Glycaemic control and its associated factors in type 2 diabetic patients in Amman, Jordan

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ضبط غلوكوز الدم والعوامل المرافقة له في السكريين من النمط الثاني في عمَّان، الأردن

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الخلاصة: أجرى الباحثون دراسة على 1000 مريض ممن يراجعون مركز إحالة للسكريين في عمَّان، الأردن، وتعرفوا على العوامل المرافقة للضبط الجيد لغلوكوز الدم، وذلك بقياس مستويات الهيموغلوبين الغلوكوزي. وقد تحسن ضبط سكر الدم تحسُّناً يُعْتَدُّ به إحصائياً بين الزيارة الأولى للعيادة وبعد 12 شهراً من المتابعة. فقد انخفضت النسبة المئوية للمرضى الذين يعانون من زيادة قصوى (تعادل 10٪ أو أكثر) من الهيموغلوبين الغلوكوزي من 15.3٪ في الزيارة الأولى إلى 6٪ بعد 12 شهراً. وزادت النسبة المئوية للمرضى الذين لديهم ضبطاً مثالياً (أقل من 7٪ من الهيموغلوبين الغلوكوزي) من 25.4٪ في الزيارة الأولى إلى 27.5٪ بعد 12 شهراً من المتابعة. وقد أوضح تحليل التقهقر المتعدد المتغيرات أن انخفاض منسب كتلة الجسم، وقصر فترة الإصابة بالسكري، والمستوى الأساسي المرتفع للهيموغلوبين الغلوكوزي ترتبط بانخفاض الهيموغلوبين الغلوكوزي بين الزيارة الأولى وبعد 12 شهراً منها.

ABSTRACT A study of 1000 patients attending a diabetes referral centre in Amman, Jordan, identified factors associated with good glycaemic control, as measured by glycosylated haemoglobin (HbA1c) levels. Glycaemic control improved significantly between the first clinic visit and at 12-months follow-up. The proportion of patients with extreme HbA1c (≥ 10%) decreased from 15.3% to 6.0% after 12 months. The percentage of patients with optimal control (HbA1c < 7%) increased from 25.4% at the first visit to 27.5% at 12-month follow-up. Multivariate regression showed that low body mass index, shorter duration of diabetes and higher baseline HbA1c were related to reductions in HbA1c between the first and 12-month visits.

Contrôle de la glycémie et facteurs associés chez des patients souffrant de diabète de type 2 à Amman (Jordanie)

RÉSUMÉ Une étude sur 1 000 patients consultant dans un centre d'orientation-recours spécialisé dans le traitement du diabète à Amman (Jordanie) a mis en évidence les facteurs associés à un bon contrôle de la glycémie, mesuré par les taux d'hémoglobine glycosylée (HbA1c). Le contrôle de la glycémie s'est amélioré de manière significative entre la première visite au centre et le suivi réalisé 12 mois plus tard. La proportion de patients présentant un taux de HbA1c extrêmement élevé (≥ 10 %) est passée de 15,3 % à 6,0 % à l'issue des 12 mois. Le pourcentage de patients présentant un contrôle optimal (HbA1c <7 %) est passé de 25,4 % lors de la première visite à 27,5 % lors de la consultation de suivi effectuée 12 mois plus tard. La régression multivariée a mis en évidence qu'un faible indice de masse corporelle, un diabète de plus courte durée et une ligne de base du taux de HbA1c plus élevée étaient associés à une baisse du taux de HbA1c entre la première consultation et celle réalisée 12 mois après.

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Introduction

The increasing prevalence of type 2 diabetes mellitus (DM) worldwide is reaching epidemic proportions and is becoming a major public health problem [1]. DM is a chronic disease that needs coordinated efforts between the patient, family and medical team. Improving glycaemic control is a high priority in decreasing the burden of DM and delaying its complications [2,3]. While research has identified patient characteristics that influence glycaemic control in type 1 DM, little is known about the factors that influence glucose control in type 2 DM [4]; such information has the potential to reduce the short- and long-term complications associated with DM.

