Factors associated with poor glycemic control among patients with Type 2 diabetes

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Abstract

Objectives: Determine factors associated with poor glycemic control among Jordanian patients with Type 2 diabetes. **Methods:** A systematic random sample of 917 patients was selected from all patients with Type 2 diabetes over a period of 6 months in 2008. A prestructured questionnaire sought information about sociodemographic, clinical characteristics, self-care management behaviours, medication adherence, barriers to adherence, and attitude towards diabetes. Weight, height, and waist circumferences were measured. All available last readings of hemoglobin A1c (HbA1c), fasting blood sugar measurements and lipid were abstracted from patients' records. Poor glycemic control was defined as HbA1c ≥7%. **Results:** Of the total 917 patients, 65.1% had HbA1c ≥7%. In the multivariate analysis, increased duration of diabetes (>7 years vs. ≤7years) (OR=1.99, P≤.0005), not following eating plan as recommended by dietitians (OR=2.98, P≤.0005), negative attitude towards diabetes, and increased barriers to adherence scale scores were significantly associated with increased odds of poor glycemic control. **Conclusion:** The proportion of patients with poor glycemic control was high, which was nearly comparable to that reported from many countries. Longer duration of diabetes and not adherent to diabetes self-care management behaviors were associated with poor glycemic control. An educational program that emphasizes lifestyle modification with importance of adherence to treatment regimen would be of great benefit in glycemic control.
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1. Introduction

Diabetes mellitus is a major cause of morbidity and mortality. In a recent study in Jordan, the age-standardized prevalence of diabetes mellitus (DM) and impaired fasting glucose were 17.1% and 7.8%, respectively (Ajlouni, Khader, Batieha, Ajlouni, & EL-khateeb, 2008). In the Arab region, the overall prevalence of DM in the Kingdom of Saudi Arabia is 23.7% among people with age between 30 and 70 years (Al-Nozha et al., 2004). The prevalence of diabetes in the United Arab Emirates, Bahrain, and Kuwait were 20.1%, 14.9% and 12.8%, respectively (International Diabetes Foundation, 2003).

Several large clinical trials have demonstrated that tight blood glucose control correlates with a reduction in the microvascular complications of diabetes (The Diabetes Control and Complications Trial Research Group, 1993; UK Prospective Diabetes Study (UKPDS) Group, 1998). The American Diabetes Association (ADA) has designated HbA1c level of <7% as a goal of optimal blood glucose control (American Diabetes Association, 2003), and the American Association of Clinical Endocrinologist has further recommended HbA1c level of <6.5% (The American

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Association of Clinical Endocrinologists medical guidelines for the management of diabetes mellitus, 2002). Despite the evidence from large randomized controlled trials establishing the benefit of intensive diabetes management in reducing microvascular and macrovascular complications (Saadine et al., 2002; Stratton et al., 2000; UK Prospective Diabetes Study (UKPDS) Group, 1998), high proportion of patients remain poorly controlled (Karter et al., 2005). Poor and inadequate glycemic control among patients with Type 2 diabetes constitutes a major public health problem and major risk factor for the development of diabetes complications. Glycemic control remains the major therapeutic objective for prevention of target organ damage and other complications arising from diabetes (Koro, Bowlin, Bourgeois, & Fedder, 2004).

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 (Wallace & Matthews, 2000). Both patient- and health care provider-related factors may contribute to poor glycemic control (Rhee et al., 2005; Wallace & Matthews, 2000). This study was conducted to determine factors associated with poor glycemic control among patients with Type 2 diabetes who attended the National Center for Diabetes, Endocrinology, and Genetics (NCDEG) in Jordan.

2. Methods

2.1. Participants

A systematic random sample (every third patient) of 917 patients was selected from all patients with Type 2 diabetes who attended NCDEG over a period of 6 months in 2008. In systematic random sampling, a number within the sampling interval was chosen. We chose a random number between 1 and 10 using random number tables. Then every third person aged 18 years or above following the first number chosen was selected each day for the whole study period. Participants were informed about the objective of the study. Based on their approval, participants were asked to read carefully and sign a consent form. Patients with Type 1 DM were excluded from the study.

2.2. Data collection

This study was approved by the NCDEG ethical committee. Personal interview was held to collect data including age, gender, level of education, income, occupation (employed, not employed), and duration of diabetes. Self-care management behaviours were collected to assess the adherence to diabetes regimens that included diet, physical exercise, and blood glucose testing. Medication adherence was measured using a validated index proposed by Choo, Rand, Inui, Lee, and Platt (1999). Barriers to adherence were assessed by a scale that was developed by

Glasgow, Maccaul, and Schafer (1986). The scale consisted of 15 items. Respondents were asked to rate how frequently they experience various barriers to self care activity using a seven-point scale that ranges from 1 (very rarely) to 7 (daily). The scale was scored by averaging the responses across the items. Higher scores indicate a higher frequency of barriers to regimen behavior.

