Contents available at ScienceDirect

Diabetes Research and Clinical Practice

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

International Diabetes Federation

Association of good glycemic control and cost of diabetes care: Experience from a tertiary care hospital in Bangladesh

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ARTICLE INFO

Article history:
Received 16 February 2016
Received in revised form
11 June 2016
Accepted 16 July 2016
Available online 8 August 2016

Keywords:
Glycemic control
Cost of diabetes care
Direct cost
Indirect cost
Complication
Type 2 diabetes mellitus (T2DM)

ABSTRACT

Aim: The present study was undertaken to assess the cost-effectiveness of good glycemic control in a population of Bangladeshi people with type 2 diabetes mellitus (T2DM).
Methods: A cross-sectional study was conducted among 496 registered patients with >1 year duration of diabetes. Glycated hemoglobin A1c level <7% was judged as the cut-off value for good glycemic control. All treatment-related records from the last year were collected from patients' guide books and all cost components were calculated.
Results: Among patients, 31% had good glycemic control. The average annual cost was US$ 314 per patient. Patients with poor glycemic control were significantly more likely to have complications [($p = 0.049$) OR 1.5] and comorbidities [($p = 0.02$) OR 1.5]. The annual cost increased rapidly with complications/comorbidities. In multivariable logistic regression analysis, gender ($p = 0.003$) and cost of care ($p = 0.006$) were significantly associated with glycemic control, and the presence of any comorbidities/complications was associated with 1.8-fold higher odds of poor glycemic control ($p = 0.013$ 95% CI: 1.131–2.786).
Conclusion: Good glycemic control can lead to substantial cost saving through prevention and control of complications.

1. Introduction

Adults with diabetes experience significantly higher health care costs than sex- and age-matched adults without diabetes [1–3]. The chronicity of diabetes mellitus (DM) is associated with the potential for serious complications and often results in significant financial burden and decreased quality of life. DM is one of the leading causes of morbidity and mortality. Poorly controlled diabetes often results in complications such as heart disease, stroke, high blood pressure, blindness, kidney disease, nervous system disease, leg amputations, and premature death. The costs associated with diabetes include increased use of health services, productivity loss, and disability. The International Diabetes Federation's most recent

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http://dx.doi.org/10.1016/j.diabres.2016.07.030
0168-8227/

estimates indicate that 8.3% of adults (382 million people across the world) have diabetes, and the number of people with the disease is set to rise beyond 592 million in less than 25 years. In 2011, diabetes was associated with 4.6 million deaths worldwide, causing more death than human immunodeficiency virus and malaria combined, and consuming at least 465 billion current US dollars (US$) in healthcare resources [4]. The estimated global healthcare expenditure used to treat diabetes and prevent complications totaled at least US$ 548 billion in 2013. By 2030, this number is projected to exceed US$ 595 billion. Compared with those living in high-income countries, people living in low- and middle-income countries pay more in healthcare expenditure because they lack access to health insurance and publicly available medical services. In some of the poorest countries, people with diabetes and their families bear almost the total cost of medical care [5].

Poor and inadequate glycemic control among patients with type 2 diabetes constitutes a major public health problem and is a major risk factor for the development of diabetes complications. A substantial body of research on diabetes management has focused on glycemic control. Large randomized controlled trials have shown that aggressive management of glycated hemoglobin A1c (HbA1c) reduces the risk of microvascular complications in patients with type 1 and type 2 diabetes [6,7]. The direct medical costs associated with diabetes-related complications totaled US$24.6 billion in 2002 [8]. Diabetes-related complications substantially increase not only the economic burden but also increase the risk for disability, death, and reduce quality of life.

Glycemic control remains the major therapeutic objective for prevention of target organ damage and other complications arising from diabetes [9]. In clinical practice, optimal glycemic control is difficult to obtain on a long-term basis because the reasons for poor glycemic control in type 2 diabetes are complex. The increasing prevalence, the emergence of complications as a cause of early morbidity and mortality, and the enormous burden on healthcare systems make diabetes a priority health concern. Both patient- and healthcare provider-related factors may contribute to poor glycemic control. With this aim the present study was undertaken to assess the cost-effectiveness of good glycemic control in a population of Bangladeshi people with type 2 diabetes mellitus (T2DM).