A patient's glycosylated haemoglobin (HbA1c) level is an indicator of the status of glycaemic control over the previous 3 months. A cut-off point of < 7% indicates optimal glycaemic control, but may not be feasible to achieve for all diabetics [5]. Nevertheless, the UK Prospective Diabetes Study found that in type 2 diabetics each percentage point reduction in HbA1c was associated with a 35% reduction in microvascular complications and a 7% reduction in all-cause mortality [6].

The objectives of this study were to investigate the extent of glycaemic control, as measured by HbA1c, in patients with type 2 DM attending the National Centre for Diabetes, Endocrinology and Genetics in Amman (NCDEG), Jordan; to assess the relationship between various demographic and clinical factors and glycaemic control; and to assess the factors related to changes in HbA1c at 12-month follow-up.

Methods

This was a historical prospective study design using a review of patients' medical records from an existing database, supplemented by a structured interview questionnaire designed for this study.

Setting

NCDEG was established in 1996 as a part of the University of Jordan hospital in Amman, Jordan. The centre provides comprehensive diabetes care to patients from all over the country by a team consisting of an endocrinologist, specialized nurses, physicians and a dietician. An established database of medical records contains each patient's clinical history. In addition, there are several specialized clinics related to complications of DM.

Sample

All patients with type 2 DM who had made 2 or more visits to the centre 2 to 3 months apart between July and December 2006, and for whom follow-up data were available over a 12-month period, were eligible for the study.

The required sample size was estimated assuming that the proportion of diabetics with poor glycaemic control was 50%, the level of significance (α) equal to 0.05 and limits of error 5%. The estimated sample size calculated for the given prevalence at 95% confidence interval (CI) was 778. We deliberately over-sampled (n = 1000) in order to account for missing data from medical records.

Approval for the study was obtained through the ethical committee of the centre. Verbal consent was obtained from each subject for access to the medical records and the interview.

Measurement and data collection

The interview was administered by a registered nurse and included information on sociodemographic variables (education, monthly family income and marital status) and also asked about smoking and patients' use of medication. Educational status was classified by the length of time in education: 0 years (illiterate), 1–12 years (school) or ≥ 12 years of education (diploma, bachelors and postgraduate education). Smoking was categorized as nonsmoker (never smoked) or smoker (regularly smoked at least 1 cigarette daily).

Data obtained from the patients' records included: treatment for diabetes, measurements of blood pressure (BP), anthropometric measurements for body mass index (BMI), fasting blood sugar, HbA1c, lipid profile, kidney function tests and eye and foot examinations obtained at each visit.

Anthropometric measurements included weight (in light clothes to the nearest 0.5 kg), height (without shoes to the nearest 0.5 cm) and waist circumference (at the narrowest point between the umbilicus and the rib cage) and hip circumference (at the widest part of the body below the waist). BMI (weight in kilograms/height in metres squared) was used to classify patients as normal weight (< 25 kg/m^2), overweight (25–29.9 kg/m^2) or obese (BMI > 30 kg/m^2).

Blood pressure was measured using a standard sphygmomanometer (EN 1060, Riester). Hypertension was defined as systolic BP ≥ 130 mmHg /or diastolic BP ≥ 80 mmHg or regular use of antihypertensive drugs).

Complications of DM such as retinopathy, neuropathy and nephropathy were noted from the records. Ophthalmic examination was done at each visit by dilating the pupil of one eye with mydriatic eye drops. Retinopathy was classified as present or absent.

Laboratory measures and biochemical analysis

The primary outcome measure was HbA1c (at baseline and 12 months). HbA1c represents an estimate of mean glucose level over the last 120 days [7]. Current guidelines for glycaemic control recommend HbA1c values < 7% as a treatment goal for most DM patients [8]. HbA1c was analysed by using a high-performance liquid chromatography method (Bio-Rad). Glycaemic control was grouped into 4 categories:

good (HBA1C < 7%), acceptable (HbA1c 7%–7.9%), poor (HbA1c > 8%–9.9 %) or extremely inadequate (HbA1c ≥ 10 %).

