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Research Article

Proportion and Potential Risk Factors of Poor Glycemic Control among Patients with Type 2 Diabetes Mellitus: Experience of a Tertiary Center in Baghdad, Iraq, 2020

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Zahraa A. Zaboon[1], Faris H. Lami[1], Sevil Hakimi[2]
[1]*Department of Community Medicine, College of Medicine, University of Baghdad. Baghdad, Iraq*
[2] *Department of Midwifery, Faculty of Health Science, EGE University, Izmir, Turkey.*

Abstract

Background: Diabetes Mellitus is the most prevalent metabolic disorder worldwide. Effective diabetes self-management and keeping the Glycosylated hemoglobin level within the normal range could decrease the burden on the health system by reducing hospital admissions and diabetic complications, lowering the financial strain on the health system.

Objective: To recognize the potential risk factors of poor glycemic control in patients having type 2 Diabetes Mellitus in Baghdad, Iraq.

Patients and Methods: This cross-sectional study was conducted in the Diabetes and Endocrine Center at Al-Kindy Teaching Hospital, Baghdad, Iraq, from June to November 2020. The total number of the study's participants was 234. Based on the cutoff point of glycosylated hemoglobin of 7, the patients with glycosylated hemoglobin of ≥7 were considered uncontrolled, and those with glycosylated hemoglobin of <7 were considered controlled.

Results: The proportion of cases with uncontrolled diabetes was 68.4% (160). The remaining 74 patients had controlled diabetes. Age, sex, marital status, and employment status were not significantly associated with the control status (P>0.05). The binary analysis showed a significant association observed between the control status and level of education (P=0.001), income (P=0.001), presence of comorbidities (P=0.028), positive family history (P=0.03), dyslipidemia (P=0.001), cholesterol level (P=0.002), high triglyceride level (P=0.001), and low-density lipoprotein-cholesterol level (P=0.025). The smoking status, body mass index, and high-density lipoprotein-cholesterol level were not significantly associated with the control status (P>0.05). The disease characteristics, including the disease duration, fasting blood glucose, type of medication, self-monitoring, healthy diet, physical activity, and medication adherence, were significant factors (P<0.001). The multivariate regression method showed that dyslipidemia, FBS≥130, physical inactivity, and poor medication adherence were significant predictors for uncontrolled DM (P-value = 0.03, 0.001, 0.03, and 0.043, respectively).

Conclusion: The most important potentially modifiable risk factors for poor diabetes control were dyslipidemia, physical inactivity, and poor adherence to the management protocol. Enhancing the education of patients and their healthcare providers on these factors is crucial to improving the patients' control status.

Key words: Risk Factors; Glycemic Control; Type 2 Diabetes Mellitus

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Introduction

Diabetes Mellitus (DM) is the most prevalent metabolic disorder worldwide and is one of the most prevalent non-communicable chronic degenerative disorders worldwide. It is characterized by chronic elevation of blood glucose due to various causes, including abnormalities in insulin secretion, action, or both. (1, 2). It is estimated that 5–10% of the population suffers from DM. This prevalence is estimated to continually rise globally, with multiple implications for social, financial, and health systems. (2) Effective diabetes self-management through keeping the glycosylated hemoglobin A1C (HbA1C) level within the normal range could decrease the burden on the health system by reducing diabetic complications and hospital admissions, minimizing the financial strain on the health system. (3) Given the importance of self-management, literature has identified factors like age, ethnicity, socioeconomic status, disease duration, use of medications, comorbidities, body mass index, understanding of nutrition, level of empowerment, and self-efficacy that could play an essential role in controlling diabetes. (4, 5)

Increasing confirmations on good diabetes control significantly impact patients and the health system. Despite the availability of many studies examining the variables influencing glycemic control in people with type 1 or type 2 diabetes (6), they still have to be documented in populations with their etiological characteristics. (7–9)

**Corresponding author's email: :zahraaabdulreda89@gmail.com*

Diabetes has a significant global and national burden. The disease is reported in 10.5% of the adult population (20-79 years) globally, with almost half of the patients unaware that they are living with the condition (10,11). The mortality rate due to diabetes reached 10.7% in adult patients (20-79 years) worldwide. In the Middle East and North Africa Region, diabetes has accounted for more than 350000 deaths, with about half of these deaths occurring in patients younger than 60 years (10). According to the last STEP survey in Iraq, more than 2 million Iraqi adults (18+) were hyperglycemic, with an overall prevalence of 13.9% (12).

