



Research Article

Contributing Factors Associated With Glycemic Control in Type 2 Diabetes Patients Karbala City, Iraq

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About Article

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ABSTRACT

A good glycemic control is very important to or prevent or delay early diabetes-related complications in T2DM patients. A cross-sectional study was conducted among total of 320 T2DM patients who were attended the Public Clinics to have their medications and whose ages above 18 years. This study was undertaken between February and June 2024. The epidemiological and clinical data was collected by direct interview with the patients and by using a structured validated questionnaire which consist of 2 parts. The first part consists of the Socio-demographic characteristics of the patients such as (age, gender, marital status, education, residence, occupation, a family income, physical activity, healthy diet and medication adherence while the second part consist of T2DM related variables including: duration, family history, co-morbid illness, FBS, HbA1C, lipid profile, type of management and BMI. SPSS version-22 was used for statistical analysis of data, suitable tables and graphs was used to expressed the frequency data. Pearson's chi-square test of independence was used to test statistical association and to identify the significant independent and un-confounded risk factors logistic regression analysis was used, $P < 0.05$ was considered statistically significant. Among total 320 patients with T2DM, (47.8%) of them aged more than 60 years, (62.2%) males, (82.5%) married. (36.9%) had monthly income (≥ 500.000 I.D), about (60%) had secondary school and college education. about 63% of them had Poor glycemic control. After applying the chi-square, the low educational level of the patients, uncontrolled Physical activity irregular self-monitoring, dyslipidemia, co-morbid diseases factor, un controlled diet, obese patients, long duration of the disease, were significant predictors of poor rate control ($P < 0.05$). On applying logistic regression analysis, low educational level of the patients (OR = 1.495, $p = 0.001$), uncontrolled Physical activity, irregular self-monitoring, Dyslipidemia were the main factors associated with poor glycemic control in patients with DM2.

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1. INTRODUCTION

By the definition of the World Health Organization (WHO) diabetes mellitus is a chronic, metabolic disease in which there is an elevation of the levels glucose in the blood, and over time poor glycemic control may cause damage to the cardiovascular system, nerves Galicia-Garcia *et al.* (2020), eyes and kidneys. Both defect in insulin secretion and the inability of the tissues to respond to insulin are the causes of T2DM (Roden & Shulman, 2019). Both genetics and the environment factors play important role in the epidemiology of T2DM (Grarup *et al.*, 2014). 5–10% of the population have DM, 90 % of them have T2DM in front of 10 % of them have type 1 and gestational types of diabetes. 415 million of people have T2DM all over the world as it was estimated in in 2015, and by 2040, it is expected to rise to 642 million (IDF, 2015). 80% of patients with T2DM are living in low-to-middle-income countries, causing large economic burden in these countries and accounts for high morbidity and mortality (Seuring, 2015), glycemic control which is estimated by the level of glycosylated hemoglobin (HbA1c), should be maintained to prevent complications. glycated hemoglobin (A1c) levels >7% (>53mmol/mol) are associated with a poor glycemic control according to the American Diabetes Association (ADA) and the International Diabetes Federation guidelines, elevated glycated hemoglobin is considered an important risk factor for causing diabetic macrovascular and microvascular complications and therefore major public health problem (Haghighatpanah, 2018). Fasting blood glucose (FBG), and postprandial glucose (PPG) are also used to evaluate glycemic control (Azzam *et al.*, 2021; Monnier & Colette, 2009). Identification of the factors associated with poor glycemic control is very important to start early appropriate interventions to prevent complications. Long duration of diabetes, lower level of education, higher BMI, inadequate follow-up, and not regularly performing home glucose tests, dyslipidemia, inadequate physical exercise, poor adherence to medications all these factors were associated with poor glycemic control according to several studies (Shan *et al.*, 2017; Demoz, 2019).

2. LITERATURE REVIEW

The study revealed that patients who receive monotherapy were more likely associated with good glycemic control compared with the combination of antidiabetics (insulin and oral antidiabetics), self-management behavior did not influence glycemic control, study done in Jimma University Medical center (JUMC) concluded that patients with no formal education and poor adherence to the medication had poor glycemic control (Ahmad *et al.*, 2014; Kassahun *et al.*, 2016). Sociodemographic factors such as age marital and employment status may not significantly associated with the glycemic control and some studies explained that females had better glycemic control compared to males (Al-Qerem, 2022). Metabolism disturbance of insulin is associated with hypertension and dyslipidemia and therefore poor glycemic control due to increase insulin resistance. Development of atherosclerosis in DM2 patients because of they have high levels of triglyceride and VLDL cholesterol and decreased levels of HDL cholesterol (Alidu, 2023). In Iraq More than 2 million Iraqis adults have Diabetes only 13.8% of patients who had good glycemic control

(HbA1c<7%) (Mansour, 2020).