Total cholesterol, triglycerides (TG) and high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol were analysed by an enzymatic colorimetric method (Cobas Integra). Lipid profile cut-offs were: high total cholesterol (≥ 200 mg/dL); high serum TG (≥ 150 mg/dL); low HDL cholesterol (< 45 mg/dL); AND high LDL cholesterol (≥ 100 mg/dL).

Albumin urea concentrations were measured by urine dipstick (Klinitic).

Statistical analysis

Data were entered and analysed using *SPSS* software. Data was screened for extreme outliers, logical inconsistencies and errors. Means and standard deviation (SD) and frequencies described the sample. Student paired *t*-test was used to assess the difference in means between the first clinic visit and 12-month follow-up intervals. The chi-squared test was used to assess statistical significance for differences of categorical variables; $P \leq 0.05$ was considered statistically significant. Multivariate linear regression was used to assess the independent effect of variables related to change in HbA1c level between the first and follow-up visits after controlling for potential confounders.

Results

Sociodemographic and clinical characteristics at the first visit

Table 1 shows the sociodemographic characteristics of the sample of 1000 patients with type 2 DM at baseline. The mean age was 58.1 (SD 9.3) years, with 48.3% of patients aged > 60 years; 50.5% of patients were female, 10% were illiterate and 15% were current smokers. The mean duration of DM was 9.4 (SD 7.2) years. One-third of patients had retinopathy and two-thirds had dyslipidaemias (Table 2). More than half of the patients were on oral hypoglycaemic drugs and only 2.1% were managed by diet alone. Obesity (BMI > 30 kg/m^2) was present in 57.6% of patients and 91.3% were overweight or obese.

Table 1 Sociodemographic characteristics of the study group of diabetic patients at the first clinic visit (*n* = 1000)

Variable	No. of patients	%
Sex		
Male	495	49.5
Female	505	50.5
Age (years)		
< 40	30	3.0
40–49	150	15.0
50–59	337	33.7
≥ 60	483	48.3
Education (years)[a]		
0	86	10.0
1–12	392	44.6
> 12	398	55.4
Current smoker	145	15.0

[a] *Data on education missing for 124 patients.*

The overall mean HbA1c level at the first visit to the clinic was 8.10%; only 24.1% of patients had HbA1c < 7% (Table 2), while 16.1% had extremely high values (≥ 10%). The lipid profile at the first visit to the clinic showed that 22.8% had high total cholesterol, 43.6% high TG, 57.4% low HDL cholesterol and 62.8% high LDL cholesterol. Microalbuminurea was present in 32.0% and a large proportion (71.7%) were hypertensive (BP ≥ 130/80 mmHg).

Sex differences in selected sociodemographic and clinical characteristics are shown in Table 3. Males were significantly older and had a longer duration of diabetes, longer duration of education, lower HDL cholesterol and LDL cholesterol levels and lower mean HbA1c at the first visit.

Glycaemic control at the first visit

Mean HbA1c levels by patient's age, sex and clinical characteristic at the first visit are shown on Table 4. Males had significantly lower mean HbA1c levels than females ($P = 0.02$). HbA1c levels increased with a longer duration of DM ($P = 0.001$). Age was not related to glycaemic control. Patients with BMI 25–29 kg/m^2 had the lowest mean HbA1c levels and HbA1c was significantly different comparing patients with BMI < 25 and ≥ 30 kg/m^2. Hypercholesterolaemia, elevated LDL cholesterol and the presence of microalbuminurea were found in those with higher HbA1c levels (all *P*-values < 0.01). A higher HbA1c level was significantly associated with the presence of retinopathy ($P < 0.001$). Patients treated with insulin, or a combination of insulin and hypoglycaemic agents, had significantly higher HbA1c levels.