2. Methods

2.1. *Operational definition*

Glycemic status was categorized as good glycemic control if HbA1c level was <7% [10] and poor glycemic control if HbA1c level was >7%. Duration of diabetes in years since diagnosis of diabetes was categorized as either ⩽7 or >7 years.

2.2. *Participants and settings*

This cross-sectional study was conducted among attendees of the outpatient department (OPD) of the Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) hospital, the only national level tertiary health care and research institute for diabetes in Bangladesh and recognized as a World Health Organization collaborating center for research on the prevention and control of diabetes. BIRDEM has the largest diabetes OPD turnover in the world under one roof and it has an in-patient hospital with about 700 beds with all modern disciplines of medicine [11]. Adult (⩾18 years) male and female patients with diabetes of more than 1 year duration (to get annual estimation of expenditure) and willing to participate voluntarily were included in the study. The sample size was determined using an appropriate statistical formula [$n = z^{2*}s^2/d^2$, where $z = 1.96$, s^2 (variance) = 196308121, d (degree of accuracy desired) = 1354.1, calculated total sample size (considering 10% non-response) = 497.66]. BIRDEM attracts patients with different demographic and socioeconomic backgrounds from all over the country and about 497,756 registered diabetes patients and serves more than 4000 patients daily [12]. The average number of patients per day in the BIRDEM OPD was sufficient to cover the total sample size of this study. A total number of 496 type 2 DM patients who meet the inclusion criteria were interviewed using a pretested structured questionnaire. Patients who had incomplete medical records were excluded.

All treatment-related records from the last year (to get the annual estimation) along with the degree and extent of complications, like cardiomyopathy, retinopathy, and nephropathy, were collected from patients' guide books. The total direct cost (cost of medical advice, investigations, medical, and other treatment) and indirect cost (cost of productivity loss and accompanying person(s)) related to management of diabetes were calculated from a consumer's point of view.

Direct cost covers direct medical cost and includes outpatient visits, laboratory testing, pharmaceutical drugs, and other medical services, and direct nonmedical costs including transportation expenses, food consumed by the patients on the way to hospital, and their attendants. The medical history of outpatient medical records was reviewed for 1 year to record the patients' demographic characteristics, clinical status, and quantities of medical services received, and the types and quantities of drugs and medical supplies used. Costs of outpatient visits, laboratory testing, and pharmaceutical drugs were calculated using the regular charge of BIRDEM hospital and BIRDEM pharmacy records, respectively, which were almost same as other city hospitals. Our calculation of unit cost of medical services employed a standard costing approach [13]. The calculation was composed of five steps: organization analysis and cost center classification, direct cost determination, indirect cost determination, full cost determination, and calculation of the unit cost of medical services [14,15]. The annual average expenditure on medical care was estimated by multiplying the average per visit expenditure by the number of visit (records from patients guide book) per year.

The indirect costs consist of opportunity cost of time lost due to morbidity (temporary disability). The morbidity-related component includes the productivity losses of time invested by patients and his/her accompanying person. Indirect healthcare cost was calculated using the human capital approach. The human capital approach considers the value of lost productivity as a result of disability and premature death, using lost earnings as a surrogate for the impact that premature death and disability had on individuals and society

[16]. To quantify loss of production due to short-term and long-term sickness absence, the average working hours (40 h/week) for men and women have been used. The average cost of labor for individual was used to value loss of production. The wage rate of housewives was estimated using minimum wage rate of Bangladesh [17]. Costs were measured in Bangladeshi Taka (BDT); to express costs in terms of international currency we applied a rate of BDT 80 per US$.

2.3. Ethical approval

Ethical approval was granted by the Ethical Review Committee of Bangladesh Diabetic Somiti. A written informed consent form, originally developed in English and later translated to Bangla (local language), was completed by individuals. All literate individuals read the consent paper by themselves and signed. For the illiterate subjects, the data collector read the consent paper to them and, if they agreed, their thumb print or signature was obtained.