A poor glycemic control is a major risk factor for the development and progression of diabetes-related complications, which can markedly increase the disease healthcare costs and reduce life expectancy and quality (Jannoo & Khan, 2019). Therefore, this study aimed to determine the risk factors associated with poor glycemic control among type 2 diabetes patients in order to achieve good glycemic control as early as possible to prevent complications and hospital admissions and therefore to decrease the burden on the patients and the health system.

3. METHODOLOGY

3.1. Study design and study population

A cross-sectional study was conducted among total 320 T2DM patients who were attended the Public Clinics to have their medications and whose ages above 18 years. This study undertaken between February and June 2024. As the majority of T2DM attended the Public Clinics to have their medications. As part of a national system, all the patients having specific chronic diseases are registered and given a chronic diseases card that include basic demographic data, address, and the diagnosis. The diagnosis of these diseases is made by a consultant/specialized physicians. The patients are offered almost free of charge medication received on monthly basis from the public clinics.

3.2. Data collection tools

Collection of the various epidemiological and clinical data through direct interview with the patients using a validated questionnaire consisting of two parts. First part consist of the socio-demographic characteristics of the patients such as (name, age, gender, marital status, level of education, residence, employment status, marital status, level of education, residence, average family income). The questionnaire includes also the physical activity which is classified into regular and irregular physical activity, adherence medication and healthy diet. Second part consist of T2DM related variables including duration of the disease, family history, co-morbid illness, Fasting blood glucose, Glycosylated hemoglobin (HbA1C), lipid profile (triglycerides and total cholesterol), type of management and regularity of visits to DM center. Anthropometric measurements including body weight in kilograms with light clothes and without shoes, Height in meters, and Body Mass Index (BMI) calculated by weight (in kilogram) divided by the square of height (in meters).

3.3. Statistical analysis

Data was analyzed by Statistical Package for Social Sciences (SPSS version-22) and suitable tables and graphs was used to express the frequency. Pearson's chi-square test of independence was used for testing the statistical association. To identify the significant independent and unconfounded risk factors logistic regression analysis was used. $P < 0.05$ was considered statistically significant.

3.4. Inclusion criteria

T2DM patients with more than 6 months duration of the disease, more than 18 years old and they accepted to engage in the study. Exclusion criteria ; Patients with T1DM. and age less than 18 years.



An appropriate sample size was calculated according to the sample size equation. The following sample equation was applied $N = Z^2 \times pq/d^2$.

Where N = Sample size. Z = statistical for a level of confidence 95%. P = expected proportion. q = 1 - p. d = absolute precision. prevalence (p) of 68.4% of poor glycemic control which was reported in the study by Zaboon *et al.* (2024) so the sample size is 312.

3.5. Ethical consideration

A written informed consent from every participant in the study was obtained after explanation of the details of the study and before collection of data. Official approval from Directorate of Health in Karbala was obtained. Data was held in a password protected computer and kept for research purpose only.

4. RESULTS AND DISCUSSION

4.1. Results

About half of the patients (47.8%) were aged more than 60 years, 57.8% males and most of them were married. 36.9% of the patients had monthly income (\geq 500.000 I.D), about 40% of participants presented with low educational level (Illiterate and primary school). Regarding occupation 23.8% housewives, 20.9% employed, 8.4% students, however about one third of them had freelance jobs Table 1.

Table 1: Socio- demographic characteristics of the patients

Variables		No	%
Gender	Male	185	57.8
	Female	135	42.2
Age in years	<40	49	15.3
	40-60	118	36.9
	>60	153	47.8
Marital status	single	56	17.5
	married	264	82.5
Family income	< 500 I. D.	202	63.1
	> 500 I. D.	118	36.9
Educational level	Illiterate	57	17.8

Table 2. Association between glycemic control with the demographics and health status of patients.