Changes in glycaemic control at 12-month follow-up

Mean HbA1c decreased significantly in the subset of patients who had measurements at follow-up, from 8.1% (SD 1.8%, range 4.7%–17.3%) at the first visit to 7.8% (SD 1.3%, range 4.9%–13.6%) at follow-up.

The distribution of HbA1c levels for 886 patients for whom complete data were available at the first and 12-month follow up visits are shown on Table 5.

Table 2 Clinical and laboratory characteristics of diabetic patients at the first clinic visit (n = 1000)

Variable	No. of patients	%	Mean value (SD)
Duration of diabetes (years)			9.4 (7.2)
< 5	303	30.3	
5–9	279	27.9	
10–19	284	28.4	
≥ 20	134	13.4	
HbA1c level (%)			8.10 (1.80)
< 7	241	24.1	
7–7.9	301	30.1	
8–9.9	296	29.6	
≥ 10	161	16.1	
Total cholesterol (mg/dL)			173.7 (38.2)
< 200	672	77.2	
≥ 200	198	22.8	
Triglycerides (mg/dL)			158.3 (84.5)
< 150	492	56.4	
≥ 150	381	43.6	
HDL cholesterol (mg/dL)			44.3 (11.1)
≥ 45	360	42.6	
< 45	486	57.4	
LDL cholesterol (mg/dL)			113.1 (32.1)
< 100	321	37.2	
≥ 100	542	62.8	
Urine albumin present	314	32.0	
Retinopathy present	326	33.4	
Dyslipidaemia present	671	68.0	
Hypertension present[a]	717	71.7	
BMI (kg/m²)			31.6 (5.4)
< 25	86	8.7	
25–29.9	335	33.7	
30–34	329	33.1	
≥ 35	244	24.5	
Type of treatment			
Oral hypoglycaemics	524	52.9	
Insulin & oral hypoglycaemics	368	37.8	
Insulin	77	7.8	
Diet alone	21	2.1	

[a]*Systolic BP > 130 mmHg, diastolic BP > 80 mmHg.*
SD = standard deviation; HbA1c = glycosylated haemoglobin; HDL = high-density lipoprotein, LDL = low-density lipoprotein; BMI = body mass index.

The percentage of patients with optimal control (HbA1c < 7%) increased from 25.4% at the first visit to 27.5% at follow-up. The proportion with extreme HbA1c levels (≥ 10%) decreased from 15.3% to 6.0% between the first and 12-month visit (P < 0.001).

Multivariate linear regression showed that the initial HbA1c level, duration of DM, and BMI were all significantly related to change in HbA1c between the first and follow-up visits after controlling for potential confounders in the analysis (age, sex, retinopathy and neuropathy were found not to be confounders) (Table 6). Patients with initially high HbA1c level were more likely to decrease their HbA1c level. The regression coefficient (β = 0.7) showed that for each 1% higher initial HbA1c, there was a 0.7% greater reduction in the HbA1c at the last visit (P < 0.001). The longer the duration of DM the less likely it was that a patient would have a reduced HbA1c between the 2 visits (β = –0.16, P < 0.001). Similarly, the higher the BMI the lower the reduction in HbA1c between the 2 visits (β = –0.09, P < 0.001).

Discussion

This is the only study from Jordan to report on glycaemic control in a large sample of patients that included subjects who attended this referral centre from all parts of Jordan. NCDEG delivers fully integrated specialized health care for patients with DM, endocrine and genetic diseases, serving both the private and public sector in Amman and elsewhere in the country. The rate of optimal glycaemic control (HbA1c < 7%) among the study sample (27.5% at 12 months) was comparable to that reported from many countries [9–11]. Extremely inadequate control (HbA1c ≥ 10%) was rare among the study group (6.0% at 12 months). An HbA1c level of < 7% as a proposed target for optimum glycaemic control in DM patients may not be feasible or practical and has been the subject of considerable discussion [11–13]. The results of our study are consistent with those by Benoit et al. [2] and Abdelazis et al. [12].

