

# Glycemic Control and Its Determinants among Patients with type 2 Diabetes Mellitus Attending a Teaching Hospital

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## Introduction

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia that result from defects in insulin secretion, or action, or both [1]. The prevalence of type 2 diabetes mellitus is rapidly increasing all over the world [2]. The number of people with diabetes is increasing due to population growth, aging, urbanization, and increasing prevalence of obesity and physical inactivity [2]. In the Arab region, the prevalence of type 2 diabetes mellitus in adult populations was reported as 23.7% in the Kingdom of Saudi Arabia, 20.1% in the United Arab Emirates, 20.1% in Bahrain and 14.9%, in Kuwait [3,4]. In Jordan, the incidence of type 2 diabetes mellitus is increasing with an overall prevalence of 17.1% [5]. Glycosylated hemoglobin (HbA1c) as a marker for average blood glucose levels over the previous months prior to the measurement is an important predictor of diabetes complications [5,6]. The role of improved glycemic control in reduction microvascular and neurological complications of diabetes was demonstrated in many observational and randomized controlled clinical trials [6-9].

Although glycemic control and its determinants among patients with type 2 diabetes mellitus in Jordan had been investigated in previous studies [10,11] none of these studies was conducted among patients treated in hospitals. The factors associated with glycemic control in hospital patients may be different from those that would be found in primary care level settings or specialized diabetes centers. Patterns of disease burden, disease complexity, comorbidity, disease outcomes, experiences of health care providers and resource utilization have been shown to differ between primary care settings and hospitals [12,13]. Recognizing the determinants of poor glycemic may contribute to a clearer understanding of modifiable antecedents of diabetes-related complications and may help to achieve improved glycemic control and improve patient function and outcomes. Therefore, this study was conducted to determine the rate of poor glycemic control and its associated factors among patients attending a tertiary teaching hospital in the north of Jordan.

## Subjects and Methods

### Study design and patients

A cross-sectional design was conducted among patients with type 2 diabetes mellitus aged 18 years and above, who attended diabetes outpatient clinics at the King Abdullah University Hospital (KAUH) in the north of Jordan in the period between June, 2008 and December, 2008. KAUH is a teaching hospital that provides secondary and tertiary health care services to more than 1 million inhabitants in the north of Jordan. A systematic random sample of 533 patients was selected during the study period. Every third patient attended the clinic in each working day was invited to participate in the study. Only patients taking a combination of oral hypoglycemic agents and insulin were included in this study. All invited patients agreed to participate in this study.

## Instruments

Six questionnaires were used to collect the necessary information about factors that might affect the glycemic control. The first questionnaire sought information about socio-demographic and relevant characteristics including age, gender, and onset and duration of type 2 diabetes mellitus. Information related to patient's self-care behaviors and other variables that may influence an individual's ability and willingness to provide diabetes self-care were collected using different questionnaires including: Diabetes Knowledge Test questionnaire [14], Attitude Toward Diabetes Scale (Positive Attitude Scale and Negative Attitude Scale) [15], Family and Friends' Support Scale [15], Long-Term Care Benefits Scale [15], and Self-Care Adherence Scale of the Diabetes Care Profile (DCP) [15]. In this study a symmetrical back-translation method was used to translate all study questionnaires. Higher scores on the Diabetes Knowledge Test questionnaire indicate higher levels of patient's knowledge about diabetes and its care. A higher score on the Positive Attitude Scale indicate that the patient would have positive coping in dealing with type 2 diabetes mellitus on a daily basis. High scores on the Negative Attitude Scale indicate perception of more maladaptation of the patient toward the diabetes and its treatment. Higher scores on the Family and Friends' Support Scale indicate the patients' perception of more family and friends' support about diabetes and its management. A higher score on the Long-Term Care Benefits Scale indicates that the patient's health beliefs were directed toward a positive outlook on recommended health regimens of type 2 diabetes mellitus in preventing or delay. A higher score of Self-Care Adherence Scale indicates the patients were compliant with recommended health regimens most of the time (see the appendix for some of the questions on the questionnaires).