Considering the increasing prevalence of DM and the high proportion of uncontrolled DM in the country, this study examined a sample of type 2 DM patients to determine the risk factors for poor glycemic control in Baghdad, Iraq, 2020.

Patients and methods

Study design, setting, sampling, and definition of variables: This cross-sectional study was conducted in the Diabetes and Endocrine Center in Al-Kindy Teaching Hospital, Baghdad, Iraq, from June to November 2020. The included cases included patients with type 2 DM for a minimum of one year and older than 18 years. Patients who were mentally unstable, critically ill, or unable to respond were excluded. The included patients were classified into two groups according to their HbA1c status. The patients with HbA1C of ≥7 were considered uncontrolled, and those with HbA1C of <7 were considered controlled. The cases were selected as a consecutive sample.

Data Collection Tool: A questionnaire was developed and filled out through direct patient interviews. The questionnaire included sections on demographics (age, gender, educational level, marital status, smoking status, employment status, average family income, alcohol drinking, and body mass index), lipid profile (total cholesterol**,** triglycerides, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C)), and disease characteristics (comorbidities, duration of DM, fasting blood sugar (FBS), HbA1C level, medications used, self-monitoring of blood sugar, physical activity classified as sedentary, occasional, or regular physical activity, healthy diet, and medication adherence using the Morisky Medication Adherence Scale-8 (MMAS-8)).

Statistical Analysis: Version 22 of the Statistical Package for Social Sciences (SPSS) was used to analyze the data. Frequencies and percentages were used to present categorical data. Pearson's Chi-square test assessed the statistical association between categorical variables. Logistic regression analysis was carried out to identify the significant unconfounded factors connected to the control status of DM. A P-value of <0.05 was regarded as statistically significant.

Ethical and official approval: The study's details were verbally explained to each patient, and their permission was granted before conducting the interview. Anonymized personal data was respected, and the data was only used for this study's purposes. Official approval was granted from the Iraqi Council of Medical Specializations and the Diabetes and Endocrine Center in Al-Kindy Teaching Hospital.

Results

In this investigation, 243 patients were included. The number of patients with uncontrolled DM was 160 (68.4%), and those with controlled DM were 74 (31.6%). The two groups were distributed according to certain sociodemographic and disease variables (table 1). A significant association between control status and educational level was found (P=0.001), inadequate income (P<0.001), presence of comorbidities (P=0.021), and positive family history (P=0.023). Other variables, namely gender, age, marital status, occupation, smoking, and BMI, were not significantly associated with DM control status (P>0.05

Table 1: Distribution of the two study groups by demographic and disease characteristics