Factors related to better glycaemic control included male sex, shorter duration of DM and lower levels of total cholesterol, LDL cholesterol and TG. A meta-analysis found that only about one-third of patients were controlled to an HbA1c level of < 7% [12]. Achieving or maintaining levels of < 7% is more difficult in patients with a longer duration

Table 3 Mean values of selected sociodemographic and clinical variables of male and female diabetic patients at the first clinic visit (*n* = 1000)

Variable	Males		Females		*P*-value
	No. of patients	Mean value (SD)	No. of patients	Mean value (SD)	
Age (years)	494	58.8 (9.9)	506	57.3 (9.3)	0.01
Education (years)	405	13.7 (4.6)	402	8.7 (5.4)	< 0.001
Duration of diabetes (years)	493	9.9 (7.4)	505	8.8 (7.0)	0.02
HbA1c (%)	491	8.07 (1.77)	505	8.30 (1.83)	0.04
LDL cholesterol level (mg/dL)	434	107.6 (30.6)	441	118.1 (33.2)	< 0.001
HDL cholesterol level (mg/dL)	432	41.2 (10.0)	440	48.4 (19.1)	< 0.001
Systolic BP (mmHg)	490	129.6 (21.1)	506	131.1 (60.7)	0.62
Diastolic BP (mmHg)	490	78.0 (11.1)	505	78.0 (10.7)	0.94
BMI (kg/m^2)	493	31.5 (5.3)	502	31.7 (5.4)	0.46

SD = standard deviation; HbA1c = glycosylated haemoglobin; LDL = low-density lipoprotein; HDL = high-density lipoprotein; BP = blood pressure; BMI = body mass index.

of DM. Rather than targeting an HbA1c level of < 7% for all diabetic patients, individualization of the target levels has been suggested [13]. However, while the risk of complications declines as HbA1c declines, the risk of hypoglycaemia increases. The balance between benefit and harm of intensive treatment may be less favourable in children < 13 years or adults over 70 years, and in people with repeated severe hypoglycaemia, or those who lack awareness of hypoglycaemia [14]. In patients with advanced DM complications, such as blindness, end-stage renal disease, advanced autonomic neuropathy or cardiovascular disease, the benefit of more intensive treatment may be limited by comorbidity and reduced life expectancy. In such patients, less stringent goals for glycaemic control may be adopted [14]. A number of studies have demonstrated that immediate feedback to the patient about their HbA1c, intense education and ensuring appropriate changes in therapy results in a significant short-term and long-term improvement of glycaemic status and enhances DM care [15–17]. This will help in individualizing target HbA1c levels according to patient's preference, age, social, psychological status and other risk factors.

Optimal glycaemic control was recorded in 24.1% of our patients at their initial visit, a figure which increased modestly to 27.5% at the last follow-up visit. Such a level of control is consistent with the results of many studies. In Saudi Arabia, for example, only 27% of the study group reached the target level of control, and the author explained this as due to poor eating habits, poor compliance with medication and the use of inappropriate herbal medicines [9]. In Kuwait, only 17.6% of patients had achieved the goal of HbA1c < 7% [10]. In Finland, only 25% of a study group had HbA1c < 7.3% [11]. However, optimal control was reported in 44%, 50% and 58% of patients from NHANES III [18], the UK Prospective Diabetes Study [6] and a study in the Netherlands [19]. The decline in HbA1c levels in our study between the first and 1-year follow-up visits suggests that patients may not have been receiving optimum management before visiting NCDEG, leaving room for further improvement in control of their DM. It is possible that physicians who treat patients in the community have more relaxed standards of control that permit higher levels of glycaemia. Lack of resources, including lack of facilities for HbA1c measurement, unavailability of medications and lack of educational efforts regarding diet and weight are alternative explanations.