## Laboratory and anthropometric measurements

The last readings of HbA1c were abstracted from patient's records. All abstracted last readings were measured 1 to 5 months before the date of data abstraction. In the laboratory, HbA1c was analyzed by suitable tubes (EDTA tubes) on Hitachi 917 analyzer (Roche) which is based on the turbidimetric inhibition immunoassay (TINIA) for hemolyzed

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whole blood. Glycemic status was categorized as good glycemic control if HbA1c < 7% and poor glycemic control if HbA1c ≥ 7% [6,7]. Weight and height were measured with light clothes and taking the shoes off. Weight was taken to the nearest 0.5 kilogram and height was taken to the nearest centimeter. Body mass index (BMI) was calculated as the ratio of weight in kilograms to the square of height in meters.

### Statistical analyses

Data were entered into computer using the Statistical Package for Social Sciences software, SPSS (SPSS Inc., Chicago, IL, USA) version 15. Data were described using means, standard deviation and proportions wherever appropriate. Differences in rate of poor glycemic control according to clinical and categorical variables were analyzed using chi-square test. Differences in means between controlled (HbA1c <7%) and not controlled (HbA1c ≥ 7%) were analyzed using t-test. Multiple binary logistic regressions were used to determine factors associated with poor glycemic control. Backward stepwise elimination method

Variable	n	(%)
<b>Sex</b>		
Male	203	(38.1)
Female	330	(61.9)
<b>Age</b>		
< 40	118	(22.1)
40-49	140	(26.3)
50-59	134	(25.1)
≥ 60	141	(26.5)
<b>Marital Status</b>		
Married	409	(76.7)
Not Married	124	(23.3)
<b>Family size</b>		
≤ 5	236	(44.3)
> 5	297	(55.7)
<b>Education</b>		
≤ 6	245	(46.0)
7-12	196	(36.8)
> 12	92	(17.3)
<b>Employment Status</b>		
Employed	216	(40.5)
Not Employed	317	(59.5)
<b>Smoking</b>		
Yes	128	(24.0)
No	405	(76.0)
<b>Body Mass Index</b>		
Normal	97	(18.2)
Overweight	317	(54.5)
Obesity	119	(22.3)
<b>Family History</b>		
Yes	477	(89.5)
No	56	(10.5)
<b>Duration</b>		
≤ 10	256	(48.0)
>10	277	(52.0)
<b>HbA1c</b>		
< 7%	258	(48.4)
≥ 7%	275	(51.6)
<b>Visit to doctors</b>		
Every month	203	(38.1)
Every two months	330	(61.9)
<b>Heart disease</b>		
No	313	(58.7)
Yes	220	(41.3)
<b>Renal Disease</b>		
No	487	(91.4)
Yes	46	(8.6)

**Table 1:** The socio-demographic, clinical, and relevant characteristics of 533 patients with type 2 diabetes mellitus who attended a teaching hospital in the north of Jordan.

Variable	HbA1c <7		HbA1c ≥ 7		P- value
	n	(%)	n	(%)	
<b>Sex</b>					
Male	90	(44.3)	113	(55.7)	0.140
Female	168	(50.9)	102	(49.1)	
<b>Age</b>					0.875
< 40	60	(50.8)	58	(49.2)	
40-49	65	(46.4)	75	(53.6)	
50-59	63	(47.0)	71	(53.0)	
60+	70	(49.6)	71	(50.4)	
<b>Marital Status</b>					0.307
Married	193	(47.2)	216	(52.8)	
Not Married	65	(52.4)	59	(47.6)	
<b>Family size</b>					0.696
≤ 5	112	(47.5)	124	(52.5)	
> 5	146	(49.2)	151	(50.8)	
<b>Education</b>					0.716
≤ 6	123	(50.2)	122	(49.8)	
7-12	93	(47.4)	103	(52.6)	
> 12	42	(45.7)	50	(54.3)	
<b>Employment Status</b>					0.530
Employed	101	(46.8)	115	(53.2)	
Not Employed	157	(49.5)	160	(50.5)	
<b>Smoking</b>					0.227
Yes	202	(49.9)	203	(50.1)	
No	56	(43.8)	72	(56.3)	
<b>Body Mass Index</b>					0.809
Normal	46	(47.4)	51	(52.6)	
Overweight	157	(49.5)	160	(50.5)	
Obesity	55	(46.2)	64	(53.8)	
<b>Family History</b>					0.754
Yes	232	(48.6)	245	(51.4)	
No	26	(46.4)	30	(53.6)	
<b>Duration</b>					0.023
≤ 10	137	(53.5)	119	(46.5)	
>10	121	(43.7)	156	(56.3)	
<b>Visit to doctor</b>					0.447
Every month	94	(46.3)	109	(53.7)	
Every two months	164	(49.2)	166	(50.3)	
<b>Heart disease</b>					0.427
No	147	(47.0)	166	(53.0)	
Yes	111	(50.5)	109	(49.5)	
<b>Renal Disease</b>					0.593
No	234	(48.0)	253	(52.0)	
Yes	24	(52.2)	22	(47.8)	