Variables	Diabetes Control status				P Value	
	Good No	Controlled %	Poor No	Controlled %		
Gender	Male	70	34.7	115	65.3	0.884
	Female	50	41.3	85	58.7	
Age in years	<40	24	49	25	51	0.142
	40-60	45	38.1	73	61.9	
	>60	51	33.3	102	66.7	
Marital status	single	23	41.1	33	58.9	0.508
	married	96	36.4	168	63.6	

Occupation	primary	73	22.8
	Secondary	98	30.6
	University	92	28.7
	Employed)	67	20.9
	Freelance	106	33.1
	Retired	44	13.8
	House wife	76	23.8
	student	27	8.4
	Total		320

Among total 320 patients only 109 (37.2%) of them had good glycemic control (HbA1c level below 7%) in front of 63.8 % had poor glycemic control Figure 1.

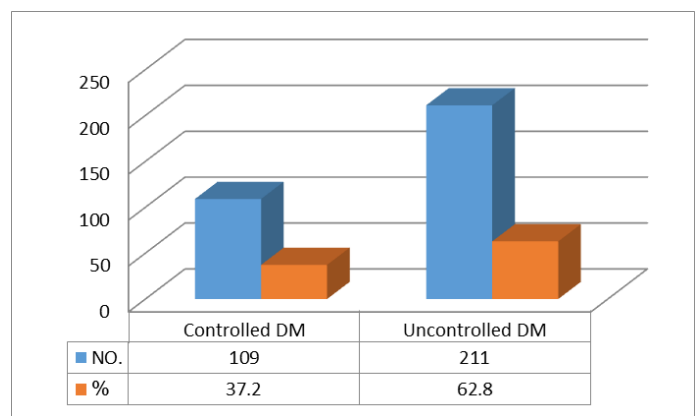


Figure 1. Distribution of T2DM patients by DM control status.

A significant association was found between controls status and duration of the disease, presence of comorbidities, educational level. The glycemic control was poor in those patients who were illiterate or had primary school educational level, in those with more than 6 years duration of the disease and lastly in the patients had co-morbid diseases. While gender, age, family income, occupation, family history of the disease, type of medication, all these factors in this study were not associated with glycemic control Table 2.



Educational level	Illiterate	5	8.8	52	91.2	0.001
	primary	15	20.5	58	79.5	
	Secondary	40	40.8	58	59.2	
	University	59	64.1	33	35.9	
Occupation	Employed	31	46.3	36	53.7	0.103
	Freelance	43	40.6	63	59.4	
	Retired	17	38.6	27	61.4	
	House wife	19	25	57	75	
	student	10	37	17	63	
Family income	Inadequate	77	38.1	125	61.9	0.371
	Adequate	42	35.6	76	64.4	
Family history of diabetes	Positive	23	37.7	38	62.3	0.971
	Negative	97	37.5	162	62.5	
Duration of the disease	<6 years	90	44.6	112	55.4	0.001
	>6 years	30	25.4	88	74.6	
Co-morbid diseases	Negative	68	43.9	87	56.1	0.023
	Positive	52	31.5	113	68.5	
Type of Medication	Insulin	28	31.8	60	68.2	0.436
	Oral	75	38.7	119	61.3	
	Combined	16	42.1	22	57.9	
Total		119	37.2	201	62.8	

Strong association between the glycemic control status with the behavioral factors and dyslipidemia, poor glycemic control was found in patients with irregular monitoring blood glucose, irregular visit to the diabetes center, uncontrolled healthy diet

suitable to diabetic patients ($P = 0.000$), uncontrolled physical activity and in patients with ($BMI; \geq 25 \text{ kg/m}^2$), cholesterol level $>200 \text{ mg/dl}$, TG level $>150 \text{ mg/dl}$, and LDL level $<100 \text{ mg/dl}$. Table 3.

Table 3. Association between the glycemic control status with the behavioral factors and lipid profile.

		Blood glucose control status				
		Good controlled		Poor controlled		
		No	%	No	%	
Monitoring blood glucose	Regular	95	74.8	32	25.2	0.000
	Irregular	24	12.4	169	87.6	
Adherent to antidiabetic drugs	Poor	4	22.2	14	77.8	0.176
	High	115	38.1	187	61.9	
Controlled physical activity	No	28	14.2	169	85.8	0.003
	Yes	91	74	32	26	
Controlled Diet	No	26	14.4	155	85.6	0.000
	Yes	93	66.9	46	33.1	
BMI	< 25	96	44.2	121	55.8	0.014
	25- 29.9	19	26.4	53	73.6	
	≥ 30	5	16.1	26	83.9	
Dyslipidemia	No	92	57.9	67	42.1	0.000