Variable	Categories	Uncontrolled DM No. 160 (%)	Controlled DM No. 74 (%)	Total No. 234	P-value	Odds ratio	95% CI
Gender	Female	101 (63.1)	38 (51.4)	139	0.059	0.616	0.3-1.07
	Male	59 (36.9)	36 (48.6)	95			
Age Group (Years)	<50	48 (30.0)	20 (27.0)	68	0.37	1.37	0.6–2.7
	50 – 60	65 (40.6)	27 (36.5)	92		1.38	0.7–2.6
	>60	47 (29.4)	27 (36.5)	74			
Education	Illiterate /	89 (55.6)	30 (40.5)	119	0.001	4.6	2.1-10.2
	Primary	57 (35.6)	22 (29.7)	79		4.0	1.7-9.3
	Secondary	14 (8.8)	22 (29.7)	36			
	University						
Marital Status	Single	5 (3.1)	0	5	0.14	0.47	1.3-1.6*
	Married	155 (96.9)	74 (100)	229			
Employment	Employed	27 (16.9)	21 (28.4)	48	0.066	0.44	0.2-1
	Retired	20 (12.5)	14 (18.9)	34		0.49	0.2-1.2
	Freelance	67 (41.9)	23 (31.1)	90		1.01	0.4-2.1
	Housewife	46 (28.7)	16 (21.6)	62			
Income	Adequate	42 (26.3)	43 (58.1)	85	<0.001	3.89	2.1 – 6.9
	Inadequate	118 (73.8)	31 (41.9)	149			
Comorbidities	Yes	116 (72.5)	43 (58.1)	159	0.021	0.52	1.06 – 3.38
	No	44 (27.5)	31 (41.9)	75			
Family history of DM	Yes	127 (79.4)	49 (66.2)	179	0.023	0.5	0.27 – 0.94
	No	33 (20.6)	25 (33.8)	58			
Smoking History	Ever use	36 (22.5)	13 (17.6)	49	0.24	0.73	0.3-1.4
	Never use	124 (77.5)	61 (82.4)	185			
BMI	<25	28 (17.5)	13 (17.5)	41	0.31	0.71	0.3-1.6
	25 – 29.9	78 (48.7)	43 (58.1)	121		0.6	0.3-1.1
	>30	54 (33.7)	18 (24.3)	72			

The association between DM management and lipid profile is shown in Table 2. The control status and dyslipidemia had a very strong association (P< 0.001), including cholesterol level, TG level, and LDL level (P=0.002, <0.001, and 0.038, respectively). The HDL level did not show a significant association with DM control.

Table 2: Distribution of the study groups by lipid profile

Variable	Categories	Uncontrolled DM No. 160 (%)	Controlled DM No. 74 (%)	Total No. 234	P-value	Odds ratio	95% CI
Dyslipidemia	Yes	121 (75.6)	39 (52.7)	160	<0.001	0.35	0.2 – 0.6
	No	39 (24.4)	35 (47.3)	74			
Cholesterol	≥200 mg/dl	56 (35.0)	11 (14.9)	67	0.002	3.08	1.5 – 6.3
	<200 mg/dl	104 (65.0)	63 (85.1)	167			
TG	≥150 mg/dl	81 (50.6)	11 (14.9)	92	<0.001	5.8	2.8 – 11.9
	<150 mg/dl	79 (49.4)	63 (85.1)	142			
LDL	≥100 mg/dl	40 (25.0)	9 (12.2)	49	0.038	2.4	1.1 – 5.2
	<100 mg/dl	120 (75.0)	65 (87.8)	185			
HDL	High	76 (47.5)	32 (43.2)	108	0.63	0.84	0.4 – 1.4
	Low	84 (52.5)	42 (56.8)	126			

The association between DM control and disease characteristics is shown in Table 3. All studied disease characteristics variables (Disease duration, FBS, medications used, physical activity, self-monitoring, healthy diet, adherence to medications, and other factors) were substantially linked to the control status (P<0.001).

To approach variables associated with poor control of DM, a multivariate regression analysis was conducted to identify the significant unconfounded factors correlated with the uncontrolled status of DM. The following variables were significant predictors: dyslipidemia, FBS≥130, inactivity, and poor adherence only (p-value= 0.03, 0.001, 0.03, and 0.043, respectively).