Glycaemic control in our study was related to a number of factors including sex, duration of DM, BMI, dyslipidaemia and treatment modality. Consistent with our findings, women were found to have worse glycaemic control than men in Saudi Arabia; the author related this to the social norms of women in some conservative Arab communities which limit their ability to take up exercise or employment outside the home [9]. Similar findings were reported from Finland [11]. However, a study from the United States found that adult men with insulin-dependent type 2 DM had significantly poorer glycaemic control than did women [4].

Our data showed that longer duration of DM was related to more difficulty with maintenance of glycaemic control. This finding is consistent with 3 earlier studies [6,11,20] but is contradicted by another report [4]. The worsening of glycaemic control over time could be explained by a reduction in pancreatic beta cell function and an increased fat mass, particularly visceral adiposity, leading to greater insulin resistance associated with the ageing process. It is known that achieving and maintaining HbA1c levels < 7% is difficult in patients with a longer duration of DM even with the addition of a third oral hypoglycaemic drug. Hypoglycaemia remains a major limiting factor in achieving tight glycaemic control with insulin.

In our study, 91.3% of patients were overweight or obese. BMI appears to be related to glycaemic control. The lack of a relationship between age and

Table 4 Mean glycosylated haemoglobin (HbA1c) levels of diabetic patients at the first clinic visit by selected variables

Variable	No. of patients[a]	Mean HbA1c level% (SD)	*P*-value
Total	1000	8.10 (1.80)	
Sex			
Male	496	8.05 (1.76)	0.02
Female	504	8.31 (1.82)	
Age (years)			
< 40	30	8.40 (2.58)	
40–49	150	8.10 (1.81)	0.29
50–59	337	8.30 (1.80)	
≥ 60	82	8.10 (1.73)	
Duration of diabetes (years)			
< 5	303	7.74 (1.91)	
5–9	278	8.20 (1.68)	< 0.001
10–19	284	8.48 (1.72)	
≥ 20	134	8.50 (1.74)	
Total cholesterol (mg/dL)			
< 200	671	7.97 (1.64)	< 0.001
≥ 200	198	8.78 (2.06)	
HDL cholesterol (mg/dL)			
> 45	360	8.13 (1.74)	0.95
≤ 45	485	8.14 (1.79)	
LDL cholesterol (mg/dL)			
< 100	321	7.93 (1.63)	0.05
≥ 100	541	8.28 (1.85)	
Triglycerides (mg/dL)			
< 150	492	7.99 (1.71)	0.02
≥ 150	380	8.36 (1.85)	
Retinopathy			
Retinopathy	326	8.58 (1.79)	< 0.001
No retinopathy	649	7.96 (1.76)	
Proteinurea			
Proteinurea	307	8.50 (1.90)	< 0.001
No proteinurea	628	8.03 (1.73)	
Type of treatment			
Oral hypoglycaemics	524	7.87 (1.64)	
Insulin	77	8.47 (1.99)	< 0.001
Insulin & oral hypoglycaemics	367	8.58 (1.86)	
Diet	21	7.27 (1.78)	
Blood pressure (mmHg)			
< 130/80	238	8.10 (1.94)	
≥ 130/80	716	8.21 (1.73)	0.4
BMI (kg/m²)			
< 25	86	8.25 (2.23)	0.01
25–29	335	7.91 (1.70)	
30–34	328	8.37 (1.71)	
≥ 35	244	8.27 (1.82)	

[a]*Not all proportions add up to 1000 due to some missing values.*
SD = standard deviation; HDL = high-density lipoprotein; LDL = low-density lipoprotein; BMI = body mass index.