2.4. Statistical analysis

The data was entered in a predesigned Microsoft Office Excel spreadsheet which was later imported into the statistical software SPSS 16 for Windows (SPSS, Inc. Chicago. IL.USA). Control of data entry was secured through both programme appliance and manually. Descriptive measures included mean, standard deviation, median and range, proportion, and percentages. Kruskal–Wallis and Mann–Whitney U tests were used for continuous variables and a Chi-square test was used to assess statistical significance of categorical variables. The odds ratio (OR) with 95% confidence interval (CI) for risk factors was calculated. A multivariable logistic regression analysis was performed to evaluate the individual effect of independent variables on dependent variables. Statistical tests were considered significant at a level of 5% ($p \leqslant 0.05$) and all p-values presented are two-tailed.

3. Results

Forty-six percent of patients had good glycemic control. Among 496 patients, 58% were females, aged 53 ± 11 years, and duration of diabetes was 8.8 ± 7 years (Table 1). The average annual cost of care was US$ 314 (direct US$ 283 and indirect US$ 31) per patient. Drugs accounted for the largest share of direct cost US$ 194 (67.7%), followed by laboratory investigations US$ 27 (12.5%) and US$ 24 (11.7%) consultation fees (Table 2).

Patients with poor glycemic control were significantly more likely to have complications [($p = 0.049$) OR 1.5 (95% CI 1.0–2.3)] and comorbidities [($p = 0.026$) OR 1.5 (95% CI 1.0–2.2)] than patients with good glycemic control (Table 3). Compared with patients without complications, cost of healthcare was 2.3 times higher for those with both cardiomyopathy and retinopathy, 1.8 times higher for those with both cardiomyopathy and nephropathy, and 3.4 times higher for those with both nephropathy and retinopathy (Table 4).

The annual medical costs (median) for patients with good glycemic control increased with increasing number of complications/comorbidities. Those without complications/comorbidities spent US$ 216 but the cost increased to US$ 264 with one or two complications/comorbidities and US$ 334 with more than two. The annual cost increased rapidly with number of complications/comorbidities: considering no complications/comorbidities it was US$ 216 and US$ 255, for one/two it was US$ 264 and US$ 291, US$ 334 for more than two, and US$ 358 among patients having good and poor glycemic status. The cost of care was significantly ($p = 0.001$) higher for those with poor glycemic status and with more than two complications/comorbidities (Table 5).

Using logistic regression analysis, patients using insulin only were 1.6 times ($p = 0.283$) more likely to be poorly controlled and those taking a combination of drugs were 1.8 times ($p = 0.125$) more likely compared with patients who were taking only oral hypoglycemic agents. Patients with the presence of any comorbidities/complications had 1.8 fold higher odds of poor glycemic control ($p = 0.013$ 95% CI: 1.131–2.786). Cost of care was significantly associated ($p = 0.006$) with glycemic control (Table 6).

Table 1 – Proportion of patients with poor glycemic control according to demographic, anthropometric and clinical characteristics ($n = 496$).

Variables	Total	n (%)	p-value
Age (years)			
⩽45	126	72 (57)	0.198
46–54	140	79 (56)	
55 and above	230	112 (49)	
Mean ± SD	**53 ± 11**		
Gender			
Male	227	107 (47)	**0.010**
Female	269	156 (58)	
Education level			
Upto primary	158	95 (60)	0.074
Higher secondary	215	110 (51)	
Graduate and above	123	58 (47)	
Monthly household income (US$)[*]			
⩽225	125	67 (54)	0.852
226–313	146	81 (56)	
314–500	125	65 (52)	
501 and above	100	50 (50)	
Duration of diabetes (years)			
⩽7	257	147 (57)	**0.050**
8 and above	239	116 (49)	
Mean ± SD	**8.8 ± 7**		
Mode of treatment			
Oral hypoglycemic agent	291	135 (46)	**0.002**
Insulin	87	53 (61)	
Combination	118	75 (64)	
BMI (kg/m^2)			
Normal	119	59 (50)	0.428
Over weight	119	60 (50)	
Obese	254	144 (56)	

χ^2-test was done. p is significant at level <0.05.
[*] US$ exchange rate 1 US$ = 80 Bangladeshi Taka (BDT).