Table 3: Distribution of the study groups by DM-related variables

Variable	Categories	Cases No. 160 (%)	Control No. 74 (%)	Total No. 234	P-value	Odds ratio	95% CI
Disease duration	<7 years ≥7 years	42 (26.3) 118 (73.8)	41 (55.4) 33 (44.6)	83 151	<0.001	3.49	1.9 – 6.2
FBS	<130 mg/dl ≥130 mg/dl	15 (9.4) 145 (90.6)	48 (64.9) 26 (35.1)	63 171	<0.001	17.8	8.7 – 36.4
Medication	OHA OHA & Insulin Insulin	45 (28.1) 85 (53.1) 30 (18.8)	56 (75.7) 13 (17.6) 5 (6.8)	101 98 35	<0.001	1.3 1	0.1-0.3 0.3-3.3
Physical activity	Sedentary Occasional Regular	96 (60.0) 48 (30.0) 16 (10.0)	20 (27.0) 26 (35.1) 28 (37.8)	116 74 44	<0.001	8.4 3.2	3.8-18 1.4-7
Self-monitoring	Yes No	80 (50.0) 80 (50.0)	64 (86.5) 10 (13.5)	144 90	<0.001	6.4	3-13.3
Healthy diet	Yes No	44 (27.5) 116 (72.5)	54 (73.0) 20 (27.0)	98 136	<0.001	7.1	3.8-13
Adherence/medication	Low/Moderate High	78 (48.8) 82 (51.2)	6 (8.1) 68 (91.9)	84 150	<0.001	0.09	0.2-0.3

Logistic regression analysis was used to identify the significant unconfounded potential risk factors. The model included all the variables that proved significant in the binary analysis. Only four factors were found statistically significant: Dyslipidemia [OR=11.3, 95%CI:1.7-108.8), P=0.03], high fasting blood sugar [OR=6.23, 95%CI:2.02-19.15), P=0.001], absence of exercise [OR=2.06, 95%CI:2.0-21.1), P=0.03], and poor adherence to the medications [OR=22.5, 95%CI:1.6-46.1), P=0.043].

Discussion

Identifying the proportion and the potential risk factors for patients with type 2 DM who have inadequate glycemic control [HbA1c level >7% (>53mmol/mol) (13)] will help physicians and patients overcome those factors and try to control them as early as possible to decrease the burden on patients and the health system.

The finding that more than two-thirds of the studied DM patients had uncontrolled DM can be attributed to the study setting where the patients are referred because of DM complications or uncontrolled status.

Underprivileged social conditions such as low education and low income were associated with poor DM control, as indicated by higher HbA1C levels. (14, 15) Many studies have demonstrated that income might contribute to the quality of medication, and in Western countries, income determines the type of insurance that may affect glycemic control. (16–18) Managing diabetes with substantial comorbidities is always challenging (19), and the presence of comorbidities was proved to be associated with inadequate glycemic control. (16)

The binary analysis in this study revealed an association between poor control and a positive family history of DM, which was in line with other studies (20). However, another study showed no association between positive family history and poor control. (21) The variability between these results remains inexplicable.

Despite establishing associations between age, BMI, gender, and smoking with control of T2DM by other studies, our results did not show such associations. Abdelmoneim and Al-Homrany reviewed the files of 198 diabetic patients attending a diabetes clinic in Abha, Saudi Arabia. They reported that type 2 diabetes in younger adults (20–40 years old) was linked to poor glycemic control. (21) Other studies found a rise in the prevalence of DM and poor glycemic control in older (60–74 years) and middle-aged (40–50 years) patients. (22) Due to these inconsistent findings regarding age, it has not been possible to establish a definitive link between age and glycemic control. Glycemic control of DM patients with higher BMI (BMI≥25 kg/m^2) tends to be harder to achieve. (23) However, some studies suggested lower BMI may exist in patients with poor glycemic control (24). This may be related to the frequent irregular meal consumption by obese diabetic patients, resulting in decreased insulin sensitivity and poorer glycemic control. (22)

Dyslipidemia, including high cholesterol, TG, and LDL levels, was found to be associated with poor control, while this was not the case for HDL. As dyslipidemia is associated with poor control,(25) the metabolic pathogenesis of DM could play an essential role in developing dyslipidemia in DM patients. (26,27)

The disease characteristics investigated in this study were significantly associated with DM control. Having DM for a long duration is known to be associated with more insulin resistance, which may contribute to its association with poor control. (24,28) On the other hand, Type 2 DM patients are frequently in denial and refuse to alter their routines and lifestyles, which prevents successful glycemic control. (21,25)