Attitude towards diabetes was assessed using attitude towards diabetes scale, which was developed by Fitzgerald et al. (1996). The scale consists of 10 items. The first six items have been negatively worded, which required reverse scoring. Each item was rated on a five-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree). The total score ranged from a minimum score of 10 to a maximum score of 50. A higher score on the scale indicates negative attitude towards diabetes and that the patient would have possible problems adapting with diabetes on a daily basis. Family and friend support about diabetes and its management was measured by family and friend support scale, which was developed by Fitzgerald et al. (1996). The scale consists of 11 items. Two items have been negatively worded which required reverse scoring. Each item was rated on five-point Likert scale from 1 representing the least supportive response to 5 representing the most supportive response. The total scores range from a minimum score of 11 to a maximum score of 55. Generally, the higher scores in the scale indicate more family and friend support about diabetes and its management.

Weight, height, and waist circumferences were measured while the subject wearing light clothes and taking the shoes off. Weight was taken to the nearest 0.5 kg, and height was taken to the nearest 0.5 cm. Body mass index (BMI) was calculated as weight in kilograms divided by height in meter squared. Blood pressure was measured using standardized sphygmomanometers EN 1060 (RIESTER). Trained nurse performed the procedure while the patient in a sitting position with the arm at the level of the heart and after 5 min of rest.

All available last readings of HbA1c, fasting blood sugar measurements, and lipid profile [high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglyceride, and cholesterol] were abstracted from patients' records. Lipid profile was analyzed using the automated spectrophotometer, COBAS INTEGRA, and HbA1c was analyzed using high-performance liquid chromatography.

2.3. Operational definition

The diagnosis of DM was reached according to the ADA criteria (American Diabetes Association, 2007). Duration of diabetes in years since diagnosis of diabetes was categorized as ≤7 and >7 years. People with systolic/diastolic blood pressure levels ≥130/80 mmHg or who were on antihypertensive medication were defined as having hypertension (American Diabetes Association, 2007). BMI was categorized as normal if BMI was <25 kg/m², overweight if BMI

was 25–29.9 kg/m^2, and obese if BMI was ≥30 kg/m^2 (World Health Organization, 1995). Glycemic status was categorized as good glycemic control if HbA1c <7% and poor glycemic control if HbA1c ≥7% (American Diabetes Association, 2007).

Criteria for abnormal lipid profile levels were based on the ADA criteria (American Diabetes Association, 2004). Hypercholesterolemia refers to a total cholesterol level ≥200 mg/dl. HDL was considered low when the level is <40 mg/dl in males and <50 mg/dl in females. LDL was considered high when the level is ≥100 mg/dl. Hyper-triglyceridemia refers to a level ≥150 mg/dl. Dyslipidemia was defined as the presence of one or more of the previous abnormalities in serum lipids. Patient's receiving medications for any of the above conditions were classified as having the condition.

Following an eating plan as recommended by the dietitian indicated that patients were following the eating plan 3 days or more in the previous 7 days. Patients were considered being engaged, at least 30 min, in physical exercise if they walked 3 days or more in the previous 7 days. Self-monitoring blood glucose was defined if patients performed home glucose monitoring for 5 days or more in the previous 7 days. Patients were classified as highly adherent if they never missed their medications in the previous 7 days and not adherent if they missed their medications once or more in the previous 7 days.

2.4. Statistical analysis

Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS, version 11.5). Data were described using mean (S.D.) for continuous variables and proportions for categorical variables. Chi-square test was used to assess statistical significance of the difference in the percentages of poor glycemic control according to independent categorical variables. Binary logistic regression was conducted to determine factors that are associated with poor glycemic control. A P value <.05 was considered statistically significant.

3. Results

3.1. Participants' characteristic

This study included a total of 917 patients (455 men and 462 women) with Type 2 DM aged between 24 and 84 years, with a mean (S.D.) of 57.4 (9.6) years. Only 11% of patients were illiterate. More than half of the patients (68.5 %) were not employed. About 19.7% were current smoker. Their clinical, anthropometric, and relevant characteristics are shown in Table 1. About 62.3% of patients were on oral antidiabetic agents, 32.0% of patients were on combination of oral antidiabetic agents and insulin and only 5.7% of patients were on insulin alone.