4. Discussion

This study estimated the proportion of patients with type 2 diabetes who did not achieve target glycemic control levels. The findings from this study highlight the significant

Table 2 – Component-wise direct and indirect cost (US$) per participants/year.

Variables	Average cost US$	Median (range) US$
Direct cost	283	249 (20–1257)
Outpatient visits	24 (11.7%)	23 (5–52)
Investigations	27 (12.5%)	26 (2–149)
Medicine cost	194 (67.7%)	164 (9–1013)
Self monitoring of blood sugar	26 (6.1%)	15 (1–394)
Food cost on the way to hospital	4 (.033%)	3 (.5–30)
Travel cost	6 (2.5%)	4 (.17–80)
Indirect cost	31	5 (0–1165)

Table 3 – Association between glycemic control and co-morbidity/complication.

Variable	Glycemic control		*p*-value	OR (95% CI)
	Poor	Good		
Complication				
Absent	78	51	**0.049**	1.5 (1.0–2.3)
Present	185	182		
Co-morbidity				
Absent	81	94	**0.026**	1.5 (1.0–2.2)
Present	182	139		

χ^2-test was done. *p* is significant at level <0.05.

Table 4 – Complication wise annual cost of diabetes.

Complication status	Average annual cost (US$)	Ratio
No complication	249	1:1
Both cardiopathy–retinopathy	596	1:2.3
Both cardiopathy–nephropathy	478	1:1.8
Both nephropathy–retinopathy	867	1:3.4

differences in cost between good and poor glycemic control. Poor glycemic control was present in 69% of patients in this study. In Jordan and Kuwait, 65.1 and 66.7% of the studied population had HbA1c >7% and ⩾8%, respectively [18,19]. In Saudi Arabia, only 27% of patients reached target levels of glycemic control [20]. In Pakistan, 46.7% of patients had HbA1c >7.5% [21]. In Trinidad, 85% had HbA1c >7% [22]. Furthermore, in the UK 69% had HbA1c >7.5% [23].

Regarding the cost comparison, Ettaro et al. [24] stated in a review article titled "Cost-of-illness studies in diabetes mellitus" that healthcare components considered in the direct cost calculations vary between the studies. Nearly all of the studies included costs associated with hospital care, physician services, and prescription drugs, but there are marked discrepancies with respect to inclusion of long-term care, emergency department services, home healthcare, and other services. Based on this review, this study covers the complete components of direct medical costs of diabetic care.

The lack of a relationship between age and poor glycemic control in our study is consistent with the findings of a study conducted in Jordan [18]. In the present study, patients with poor glycemic control were more likely (64%) to be prescribed a combination of oral antidiabetic agents and insulin, which may indicate that physicians are attempting multi-therapy to provide better disease control. The association between treatment with a combination of oral anti-diabetic agents and insulin and poor glycemic control is consistent with other studies [18,25].

The cost of diabetes care tends to increase in relation to a country's degree of economic development, although it is difficult to compare costs between different countries because of social and economic differences and differences in the methods used. Nevertheless, it can be useful to assess the magnitude of the economic burden of diabetes in Bangladesh. The average annual cost of care per patient was US$ 314 (direct US$ 283 and indirect US$ 31) which was less than the costs in developed countries such as the USA (direct medical costs, U$11,744) [26], Germany (direct total cost, U$4,713) [27], China (direct medical cost, U$1,321) [28], and India (direct total cost, U$525.5) [29] but was more than those in developing countries like Iran (direct total cost, U$152) [30] and Pakistan (annual mean direct cost US$ 197) [31]. This study shows that drugs accounted for the largest share of direct cost, followed by laboratory investigations and consultation fees. These results are consistent with those of previous studies reported by Tae Ho Kim et al. [32].