Since medications are given chronologically, i.e., patients with new-onset DM are given oral medicine first and tend to increase the dose or frequency later. Patients with insulin or combined therapy expect resistance to previous glycemic control medicines

that could not control their DM. This was demonstrated in a national study(28), which found that treatment with insulin is associated with poor glycemic control. Also, poor insulin self-management due to a lack of information or skills contributes to inadequate glycemic control among patients on Insulin therapy. (28) Other studies indicated that a lack of diabetes-related knowledge affects one's ability to follow medication instructions and monitor one's blood sugar levels. (21)

A healthy diet and medication adherence play an essential role in DM control. A healthy diet improves by improving the knowledge, attitude, and practices that eventually lead to better disease control. (29) Overall, persons with type 2 DM who followed diets based on carb counting showed improvements in their HbA1c and fasting blood glucose levels. (26) Adopting an intervention program to increase medication adherence can enhance glycemic control. (30)

Dyslipidemia has been shown to play a part in managing diabetes mellitus. (20,22), but the specific mechanism of dyslipidemia on DM control is not fully clear. However, insulin resistance has a major impact on the pathogenesis of dyslipidemia in diabetics. (23) The importance of dyslipidemia in DM patients increases the risk of coronary heart disease. (20) The American Diabetes Association's 2019 guidelines advise using a high-intensity statin to treat all DM patients with dyslipidemia. (22)

Also, adherence to medications has a strong correlation with inadequate glycemic control. (21) The medical condition may worsen due to patients' non-adherence to their prescription diabetic treatment, linked to poor glucose control and subpar effects from the drug, developing comorbidities, reducing the quality of life, elevating healthcare costs, and increasing mortality. (17) Educational programs will positively impact adherence to DM medication and control by lowering the HbA1C. (18)

Physical activity has an essential role in controlling HbA1C(20). Patients with DM experienced a decrease in HbA1C after adapting to a physical activity program (31). Given that fact, an educational program for physical activity and adherence will increase the control of DM patients. Finally, and as expected, DM control directly affects FBS; patients with high HbA1C have a higher level of FBS than controlled ones.

While disease characteristics (Duration, Medication, self-monitoring, and healthy diet) were associated with the DM control status in the binary analysis, they failed to show such an association using the logistic regression analysis. These variables might be confounded by other factors that render them insignificant in this study.

One of the study's shortcomings is the limited number of well-controlled diabetics. This may reflect the general status of the DM population in the country where uncontrolled DM is predominant.

In conclusion, the most important potential modifiable determinants affecting DM's control status were dyslipidemia, high FBS, physical inactivity, and poor medication adherence. Enhancing the education of the patients and their healthcare providers on these factors is crucial to improving the patients' control status.

Author contributions:

Study conception & design: (*Zahraa A. Zaboon & Faris H. Lami*). Literature search: (*Zahraa A. Zaboon*). Data acquisition: (*Zahraa A. Zaboon*). Data analysis & interpretation: (*Zahraa A. Zaboon & Faris H. Lami)* Manuscript preparation: (*Zahraa A. Zaboon*). Manuscript editing & review: (*Faris H. Lami, Eman Ali*).

Authors' declaration:

Conflicts of Interest: **Dr. Faris Lami** is an Editor-in-Chief of the journal but did not participate in the peer review process other than as an author. The authors declare no other conflict of interest.

We confirm that all the Figures and Tables in the manuscript belong to the current study. Besides, the figures and images that do not belong to the current study have been permitted to be re-published in the attached manuscript. Authors sign on ethical consideration's approval-Ethical Clearance: The project was approved by the local ethical committee, the Iraqi Council of Medical Specializations, and the Diabetes and Endocrine Center in Al-Kindy Teaching Hospital according to code number (212) on (25/ 06/ 2020).