**Table 2:** The rate of poor glycemic control according to socio-demographic, clinical, and relevant characteristic of patients.

was used to reach the “best fitting model” that includes the significant variables only. A P-value of <0.05 was considered statistically significant.

## Results

### Patients’ characteristics

This study included a total of 533 (203 males and 330 females) patients with type 2 diabetes mellitus. Their age ranged from 18 to 79 years with a mean (SD) of 50.1 (14.1). The BMI values ranged from 18.9 to 41.2 kg/m<sup>2</sup> with a mean (SD) of 27.6 (3.5) kg/m<sup>2</sup>. More than half of participants (59.5%) were unemployed and 17.3% had more than 12 years of education. The majority of participants (89.5%) had a family history of diabetes and 52.0% had diabetes for duration of more than 10 years. The participants’ socio-demographic, clinical, and relevant characteristics are shown in Table 1.

### The rate of poor glycemic control

Of the total 533 patients with type 2 diabetes, 51.6% had poor glycemic control. Table 2 shows the rate of poor glycemic control according to socio-demographic, clinical, and relevant characteristic of

participants. The rate of poor glycemic control among patients having diabetes for more than 10 years (56.3%) was significantly higher than that among those having diabetes for 10 years or less (46.5%). The rate of poor glycemic control did not differ significantly among patients according to their other characteristics.

### Glycemic control and diabetes related variables

Table 3 presents the differences in the mean scores of knowledge of diabetes scale, attitude toward diabetes scale, perceived family and friends support scale, benefits of treatment scale, and adherence with health regimens scale between patients according to their glycemic control. Patients with poor glycemic control did not differ significantly in their knowledge of diabetes, attitude toward diabetes, perceived family and friend support, long term benefit score, and self care adherence score.

### Multivariate analysis of factors associated with poor glycemic control

In the multivariate analysis (Table 4), the only variables that were significantly associated with poor glycemic control were duration of diabetes and family support score. Patients with duration of diabetes of more than 10 years had higher odds of poor glycemic control (OR=1.53; 95% CI: 1.09, 2.17) compared to those with duration of 10 years or less. Increased family and friend support score was associated with decreased odds of poor glycemic control (OR=0.96; 95% CI: 0.93, 0.98).

### Discussion

More than half (51.6%) of participants with type 2 diabetes mellitus had poor glycemic control. This finding is similar to that reported in Saudi Arabia where half of the studied populations had poor glycemic control [16,17]. In Bahrain, 78.2% of diabetic patients had poor glycemic control [18]. In USA, data from National Health and Nutrition Examination Surveys (1988-1994 and 1999-2002) reported that 42% and 50% of people with diabetes respectively met the HbA1c target of 7% [19,20]. In the United Kingdom (UK), a series of retrospective analysis of data found that 79% and 76% of patients in 1998 and 2002, respectively had inadequate glycemic control with HbA1c >7.5% [21]. In other studies in Jordan, Khattab et al. [11] reported that 65.1% of

the diabetic patients attending the National Center for Diabetes, Endocrinology and Genetics (NCDEG) had HbA1c  $\geq$  7%. While, Al Omari et al. [10] reported that 43.9% of the patients who attended the diabetic clinic at the primary care level in the university teaching family health centre had HbA1c  $\geq$  7%. The lower rate of poor glycemic among patients treated at the primary care level may be explained by that primary health care settings treat patients with medical conditions before they become serious enough to require hospitalization or emergency treatment. In the university teaching family health centre, there is close follow up in the clinic and continuity of care is ensured as the patient has to see the physician to take the prescription which prescribed on monthly basis. Besides the proper counseling and teaching of diabetic patients in the clinic there is regular group counseling with the presence of family physicians, nurses, pharmacist and dietitian. This approach had been shown to enhance the patient-doctor relationship and to have a positive effect on the compliance of the patient. On the other hand, the majority of patients treated in NCDEG are referred from hospital and medical centers to receive the specialized diabetes care. Being a referral specialized center might explain the higher rate of poor glycemic control compared to that in other setting in Jordan.