	Yes	28	17.4	133	82.6	
Cholesterol	<200 mg/dl	115	46.2	134	53.8	0.002
	≥200 mg/dl	4	5.6	67	94.4	
TG	<150 mg/dl	99	44.6	123	55.4	0.001
	≥150 mg/dl	20	20.4	78	79.6	
HDL	Low	62	33	126	67	0.063
	High	57	43.2	75	56.8	
LDH	<100 mg/dl	109	42.7	146	57.3	0.004
	≥100 mg/dl	10	15.4	55	84.6	
Total		119	37.2	201	62.8	

On applying logistic regression analysis, low educational level of the patients (OR =1.495, p = 0.001), uncontrolled Physical activity (OR =1.232, p = 0.002), irregular self-monitoring (OR =2.206, p = 0.003), Cholesterol ≥ 200 mg/dl (OR =25.645, p = 0.000), and LDL ≥100 mg/dl (OR = 4.827, p = 0.004) were the independent variables remained significantly associated with poor glycemic control in Table 4.

Table 4. Logistic regression analysis (OR with 95% CI) for determining predictors of poor for glycemic control.

	P	OR	95% CI	
			Lower	Upper
Clinical characteristics				
BMI	.195	1.511	.810	2.819
Long duration of the disease	.961	1.021	.448	2.328
Co-morbid diseases	.207	.735	.456	1.185
Behavioral factors				
Unhealthy diet	.354	.636	.244	1.658
Uncontrolled Physical activity	.003	1.232	.088	.611
Irregular self-monitoring	.003	2.206	.073	.580
Lipid profile				
Cholesterol ≥200 mg/dl	.000	25.645	6.522	100.837
TG ≥150 mg/dl	.905	1.053	.448	2.476
LDL ≥100 mg/dl	.004	4.827	1.654	14.083
HDL	.301	.680	.327	1.413
Low educational level	.001	1.495	.328	.747

4.2. Discussion

Assessment the factors associate with poor glycemic control among type 2 diabetes mellitus patients is very important to start proper intervention and get better treatment outcomes and therefore prevent complications (Imran *et al.*, 2013).

Among a total of 320 type 2 diabetes patients conducted in the current study; the prevalence of good glycemic control was 37.2%. It was more than the results reported in other study conducted in Al-Kindy Teaching Hospital, Baghdad (31.6 %) (Zahraa *et al.*, 2024), in Saudi Arabia (24.1%) (Alzaheb & Altemani, 2018), United Arab Emirates (31%) (Al-Rasheedi, 2015), and inferior to the result reported in other studies in Ethiopia (58.4 %) (Nigussie *et al.*, 2021), Iran (48.6 %)

(Azadnajafabad *et al.*, 2023) the difference in the results could be due to many factors such as sample size differences, difference in categorization of glycemic control by using fasting blood glucose or hemoglobin A1c, or because of study setting where the uncontrolled glycemic status patients are usually referred. However, the socioeconomic and life style differences between these communities play important role in the results of these studies (Shita & Iyasu, 2022). After applying the chi-square, glycemic control status was significantly associated with the duration of the disease, 48.7% of study participants who had DM duration less than 7 years had controlled DM in front of 24.5% of those patients who had more than 7 years duration of the disease. The finding was similar to the results of other