Table 5 – Annual cost of diabetes according to severity among good and poor glycemic control.

Type of complication	Median annual cost of care (US$)		*p*-value
	Good glycemic control	Poor glycemic control	
No complication/co-morbidity	216	255	0.907
1–2 complication/co-morbidity	264	291	0.134
More than 2 complication/co-morbidity	334	358	0.589
p-value	0.106	**0.001**	

Kruskal Wallis Test and Mann–Whitney-U test was done. *p* is significant at level <0.05.

Table 6 – Logistic regression analysis of explanatory variables considering glycemic control as dependent variable.

Variables	Beta coefficient (β)	*p*-value	OR	95% Confidence Interval for β	
				Lower bound	Upper bound
Age	−0.023	**0.032**	0.977	0.957	0.998
Duration of diabetes	−0.020	0.274	0.980	0.945	1.016
Gender					
Female	Reference		1.00		
Male	−0.618	**0.003**	0.539	0.356	0.816
Mode of treatment					
Oral hypoglycemic agent	Reference	**0.017**	1.00		
Insulin	0.354	0.283	1.641	0.740	2.800
Combination	0.495	0.125	1.775	0.872	3.088
Co-morbidity/complication					
Absent	Reference		1.00		
Present	0.574	**0.013**	1.775	1.131	2.786
Cost of care	0.000	**0.006**	1.000	1.000	1.000
(Constant)	1.667	**0.003**	5.296		

It is important to note that this study examines costs directly attributable to diabetes (e.g. a diagnosis of T2DM or receipt of antidiabetic medication) and along with the costs associated with diabetic complications such as neuropathy, nephropathy, or retinopathy which are associated with poor levels of glycemic control.

Regarding complications, the actual economic burden of diabetic care without covering the cost of complications was underestimated [33–35]. This study confirmed such findings. Patients with poor glycemic control were 1.5 times more likely to have complications and comorbidities thus increasing the cost of care significantly than patients with good glycemic control. Similar findings were found in many studies which have demonstrated that the presence and number of diabetic complications/comorbidities have an impact on the cost of diabetic care [36,37].

Patients with both cardiomyopathy and retinopathy had 2.3 times higher cost of care compared with patients without complications, those with both cardiomyopathy and nephropathy had 1.8 times higher costs, and those with both nephropathy and retinopathy have 3.4 times higher costs. This trend is reported in the study conducted in Korea where cost of care increased with an increased number of complications [32]. This indicates that complications are a major source of costs for patients with diabetes and suggests that prevention and proper management of complications may be effective interventions for reducing the long-term economic burden of diabetic therapy which is also supported by the study conducted by Yach et al. Costs due to the complications contribute to the largest fraction of diabetic care [38].

This is the first study to be conducted in Bangladesh to determine the factors associated with poor glycemic control. However, this study is cross-sectional, where causal relationship between the independent and dependent variables cannot be established, so a longitudinal study is needed to assess the relationship between those variables over time. In conclusion, the proportion of patients with poor glycemic control was high, which is nearly comparable to that reported from many countries. Mode of treatment and comorbidity/-complication status were associated with poor glycemic control. The results of this study were consistent with such studies indicating that costs were positively associated with complications [39,40].

The study demonstrates the cost effectiveness of prevention/screening of complications. Good glycemic control can lead to substantial cost saving through prevention and control of complications. Verification of the long-lasting observations on diabetes shown in this study is necessary.

Funding Source

This study was supported by Bangladesh Diabetic Somiti.

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Author Disclosures

The authors (AA, MS, HAC, MAH, MNH, LA) report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information

Concept and design – AA, MNH, LA; acquisition of data – AA, HAC; analysis and interpretation of data – AA, MS, MAH, MNH, LA; drafting of the manuscript – AA, HAC; drafting the article or revising it critically for important intellectual content – AA, MAH, LA; final approval of the version to be submitted – AA, MNH, LA.