Table 5 Glycosylated haemoglobin (HbA1c) levels of diabetic patients at the first clinic visit and 12-month follow-up (*n* = 886)

HbA1c (%)	Baseline		12-month follow-up		*P*-value
	No. of patients	%	No. of patients	%	
< 7	225	25.4	244	27.5	< 0.001
7–7.9	266	30.0	302	34.1	
8–9.9	260	29.3	287	32.4	
≥ 10	135	15.2	53	6.0	

glycaemic control in our study is inconsistent with the findings of a number of studies [2,19] which reported that younger age was associated with poorer glycaemic control [19]. As in other studies, patients treated with insulin, or a combination of insulin and hypoglycaemic agents, were found to have poorer glycaemic control [2,19,21]. This may be related to the fact that patients treated by insulin or combination therapy have more severe disease that requires more aggressive treatment to control their disease, while patients with milder disease are more easily controlled by diet or oral hypoglycaemic agents.

Our study also concurs with others that showed a significant positive relationship between HbA1c and elevated total and LDL cholesterol [2,19,22]. In our sample, 75.8% of patients had uncontrolled DM, as indicated by HbA1c ≥ 7%. Although high TG and low HDL represent the typical pattern of diabetic dyslipidaemia, such a pattern was not evident in our study, probably because the patients had been treated with lipid-lowering drugs. Because of the multiplicative cardiovascular risk of hyperglycaemia and dyslipidaemia, lipid abnormalities should be treated aggressively as part of a comprehensive DM care programme.

Factors related to greater improvement in HbA1c levels at follow-up in our study included higher initial HbA1c, shorter duration of DM and lower BMI. To our knowledge, this is the first study in Jordan to report on changes in HbA1c level during a follow-up period.

Limitations

Several limitations affect the generalizability of our study findings to all diabetic patients in Jordan. This study used convenience sampling and, although patients receiving care in NCDEG came from all over Jordan, the sample of patients may differ from diabetics in the general population in certain aspects such as socioeconomic status, severity of their disease and health awareness and motivation. It is reasonable to assume that the rate of optimal control in patients treated outside the centre is lower.

Patients with only 1 prior visit to the clinic were excluded and therefore patients who lived outside Amman may have been less likely to meet the inclusion criteria of having attended NCDEG more than twice, creating a selection bias between residents of Amman and those outside of Amman. Thus, patients with poor metabolic control or less interest in their disease may have been excluded.

The use of secondary data is associated with inherent limitations because study variables that are desirable to know may not be contained in the data. Detailed data about some aspects of patient management at baseline were not available in this study. Such data, such as changes in drug management, could account the improvements in HbA1c levels. Such details would be useful to assess in future studies.

Certain important aspects were not available to the us in this study, such as physical activity levels and compliance of patients with the treatment protocol; both are likely to influence glycaemic control. To clarify these limitations a prospective longitudinal study is needed that includes all patients attending NCDEG, information about distance of travel to the centre and other variables, a longer follow-up period than the current 12 months and more comprehensive information on all relevant variables.

Nevertheless, this study had multiple strengths. The study objectives were achieved at in a short time at relatively low cost and. Important research questions were answered using the rich and complete data source of the medical records of NCDEG.

Table 6 Multivariate linear regression analysis of factors related to changes in glycosylated haemoglobin (HbA1c) levels of diabetic patients between the first clinic visit and 12-month follow-up (*n* = 882)

Variable	β regression coefficient	*P*-value
HbA1c level	0.70	< 0.001
Duration of diabetes	–0.16	< 0.001
BMI	–0.09	< 0.001

BMI = body mass index.

Conclusions

The proportion of optimal glycaemic control among the study population at 12-month follow up (27.7%) was comparable to that reported from many countries. Extremely inadequate control (HbA1c ≥ 10%) was rare among the sample. Factors related to better glycaemic control at 12 months after the first clinic visit included male sex, shorter duration of diabetes and lower levels of total cholesterol, LDL cholesterol and TG. Multivariate linear regression analysis showed that factors related to greater changes in HbA1c level included higher initial HbA1c, shorter duration of DM and lower BMI.

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