studies in Iraq (Fasil *et al.*, 2018), and in Ethiopia (Al-Rasheedi, 2015). While other studies reported that high proportion of poor glycemic control was found among those diabetic patients who had less than seven years duration of the disease (Fasil *et al.*, 2018; Rahman *et al.*, 2020). This is may be due to that the insulin resistance is increased with a long duration of the disease which may lead poor glycemic control (Mansour *et al.*, 2020). No significant association was found between controls status and family history of the disease in contrast to other studies which found that good glycemic control was found in diabetic patients who had family history of the disease, other study reported that the genetic factor may affect the duration and severity of the disease (Alzaheb & Altemani, 2018; Gong *et al.*, 2008; Gebermariam, 2020), and in consistent with another study reported that no association between glycemic control and positive family history (Al-Mutairi *et al.*, 2023). No significant association was found between controls status and the age of the patients, in contrast to other studies which found that younger age T2DM patients had poor glycemic control (Cheng *et al.*, 2019; Legese *et al.*, 2023). This is may be due to that more than 50% of the patients in the current study aged more than 50 years and the adherence to medication and healthy diet may be increased with age (Huber & Reich, 2016) other study found that T2DM patients who were 65 years old, had poor glycemic control and they suggested that the cause due to inadequate physical exercise, with presence of comorbidities in old age patients (Legese *et al.*, 2023). In the current study gender, was not significantly associated with the glycemic status, same findings was found by other studies (Zaboon *et al.*, 2024; Dinavari *et al.*, 2023) other studies reported that poor glycemic control was more in female (Haghighatpanah *et al.*, 2018), or in males (Roy *et al.*, 2016). Higher educational level was associated with good glycemic control. The poor glycemic control was found in illiterate or had primary school patients, other study in Iraq demonstrated the same results (Zaboon *et al.*, 2024). While studies conducted in KSA and Emirates showed that educational level may not be associated with glycemic control (Al-Rasheedi, 2024; Jong *et al.*, 2016). Educational level may increase awareness about practice of self-management and medication adherence that lead to glycemic control (Gong *et al.*, 2008). In this study poor glycemic control was found in patients with irregular monitoring blood glucose, in agreement with other studies found that low HbA1c was associated with frequent and regular self-monitoring blood glucose frequency (Rochmah *et al.*, 2024; Kong & Cho, 2024). The other most important cause of poor glycemic control in this study is inadequate physical exercise of the patients, same results was found by other studies (Al-Rasheedi, 2014; Zeru, 2021). Some studies mentioned that the insulin sensitivity will be increased by physical activity (Tegegne *et al.*, 2024), comorbidity was associated negatively with glycemic control, in accordance with the findings of other studies (Legese *et al.*, 2023; Tegegne *et al.*, 2024). The reason might be due that the burden of additional medication pill may lead to poor adherence to medication and therefore poor glycemic control (Urina-Jassir *et al.*, 2021). In contrast other studies found that comorbidities may increase the risk for poor glycemic control (Demoz, 2019; Omar *et al.*,

2018) in the current study poor glycemic control was found in those patients had BMI ≥ 25 kg/m², frequent and irregular food consumption lead to weight gain and obesity therefore worsen insulin resistance (ADA, 2020), same results were found by other studies concluded that, increased BMI associated with poor glycemic control (Kennedy-Martin *et al.*, 2021; Boye *et al.*, 2021). Dyslipidemia which is a preventable and modifiable risk factors of atherosclerotic cardiovascular diseases is high in the newly diagnosed DM2 patients (Bello-Ovosi *et al.*, 2019). In the current study there was increase of poor glycemic control status and presence of dyslipidemia including cholesterol level >200 mg/dl, TG level >150 mg/dl, and LDL level >100 mg/dl. same finding was obtained by other studies (Zaboon *et al.*, 2024; Al Quran *et al.*, 2022). good glycemic control was more likely in patients with good adherence to diabetic diets and the association was significant. This result is consistent with that of other studies (Mohammed & Sharew, 2019; Shareef *et al.*, 2024). Therefore education program for the patients with DM2 about the importance of dietary modification and compliance to the recommended diet in order to control patients' blood sugar. In this study adherence to diabetic medication was not associated with glycemic control. While other studies found that the risk of poor glycemic control was increased by low medication adherence (Demoz *et al.*, 2019; Zaboon *et al.*, 2024). The variation could be due to that most of the patients in this study might have good knowledge and awareness about their illness and medications, in addition that the patients are offered almost free of charge medication received on monthly basis from the public clinics. Occupation of the patients in this study had no association with glycemic control in contrast to other study reported that farmers and house wives had poor glycemic control compared to others (Haghighatpanah *et al.*, 2018; Kassahun *et al.*, 2016). Patients' income was not associated with the glycemic status of the patients, in contrast with other studies conducted in Baghdad13 and in Bangladesh (Rahman *et al.*, 2020). This is may be due to the fact that patients in Iraq are offered almost free of charge medication received on monthly basis from the public clinics as a part of a national system of health. On applying logistic regression analysis, low educational level of the patients, uncontrolled Physical activity, irregular self-monitoring, Dyslipidemia were the main risk factors of poor glycemic control among DM2 patients, in agreement with other studies (Mansour *et al.*, 2020; Zaboon *et al.*, 2024).

5. CONCLUSION

He prevalence of good glycemic control was 37.2%. The low educational level of the patients, uncontrolled physical activity, irregular self-monitoring and dyslipidemia were the independent variables remained significantly associated with poor glycemic control. Education programs for population should be taken to increase the awareness of the patients about the risk factors and complications of diabetes and the importance of the regular visits to the diabetic center together with teaching the patients by health providers the diabetes self-care activities to improve good glycemic control and prevent complications.



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