Table 1
Anthropometric, clinical, and relevant characteristics of participants

Variable	n (%)
BMI, mean (S.D.)=31.8 (5.7)	
Normal	82 (9.0)
Over weight	303 (33)
Obesity	532 (58)
Hypertension	
Yes	705 (76.9)
No	212 (23.1)
Dyslipidemia	
Yes	744 (81.1)
No	173 (18.9)
Cholesterol (mg/dl), mean (S.D.)=163.4 (36.1)	
≥200	137 (14.9)
<200	780 (85.1)
Triglyceride (mg/dl), mean (S.D.)=152.5 (71.3)	
≥150	387 (42.2)
<150	530 (57.8)
Low density lipoprotein (mg/dl), mean (S.D.)=102.6 (31.1)	
≥100	434 (47.3)
<100	483 (52.7)
High density lipoprotein (mg/dl), male: mean (S.D.)=40.1 (9.7)	
≥40	220 (48.4)
<40	235 (51.6)
High density lipoprotein (mg/dl), female: mean (S.D.)=47.1 (12.1)	
≥50	184 (39.8)
<50	278 (60.2)
Duration of DM (year), mean (S.D.)=9.03 (7.04)	
>7	451 (49.2)
≤7	466 (50.8)

3.2. Self-care management behaviors

About 81.4% of patients did not follow diabetic meal plan as recommended by the dietitians. Two thirds (67.9%) of patients did not participate in physical exercise. Only 38.1% of patients used to test their blood sugar at home. Most of the patients (91.9%) were highly adherent to their medications. Most patients (91.1%) reported having family support about diabetes and its management.

3.3. Glycemic control

Of the total 917 patients, 65.1% had HbA1c ≥7%. Table 2 shows the proportion of patients with poor glycemic control according to demographic, anthropometric, and clinical characteristics. Diabetes was more likely to be poorly controlled among those with increased duration of diabetes, lower level of education, higher BMI, hypercholesterolemia, hypertriglyceridemia, and elevated LDL. The highest level of poor glycemic control was among patients on combination of oral antidiabetic agent and insulin (92.5%). Table 3 shows the proportion of patients with poor glycemic control according to diabetes self-care management behaviors. Poor glycemic control was more common among patients who did not follow dietary regimens, did not practice any physical activity, who were not adherent for medications and did not regularly perform home glucose monitoring.

Table 2
Proportion of patients with poor glycemic control according to demographic, anthropometric and clinical characteristics

Variable	Total	n (%)	P
Gender			.201
Male	455	287 (63.4)	
Female	462	310 (67.1)	
Age (year)			.734
<50	172	108 (62.8)	
50-59	312	207 (66.3)	
≥60	433	282 (65.1)	
Level of education			<.0005
Illiterate	101	76 (75.2)	
≤High school	317	225 (71.0)	
>High school	499	296 (59.3)	
Body mass index (kg/m²)			.003
Normal	82	46 (56.1)	
Overweight	303	181 (59.7)	
Obesity	532	370 (69.5)	
Duration of diabetes (year)			<.0005
≤7	466	233 (50.0)	
>7	451	364 (80.7)	
Type of diabetic treatment			<.0005
OAA alone	571	279 (48.9)	
Insulin alone	52	46 (88.5)	
Combination of OAA and insulin	294	272 (92.5)	
Hypertension			.409
Yes	705	464 (65.8)	
No	212	133 (62.7)	
Cholesterol(mg/dl)			.004
≥200	137	104 (75.9)	
<200	780	493 (63.2)	
Triglyceride(mg/dl)			.017
≥150	387	269 (69.5)	
<150	530	328 (61.9)	
Low density lipoprotein (mg/dl)			.001
≥100	434	307 (70.7)	
<100	483	290 (60.0)	
High density lipoprotein (mg/dl), male ≥40			.497
≥40	220	135 (61.4)	
<40	235	152 (64.7)	
High density lipoprotein (mg/dl), female			.105
≥50	184	115 (62.5)	
<50	278	195 (70.1)	

OAA, oral antidiabetic agents.

Table 3
Proportion of patients with poor glycemic control according to diabetes self-care management behaviors

Variable	Total	n (%)	P
Follow eating plan as recommended by dietitians			
Yes	171	59 (34.5)	<.0005
No	746	538 (72.1)	
Participate in at least 30 minutes of physical exercise			
Yes	294	161 (54.8)	<.0005
No	623	436 (70.1)	
Self-monitoring blood glucose			
Yes	349	178 (51.1)	<.0005
No	568	419 (73.8)	
Medication adherence			
Highly adherent	843	537 (63.7)	.001
Not adherent	74	60 (81.1)	

Table 4
Logistic regression analysis of factors associated with poor glycemic control among patients with Type 2 diabetes

