There were several limitations of this cost-of-illness analysis. Chiefly, incidence and prevalence rates were not exclusively derived from Turkey-specific studies, and rates derived from international studies were assumed to be generalisable to all patients with Type 2 diabetes in Turkey. A paucity of published follow-up studies of diabetes

complications in Turkey necessitated the use of incidence rates from studies such as the UKPDS, which enrolled low-risk newly diagnosed patients. Parameter variation revealed that the cost-of-illness results were sensitive to the cardiovascular incidence and prevalence rates used, indicating that it may be worthwhile to utilise Turkey-specific cardiovascular risks in a cost-of-illness model where possible. It was also a limitation that diabetes complications costs were derived from a single centre in Turkey. More comprehensive cost-of-illness studies will perform multi-centre cost collection. This approach would be considered appropriate in countries with large variations in health service delivery, particularly along urban and rural divides.

A further limitation of the analysis was that the cost of undiagnosed patients was excluded. Despite occurring in patients without a formal diabetes diagnosis, hyperglycaemia is a risk factor for costly end-stage complications such as cardiovascular events. The alternative cost estimates of 17.049 and 19.289 million Turkish Lira, based on the assumption that all patients were diagnosed, could also represent the cost of diabetes irrespective of diagnosis. However, due to the reliance of incidence and prevalence rates of complications derived from studies of diagnosed patients with Type 2 diabetes receiving contemporary treatment, the cost of illness may be underestimated when the model results represent all patients with diabetes regardless of diagnosis. Based on the findings of this analysis, we conclude that the direct medical cost of Type 2 diabetes mellitus in Turkey is high, between 11.366 and 12.859 million Turkish Lira overall and 2622 and 2966 Turkish Lira per patient. The cost of Type 2 diabetes is equivalent to 1% of GDP.

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Conflicts of Interest

There are no conflicts of interest.

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