Conflict of interest

None.

Acknowledgments

We would like to thank the Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM), a comprehensive tertiary care hospital of the Diabetic Association of Bangladesh, Dhaka, and all the T2DM patients who participated in the study for their kind contribution.

REFERENCES

[1] Selby J, Grumbach K, Quesenberry CJ, Schmittdiel JA, Truman AF. Differences in resource use and costs of primary care in a large HMO according to physician specialty. Health Serv Res 1999;34:503–18.
[2] Brown JB, Nichols GA, Glauber HS, Bakst AW. Type 2 diabetes: incremental medical care costs during the first 8 years after diagnosis. Diabetes Care 1999;22:1116–24.
[3] Sidorov J, Shull R, Tomcavage J, Girolami S, Lowton N, Haris R. Does diabetes disease management save money and improve outcomes? A report of simultaneous short-term savings and quality improvement associated with a health maintenance organization-sponsored disease management program among patients fulfilling health employer data and information set criteria. Diabetes Care 2002;25:684–9.
[4] Zhang P, Zhang X, Brown J, Vistisen D, Sicree R, Shaw J, et al. Global healthcare expenditure on diabetes for 2010 and 2030. Diabetes Res Clin Pract 2010;87(3):293–301. http://dx.doi.org/10.1016/j.diabres.2010.01.026.
[5] International Diabetes Federation. Diabetes Atlas. 6th edition, IDF Diabetes Atlas. <www.idf.org/diabetesatlas>. ISBN: 2-930229-85-3.
[6] The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med 1993;329:977–86.
[7] UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with Type 2 diabetes. Lancet 1998;352:837–53.
[8] Hogan P, Dall T, Nikolov P. American Diabetes Association: Economic costs of diabetes mellitus in the US in 2002. Diabetes Care 2003;26:917–32.
[9] Koro CE, Bowlin SJ, Bourgeois N, Fedder DO. Glycemic control from 1988 to 2000 among U.S. adults diagnosed with type 2 diabetes: a preliminary report. Diabetes Care 2004 Jan;27 (1):17–20.
[10] American Diabetes Association. Screening for type 2 diabetes. Diabetes Care 2004;28(Suppl. 1):S11–4.
[11] Morkrid K, Ali L, Hussain A. Risk factors and prevalence of diabetic peripheral neuropathy: a study of type 2 diabetic outpatients in Bangladesh. Int J Diabetes Dev Ctries 2010 Jan;30(1):11–7. http://dx.doi.org/10.4103/0973-3930.60004.
[12] DAB: Statistical Year Book. Vol. July 2011–June 2012. Dhaka: Diabetic Association of Bangladesh, 2012.
[13] Drummond MF, O'Brien BJ, Stoddart GL, Torrance GW. Methods for the economic evaluation of health care programmes. 2nd ed. Oxford: Oxford Medical Publication; 1997.
[14] Shepard DS, Hodgkin D, Anthony YE. Analysis of hospital costs: a manual for managers. Geneva: World Health Organization; 2000.
[15] Riewpaiboon A. Institutional Cost Analysis. Bangkok: Faculty of Pharmacy, Mahidol University, 2003. [20,21].
[16] Moore R. Economic burden of illness in Canada. Canadian Public Health Association for Health Canada 1993.
[17] <http://www.minimum-wage.org/international/en/Bangladesh>; [cited on 12 November 2011].
[18] Maysaa K, Yousef SK, Abdelkarim AK, Ajlouni K. Factors associated with poor glycemic control among patients with Type 2 diabetes. J Diabetes Complications 2010;24:84–9.
[19] Al-Sultan FA, Al-Zanki N. Clinical epidemiology of Type 2 diabetes mellitus in Kuwait. Kuwait Med J 2005;37(2): 98–104.
[20] Akbar DH. Low rates of diabetic patients reaching good control targets. East Mediterr Health J 2001 Jul–Sep;7(4-5): 671–8.