Variable	OR (95% confidence interval)	P
Duration of diabetes (year)		
≤7	1	
>7	1.99 (1.40, 2.82)	<.0005
Treatment modalities		
Oral antidiabetic agents alone	1	
Insulin alone	4.49 (1.81, 11.13)	.001
Oral antidiabetic agents and insulin	7.50 (4.57, 12.31)	<.0005
Following eating plan as recommended by dietitians		
Yes	1	
No	2.98 (1.99, 4.47)	<.0005
Negative attitude towards diabetes [a]	1.04 (1.01, 1.08)	.020
Barriers of adherence [b]	1.02 (1.01, 1.03)	.002

[a] A higher score on the scale indicates that the patient would have possible problems adapting with diabetes on a daily basis.
[b] A higher score indicates a higher frequency of barriers to regimen behavior (taking medication, glucose testing, diet, and exercise).

3.4. Multivariate analysis of factors associated with poor glycemic control

In the multivariate analysis, increased duration of diabetes (>7 vs. ≤7years) (OR=1.99, $P\leq.0005$), not following eating plan as recommended by dietitians (OR=2.98, $P\leq.0005$), negative attitude towards diabetes and increased score of barriers to adherence scale were significantly associated with increased odds of being poorly controlled. Compared to patients who were on oral antidiabetic agents alone, those on other treatment modalities were more likely to be poorly controlled. Insulin in combination with oral antidiabetic agents was associated with increased odds of poor glycemic control (OR=7.50, $P\leq.0005$) (Table 4).

4. Discussion

This study estimated the proportion of patients with Type 2 diabetes who did not achieve target level of HbA1c in NCDEG. Poor glycemic control (HbA1c >7%) was present in 65.1% of patients. In Kuwait, 66.7% of the studied population had HbA1c ≥8% (Al-Sultan & Al-Zanki, 2005). In Saudi Arabia, only 27% of the patients reached target level of glycemic control (Akbar, 2001). In Pakistan (Habib & Aslam, 2003), 46.7% of patients had HbA1c >7.5%. In Trinidad, 85% had HbA1c >7% (Ezenwaka & Offiah, 2001). Furthermore, HbA1c reported from National Health and Nutrition Examination Survey III was >9% in 24.5% of patients (Saaddine et al., 2006). In UK, 69% had HbA1c >7.5% (Fox, Gerber, Bolinder, Chen, & Kumar, 2006).

This study showed that longer duration of diabetes was associated significantly with poor glycemic control. This

finding is consistent with that reported by other studies (Benoit, Fleming, Tsimikas, & Ming, 2005; Valle, Koivisto, Reunanen, Kangas, & Rissanen, 1999; Verma, Paneri, Badi, & Raman, 2006). Longer duration of diabetes is known to be associated with poor control, possibly because of progressive impairment of insulin secretion with time because of B-cell failure, which makes the response to diet alone or oral agents unlikely (UK Prospective Diabetes Study (UKPDS) Group, 1998).

In the present study, patients with poor glycemic control were more likely to be prescribed combination of oral antidiabetic agents and insulin, which may indicate that physicians are attempting multitherapy to provide better disease control. The association between treatment with combination of oral antidiabeticc agents and insulin and poor glycemic control is consistent with other studies (AL-Nuaim et al., 1998; Goudswarrd, Stolk, Zuithoff, & Rutten, 2004; Valle et al., 1999). This finding reflects the fact of deteriorations of diabetes over time, and the need for higher doses or additional mediations increases over time. Therefore, patients who were treated by combination therapy of oral antidiabetic agents and insulin had more progressive disease which required more aggressive treatment to provide glycemic control, but this phenomenon could be attributed to delay in applying insulin in the treatment of patients with poor glycemic control.

The lack of a relationship between age and poor glycemic control in our study is not consistent with the findings of a number of studies (EL-Kebbi et al., 2003; Nichols, Hillier, Javor, & Brown, 2000; Rothenbacher, Ruter, Saam, & Brenner, 2003) which reported that younger age was associated with poor glycemic control.

We found that poor glycemic control was more common among patients who were not adherent for medications. Therefore, patients should be motivated to use the medications as prescribed. In spite of the importance of diet and exercise in control of diabetes, only a small percentage of patients with Type 2 diabetes were adherent to diet regimen and physical activity. Continuous education is recommended to encourage physical activity and diet regimen adherence.

This study was the first study conducted in Jordan 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. At the same time, medication adherence, nutritional intake, testing blood glucose and physical activity were obtained by self-report and may be limited by recall bias.

In conclusion, the proportion of patients with poor glycemic control was high, which is nearly comparable to that reported from many countries. Longer duration of diabetes, and not adherent to diabetes self care management behaviors were associated with poor glycemic control. An educational program that emphasizes lifestyle modification with importance of adherence to treatment regimen would be of great benefit in poor glycemic control.

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