Previous studies had found conflicting results on factors associated with poor glycemic control. This may be explained by the differences in study designs, characteristics of the study populations, and the types of treatment facilities. Furthermore, this may be explained by differences in race and ethnicity of the studied populations. Dosage for oral medication or insulin, compliance with regimens, self-monitoring of blood glucose, and socio-economic status may differ by race/ethnic group leading to greater improvements in control in some groups but not in others. Socio-economic status may influence diabetes management and control since it is often associated with access to health care, healthcare utilization, use of medication, and access to good nutrition.

The current study showed that patients with duration of diabetes of more than 10 years were more likely to have poor glycemic control compared to those with duration of 10 years or less. This finding is consistent with that reported in previous studies where longer duration of diagnosed diabetes was associated with increased HbA1c values [22-24]. This might be explained by that the amount of carbohydrate attached to the HbA1c increases with increasing duration of the disease [25]. The United Kingdom Prospective Diabetes Study (UKPDS) [26] and the Belfast Diet Study [27] showed that beta cell function decreased during the 5 to 10 years after diagnosis of diabetes which lead to decreases in insulin.

Increased family and friend support score was shown in this study to be associated with decreased odds of poor glycemic control. This finding is in agreement with the findings of others. Delamater et al. [28] have shown that low levels of conflict, high levels of cohesion and organization, and good communication patterns are associated with better regimen adherence. Furthermore, McDonald et al. [29] found that social support may enhance diabetes mellitus management and Gilliland et al. [30] reported that those exposed to treatment entailing social support maintain steady HbA1c level. Thompson et al. [31] and Harris [32] found that greater level of social support from spouses and other family members are associated with better adherence with health regimen. Winkler et al. [33] found social support also serves to buffer the adverse effect of stress on diabetes management. On the other hand, Chlebowy et al. [34] found that social support was not significantly associated with glycemic control among Caucasians and African Americans.

	HBA1c <7		HBA1c $\geq$ 7		P-value
	Mean	SD	Mean	SD	
Knowledge of diabetes test	7.5	1.9	7.4	1.9	0.297
Positive attitude toward diabetes	6.9	2.8	6.7	2.8	0.281
Negative attitude toward diabetes	20.0	5.1	20.4	5.0	0.469
Perceived family and friend support	44.3	5.2	43.4	5.0	0.062
Long term benefit	20.3	3.9	2.3	4.4	0.861
Self care adherence	13.4	2.4	13.7	2.9	0.235

**Table 3:** The difference in the means scores of knowledge of diabetes scale, attitude toward diabetes scale, perceived family and friends support scale, benefits of treatment scale, and adherence with health regimens scale between patients according to their glycemic control.

Variable	OR (95%, CI)	P-value
<b>Duration of diabetes</b>		
≤ 10 years	1	0.015
> 10 years	1.53 (1.09, 2.17)	
<b>Family and friend support score</b>	0.96 (0.93, 0.98)	0.037

**Table 4:** Multivariate analysis of factors associated with poor glycemic control among patients with type 2 diabetes mellitus.

In the present study, knowledge, attitude, and self-care adherence were not found to have significant relationships with glycemic control. The finding is similar to the findings of other authors who found that there was no correlation between knowledge [35] and attitude [36] with glycemic control. However, other studies [37-39] found that diabetes knowledge, attitude and adherence to health regimens were associated with glycemic control. Lack of relationships among age and gender and poor glycemic control in our study is consistent with Shani et al. [40] who found neither age nor gender were related to the achievement of good glycemic control. Moreira et al. [41] found that gender was not associated with improved glycemic control. However, Wahba and Chang [42] found that older patients had better improvements in HbA1c.

In conclusion, the proportion of poor glycemic control among patients with type 2 diabetes mellitus in KAUH is relatively high. Duration of diabetes of more than 10 years and decreased family support score were associated with poor glycemic control. Educational programs that emphasize lifestyle modification with emphasis on family support are encouraged.

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