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نسبة وعوامل الإختطار المحتملة لضعف السيطرة على نسبة السكر في الدم بين مرضى السكري من النوع الثاني: تجربة مستشفى ثالثي في بغداد، العراق، 2020

زهراء زبون[1] أ.د. فارس حسن اللامي[1] أ.د. سيفيل حكيمي [2]
[1] فرع طب المجتمع, كلية الطب, جامعة بغداد, بغداد, العراق
[2] قسم القبالة، كلية العلوم الصحية، جامعة EGE، إزمير، تركيا

الخلاصة

الخلفية: داء السكري هو أكثر حالات إضطراب التمثيل الغذائي إنتشارًا في جميع أنحاء العالم. يمكن أن تؤدي الإدارة الذاتية الفعالة لمرض السكري والحفاظ على مستوى الهيموجلوبين الغليكوزيلاتي ضمن المعدل الطبيعي إلى تقليل العبء وتقليل الضغط المالي على النظام الصحي عن طريق تقليل الرقود في المستشفى ومضاعفات مرض السكري.

الهدف: التعرف على عوامل الإختطار المحتملة لضعف السيطرة على نسبة السكر في الدم لدى المرضى المصابين بداء السكري من النوع 2 في بغداد، العراق.

الطريقة: أجريت هذه الدراسة المقطعية في مركز السكري والغدد الصماء في مستشفى الكندي التعليمي، بغداد، العراق. بلغ العدد الإجمالي للمشاركين في الدراسة 234. وبناءً على نسبة الهيموجلوبين الغليكوزيلاتي لـ 7، تم إعتبار المرض عند المرضى الذين تبلغ نسبة الهيموغلوبين الغليكوزيلاتي ≤ 7 غير مسيطر عليه، وأولئك الذين لديهم هيموجلوبين غليكوزيلاتي أقل من 7 يعتبر المرض مسيطر عليه.

النتائج: بلغت نسبة مرضى السكري غير المنضبط 68.4٪ (160). أما الـ 74 مريضا الباقون فكانوا يسيطرون على مرض السكري. لم يظهر العمر والجنس والحالة الإجتماعية والمهنة تمايزاً إحصائيا بين المجموعتين (P> 0.05). أظهر التحليل الثنائي إرتباطًا معنويًا بين حالة السيطرة على السكري ودرجة التعليم (P = 0.001)، والدخل (P = 0.001)، ووجود الأمراض المصاحبة (P = 0.028)، والتاريخ العائلي الإيجابي (P = 0.03)، وخلل شحميات الدم (P = 0.001)، مستوى الكوليسترول (P = 0.002)، ارتفاع مستوى الدهون الثلاثية (P = 0.001) ، ومستوى البروتين الدهني منخفض الكثافة (P = 0.025). لم تختلف حالة التدخين ومؤشر كتلة الجسم ومستوى البروتين الدهني عالي الكثافة بشكل كبير عن حالة السيطرة على السكري (P> 0.05). كانت خصائص المرض، مثل مدة المرض، ونسبة الجلوكوز في الدم، ونوع الدواء، والمراقبة الذاتية، والنظام الغذائي الصحي، والنشاط البدني، والإلتزام بالأدوية، من العوامل المهمة (P <0.001). أظهرت طريقة الإنحدار متعدد المتغيرات أن عسر شحميات الدم، FBS≥130، قلة النشاط البدني، وضعف الالتزام بالعلاج كانت محددات مهمة لعدم السيطرة على السكري (القيمة P = 0.03، 0.001، 0.03، و0.043، على التوالي).

الإستنتاج: كانت أهم عوامل الإختطار التي يمكن تعديلها لضعف السيطرة على مرض السكري هي عسر شحميات الدم، وقلة النشاط البدني، وضعف الإلتزام بالبروتوكول العلاجي. يعد تعزيز تثقيف المرضى ومقدمي الرعاية الصحية حول هذه العوامل أمرًا بالغ الأهمية لتحسين حالة السيطرة على مرض السكري.

الكلمات المفتاحية: عوامل الإختطار، السيطرة على نسبة السكر في الدم، السكري من النوع الثاني