[21] Habib SS, Aslam M. Risk factors, knowledge and health status in diabetic patients. Saudi Med J 2003;24(11):1219–24.
[22] Ezenwaka CE, Offiah NV. Differences in glycemic control and cardiovascular risk in primary care patients with type 2 diabetes in West Indies. Clin Exp Med 2001;2:91–8.
[23] Fox KM, Gerber RA, Bolinder B, Chen J, Kumar S. Prevalence of inadequate glycemic control among patients with Type 2 diabetes in the United Kingdom general practice research data base: a series of retrospective analysis of data from 1998 through 2002. Clin Ther 2006;28(3):388–95.
[24] Ettaro L, Songer TJ, Zhang P, Engelgau MM. Cost-of-illness studies in diabetes mellitus. Pharmacoeconomics 2004;22:149–64.
[25] Goudswarrd AN, Stolk RP, Zuithoff P, Rutten GE. Patients characteristics do not predict poor glycaemic control in Type 2 diabetes patients treated in primary care. Eur J Epidemiol 2004;19:541–5.
[26] American Diabetes Association. Economic costs of diabetes in the U.S. In 2007. Diabetes Care 2008;31:596–615.
[27] Koster I, von Ferber L, Ihle P, Schubert I, Hauner H. The cost burden of diabetes mellitus: the evidence from Germany–the CoDiM study. Diabetologia 2006;49:1498–504.
[28] Wang W, McGreevey WP, Fu C, Zhan S, Luan R, Chen W, et al. Type 2 diabetes mellitus in China: a preventable economic burden. Am J Manag Care 2009;15:593–601.
[29] Tharkar S, Devarajan A, Kumpatla S, Viswanathan V. The socioeconomics of diabetes from a developing country: a population based cost of illness study. Diabetes Res Clin Pract 2010;89:334–40.
[30] Esteghamati A, Khalilzadeh O, Anvari M, et al. The economic costs of diabetes: a population based study in Tehran, Iran. Diabetologia 2009;52:1520–7.
[31] Khowaja LA, Khuwaja AK, Cosgrove P. Cost of diabetes care in out-patient clinics of Karachi, Pakistan. BMC Health Serv Res 2007;7(1):189. http://dx.doi.org/10.1186/1472-6963-7-189.
[32] Tae HK, Ki HC, Hae JK, Seung JH, Dae JK, Jiyeong K, et al. Direct medical costs for patients with type 2 diabetes and related complications: a prospective cohort study based on the Korean national diabetes program. J Korean Med Sci 2012 Aug;27(8):876–82.
[33] O'Brien JA, Patrick AR, Caro JJ. Cost of managing complications resulting from type 2 diabetes mellitus in Canada. BMC Health Serv Res 2003;3:7.
[34] Morsanutto A, Berto P, Lopatriello S, Gelisio R, Voinovich D, Cippo PP, et al. Major diabetes complications have an impact on total annual medical cost of type 2 diabetes. Diabetes Care 2004;27:1841–2.
[35] Norlund A, Apelqvist J, Bitzen PO, Nyberg P, Shorten B, et al. Cost of illness of adult diabetes mellitus underestimated if comorbidity is not considered. J Intern Med 2001;250:57–65. http://dx.doi.org/10.1046/j.1365-2796.2001.00852.x.
[36] Massi-Benedetti M. The cost of diabetes Type II in Europe: the CODE-2 study. Diabetologia 2002;45:S1–4.

[37] Morsanutto A, Berto P, Lopatriello S, Gelisio R, Voinovich D, Cippo PP, et al. Major complications have an impact on total annual medical cost of diabetes: results of a database analysis. J Diabetes Complications 2006;20:163–9.
[38] Yach D, Stuckler D, Brownell KD. Epidemiologic and economic consequences of the global epidemics of obesity and diabetes. Nat Med 2006;12:62–6.
[39] Brown JB. The progressive cost of complications in type 2 diabetes mellitus. Arch Intern Med 1999;159:1873–80.
[40] Arthorn R, Penkae P, Kwanjai P. Diabetes Cost Model of a Hospital in Thailand. Value Health 2007;10:4.