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Factors Associated With Poor Glycemic Control Among Patients With Type 2 Diabetes Miletus In Makkah

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Abstract:

***Objectives**: Determine factors associated with poor glycemic control among patients with Type 2 diabetes in Makkah hospitals. **Methods**: A systematic random sample of 611 patients was selected from all patients with Type 2 diabetes over a period of 6 months in 2022 (April to October 2022). A restructured questionnaire sought information about sociodemographic, clinical characteristics, self-care management behaviors, medication adherence, barriers to adherence, and attitudes toward diabetes. Weight, height, and waist circumferences were measured. All available last readings of hemoglobin A1c (HbA1c), fasting blood sugar measurements, and lipids were abstracted from patients' records. Poor glycemic control was defined as HbA1c ≥6.5%. **Results**: Of the total 611patients, 66.6% had HbA1c ≥6.5%. In the multivariate analysis, increased duration of diabetes (N7 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 (OR=1.04, P=.020, and increased barriers to adherence scale scores were significantly associated with increased odds of poor glycemic control(OR= 1.02, P=.002). **Conclusion**: The proportion of patients with poor glycemic control was high, which was comparable to that reported from many previous studies. Longer duration of diabetes and not adherent to diabetes self-care man[1]agement behaviors were associated with poor glycemic control. **Recommendation**: An educational program that emphasizes lifestyle modification with the importance of adherence to treatment regimen would be of great benefit in glycemic control*

***Key words:** Diabetes; Glycemic control.*

Introduction:

Diabetes is a chronic illness that requires continuing medical care and education to prevent acute complications and to reduce the risk of long-term complication.1 Poor glycemic control is the most common cause of hospital admissions in diabetics 2. More than 135 million people worldwide had diabetes mellitus (DM) in 1995, which are approximately

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4% of the global population. Approximately 300 million people are expected to have the disease by 2025 (5.4%). (**Habib, S. S., & Aslam, M., 2003**).

Diabetes mellitus is a major cause of morbidity and mortality. In a recent study in Sana'a, 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 highest comparative diabetes prevalence rates in 2021 are reported in Pakistan (30.8%), French Polynesia (25.2%) and Kuwait (24.9%) (Table 3.5). These countries are also expected to have the highest overall comparative diabetes prevalence in 2045, with figures in Pakistan reaching 33.6%, Kuwait 29.8% and French Polynesia 28.2%. (**International Diabetes Federation, 2021)**.

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 6.5% as a goal of optimal blood glucose control (**American Diabetes Association, 2013**), and the American Association of Clinical Endocrinologists has further recommended HbA1c level of b6.5% (**The American Association of Clinical Endocrinologists medical guidelines for the management of diabetes mellitus, 2012**). 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**), a 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 a major risk factor for the development of diabetes complications. Glycemic control remains the major therapeutic objective for the 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 healthcare- provider-related factors may contribute to poor glycemic control(**Rhee et al., 2005; Wallace & Matthews, 2020**). Risk factors of Diabetes mellitus type-2 are family history of diabetes mellitus, previous gestational diabetes mellitus history, old age, obesity, type of diet and lack of physical exercise (**Muhammad Farman and Khansa Ghaffar,2019**). Prevention and treatment involve a healthy diet, and physical exercise **(Shouip Hossam A., 2014)**. This study was **conducted** to determine factors associated with poor glycemic control among patients with Type 2 diabetes who attended the Al-Thawra Hospital in Sana'a city.

Methodology Study design

Cross-sectional study was used to achieve the aim of the study.

Study setting
This study is a cross sectional study that was conducted in Makkah hospitals

Aim of the study:

Determine factors associated with poor glycemic control among patients with Type 2 diabetes in Makkah hospitals

Pilot study

A pilot study was carried out on (30) (5%) patients in Makkah hospitals before the period of data collection. It was done to test the clarity and practicability of the tools. The results of the data obtained from the pilot study should help in the modification of the tools, items have been modified and corrected as needed.

Participants

A Convenience sample was used to include 611 patients according to the following inclusion criteria: gender, age, employee, level of education, Body Max Index (BMI), duration of diabetics, Type of treatment. The data was collected from April 2022 to October 2022. The length of data collection period to ensure the representativeness. 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.

Data collection

This study was approved by the ethical committee. Personal interview was held to collect data including age, gender, level of education, occupation (employed, not employed), and duration of diabetes. Self-care management behaviors were collected to assess 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**). 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 the 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 a negative attitude towards diabetes and that the patient would have possible problems adapting with diabetes daily.

Family and friend support for diabetes and its management was measured by the 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 a 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 on the scale indicate more family and friend support for 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 meters squared. Blood pressure was measured using standardized mercury sphygmomanometers. A trainee nurse performed the procedure while the patient was in a sitting position with the arm at the level of the heart and after 10 minutes 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. The lipid profile was analyzed using

the automated spectrophotometer, and HbA1c was analyzed using high-performance liquid chromatography.

Operational definition

The diagnosis of DM was reached according to the ADA criteria (**American Diabetes Association, 2013**). Duration of diabetes in years since diagnosis of diabetes was categorized as ≤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, 2013**). BMI was categorized as normal if BMI was 25 kg/m2, overweight if BMI was 25–29.9 kg/m2, and obese if BMI was ≥30 kg/m2 (**World Health Organization, 1995**). Glycemic status was categorized as good glycemic control if HbA1c 6.5% and poor glycemic control if HbA1c ≥6.5% (**American Diabetes Association, 2013**).

Criteria for abnormal lipid profile levels were based on the ADA criteria (**American Diabetes Association, 2020**). Hypercholesterolemia refers to a total cholesterol level ≥200 mg/dl. HDL was considered low when the level was 40 mg/dl in males and 50 mg/dl in females. LDL was considered high when the level was ≥100 mg/dl. Hypertriglyceridemia refers to a level ≥150 mg/dl. Dyslipidemia was defined as the presence of one or more of the previous abnormalities in serum lipids. Patients 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 for 3 days or more in the previous 7 days. Patients were 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.

Statistical analysis

Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS, version 21). Data were described using mean (SD) for continuous variables and proportions for categorical variables. The chi-square test was used to assess the 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. The P- value of 0.05 was considered statistically significant

Results:

Participants' characteristic

This study included a total of 611patients (302 men and 309 women) with Type 2 DM aged between 24 and 84 years, with a mean (S.D.) of 52.2 (9.1) years. More than half (54.5%) of patientswere illiterate. More than two third (75.1%) of the patients were not employed. Their clinical, anthropometric, and relevant characteristics are shown in Table 1. Nearly four-fifths (77.7%) of patients suffer of hypertension, more than half (58.9) of patients are overweight according to BMI, four-fifths (78.9%) of patients complain of dyslipidemia, and less than one-fifth (14.6%) of patients have high cholesterol more than 200 mg/dL. About 62.4% of patients were on oral antidiabetic agents, 32.0% of patients were on combination of oral antidiabetic agents and insulin and only 5.6% of patients were on insulin alone.

Variable	n	(%)
BMI, mean (S.D.) = 31.8 (5.7)		

Normal	201	32.9
Overweight	355	58.1
Obesity	55	9
Hypertension		
Yes	475	77.7
No	136	22.3
Dyslipidemia		
Yes	482	78.9
No	129	21.1
Cholesterol (mg/dl), mean (S.D.)=163.4 (36.1)		
≥200	89	14.6
< 200	522	85.4
Triglyceride (mg/dl), mean (S.D.)=152.5 (71.3)		
≥150	258	42.2
< 150	353	57.8
Low density lipoprotein (mg/dl), mean (S.D.)=102.6 (31.1)		
≥100	282	46.2
< 100	329	53.8
High density lipoprotein (mg/dl), male: mean (S.D.)=40.1 (9.7)		
≥40 220	145	48.0
< 40 235	157	52.0
High density lipoprotein (mg/dl), female: mean (S.D.)=47.1 (12.1)		
≥50	123	39.9
< 50	186	60.1
Duration of DM (year), mean (S.D.)=9.03 (7.04)		
< 7	301	49.3
≤7	310	50.7

Self-care management behaviors

About four fifth (81.3%) 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 less than third (38.0%) of patients used to test their blood sugar at home. Most of the patients (92.0%) were highly adherent to their medications.

Glycemic control

Of the total 611 patients, two third (66.6%) had HbA1c ≥6.5%. 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 (92.9%).

Variable	Total (%)	No.	%	P
Gender				.201
Male	302 (49.4)	191	63.3	
Female	309 (50.6)	207	66.9	
Employee				.102

Yes	152 (24.9)	78	51.3	
No	459 (75.1)	320	69.7	
Age (year)				.734
24 -44	115 (18.8)	72	62.6	
45-64	208 (34.0)	138	66.3	
≥65	288 (47.2)	188	65.3	
Level of education				.0005
Illiterate	276 (54.5)	208	75.4	
≤High school	211 (34.5)	150	71.1	
>High school	124 (11)	40	32.3	
Body mass index (kg/m^2)				.003
Normal	202 (33.1)	114	56.4	
Overweight	324 (53.1)	194	59.6	
Obesity	135 (22.1)	103	76.3	
Duration of diabetes (year)				.0005
≤ 7	311(50.9)	155	50.1	
> 7	300 (49.1)	243	81.0	
Type of diabetic treatment				.0005
* OAA alone	381 (62.4)	186	48.8	
Insulin alone	34 (5.6)	30	88.2	
Combination of OAA and insulin	196 (32.0)	182	92.9	
Hypertension				.401
Yes	404 (66.1)	266	65.8	
No	207 (33.9)	132	63.8	
Cholesterol(mg/dl)				.004
≥ 200	91 (14.9)	69	75.8	
< 200	520 (85.1)	329	63.3	
Triglyceride(mg/dl)				.017
≥150	258 (42.2)	180	69.8	
<150	353 (57.8)	218	61.8	
Low density lipoprotein (mg/dl)				.001
≥100	289 (47.3)	204	70.6	
<100	322 (52.7)	194	60.2	
High density lipoprotein (mg/dl), male				.497
≥ 40	147 (48.7)	90	61.3	
< 40	155 (51.3)	100	64.5	
High-density lipoprotein (mg/dl), female				.105
≥ 50	123 (39.8)	77	62.6	
< 50	186 (60.2)	131	70.4	
HbA1c				.102
≥ 7 %	407 (66.6)	294	72.2	
< 7 %	204 (33.4)	104	51.0	

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 by (72.2%), did not practice any physical activity by (70.1%), who did not regularly perform home glucose monitoring by (73.6%) and who were not adherent for medications by (81.6%)

Variable	Total (%)	No.	%	P
Follow the eating plan as recommended by the dietitian				.0005
Yes	114 (18.7)	39	34.5	

No	497 (81.3)	359	72.2	
Participate in at least 30 minutes of physical exercise				.0005
Yes	196 (32.1)	107	54.6	
No	415 (67.9)	291	70.1	
Self-monitoring blood glucose				.0005
Yes	232 (38.0)	119	51.3	
No	379 (62.0)	279	73.6	
Medication adherence				.001
Highly adherent	562 (92.0)	358	63.7	
Not adherent	49 (8.0)	40	81.6	

Table 4:

Variable	OR (95% confidence interval)	p
Duration of diabetes (year)		
≤ 7	1	.0005
> 7	1.99 (1.40, 2.82)	
Treatment modalities		
Oral antidiabetic agents alone	1	
Insulin alone	4.49 (1.81, 11.13)	.001
Oral antidiabetic agents & 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

Discussion:

This study estimated the proportion of patients with Type 2 diabetes who did not achieve target level of HbA1c in Al-Thawra Hospital in Sana'a. Poor glycemic control (HbA1c 6.5%) was present. Population had HbA1c ≥7 % (**Al-Sultan & Al-Zanki, 2005**).

In this study, we found that women suffer from type 2 diabetes more often than men by a ratio of 1:1.02. We also found that the ages ranged from 24 to 84, these results are agreement a study with (**Akbar, 2001**), and disagree with (**Fox, 2006**) t was found that men are more susceptible to diabetes than women, as their results were 53% for men.

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 progres- sive 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 antidiabetic 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 higherdoses or additional mediations

increases over time. There- fore, 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. Despite 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 Makkah's 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

Conclusion:

The proportion of patients with poor glycemic control was high, which was comparable to that reported from many previous studies. Longer duration of diabetes and not adherent to diabetes self-care management behaviors were associated with poor glycemic control.

Recommendations:

Conducting an educational program for diabetic's patients on the importance of adhering to nutrition plan, using medication, and exercise

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