

Inadequate glycemic control among patients with type 2 diabetes in Jordan: prevalence and associated factors



Original article

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Received: 3 February 2025; Accepted: 25 February 2025; Published: 20 March 2026

Abstract: Background: Diabetes mellitus (DM) is a chronic illness with potentially fatal and debilitating consequences. Problems with glycemic management are a major issue that adds an added strain to public health services.

Objectives: The purpose of this study is to evaluate the prevalence of poor glycemic control and its related variables among type 2 diabetes mellitus (T2DM) patients in southern Jordan.

Methods: A cross-sectional study was carried out in the Prince Hashem bin Abdullah II Hospital in Jordan's southernmost province. For the period April–July 2024, 516 individuals with T2D were enrolled. A structured questionnaire that had been pre-prepared was used to collect data. As an index of glycemic control, a glycosylated hemoglobin (HbA1c) 7% cut-off point was adopted.

Results: Poor glycemic control was prevalent in 81.0% of T2DM individuals. Inadequate glycemic control was significantly worse in non-married patients and those with 10 or more years of diabetes duration, insulin treatment, dyslipidemia, neuropathy, cardiovascular illness, and glomerular filtration rate (GFR = 60 mL/min; [$P < 0.05$]). Moreover, dyslipidemia and insulin administration increased the likelihood of poor glycemic control (odds ratio [OR]: 2 and 5, respectively) ($P < 0.05$).

Conclusions: Inadequate glycemic control was common among the current study participants. To prevent disease consequences and enhance the health of patients with diabetes, health care professionals should pay special attention to related risk factors such as dyslipidemia, neuropathy, cardiovascular disease (CVD), extended illness duration, and insulin usage.

Keywords: diabetes management • glycemic control • Jordan • type 2 diabetes

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1. Introduction

Diabetes mellitus (DM) is a chronic disease that affects approximately 537 million people worldwide, with a projected increase to 783 million by 2045.¹

Diabetes increases the chance of dying by 2–3 times and increases the risk of having a heart attack or stroke by 2–3 times.² Diabetes is the fourth leading

How to cite this article: Amin MA, Alshraideh J, Yacoub MI, Abu Sabra MA. Inadequate glycemic control among patients with type 2 diabetes in Jordan: prevalence and associated factors. *Front Nurs.* 2026;1:131–138.

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cause of mortality in Jordan, accounting for 7% of all fatalities. Jordan's total diabetes prevalence grew from 13.0% in 1994 to 17.1% in 2004, 22.2% in 2009, and 23.7% in 2017.^{3,4} In Jordan's central and northern areas, diabetes comorbidities include dyslipidemia (95.4%), hypertension (68.2%), and ischemic heart disease (18.7%). The most prevalent DM sequelae were neuropathy (27.4%), retinopathy (24.1%), and nephropathy (15.1%).⁵

The fundamental goal of diabetes management is to establish glycemic control. In persons with diabetes, glycated hemoglobin (HbA1C) of 7% and fasting blood glucose (FBG) of 130 mg/dL are used to monitor glycemic control.⁶ Glycemic control issues are a pressing challenge that puts additional demand on public health systems.⁷ A study in Jordan indicated that more than half (58%) of the 287 patients who participated in the trial had poor glycemic control.⁸ Another research done in Jordan's north found that (92.7%) of 520 participants had inadequate glycemic control.⁹ Due to a lack of research, glycemic control among DM patients in Jordan's south needs to be more reported. Diabetes patients in southern Jordan did not get specialized diabetes management; instead, they tracked their condition in primary healthcare facilities or internal medicine clinics whenever they encountered an issue connected to their disease. Diabetes treatment in Jordan's south is given by health care providers who have not received specialized education or training in the advanced care of DM patients. As a result, this study aimed to assess the prevalence of poor glycemic control in Jordan's south and its related characteristics among persons with T2D.

2. Methods

2.1. Study design

A cross-sectional research methodology was used from April to July 2024. A total of 516 participants with type 2 diabetes mellitus (T2DM) were enrolled in the study. Participants who visited the internal medicine clinic at Prince Hashem bin Abdullah II Hospital in Jordan's south and satisfied the inclusion criteria (diagnosed with T2DM for 1 year or more, (aged >20 years), consented to participate in the study, and had the opportunity to participate. Individuals with type 1 diabetes and pregnant women with gestational diabetes were excluded.

2.2. Data collection

A structured questionnaire modified from related literature was used to collect data.⁸ Patients' sociodemographic data, such as gender, age, marital status,

occupation, smoking history, and income, were collected through face-to-face interviews. Clinical data and consequences of diabetes were obtained from medical records. These data included diabetes type and duration, diabetes medication, the existence of other comorbidities such as hypertension and dyslipidemia, and diabetic complications (retinopathy, nephropathy, and neuropathy). During the clinic visit, the researcher used a standard methodology to take anthropometric measurements (weight and height) as well as a lab test for HbA1C.

2.3. Ethical considerations

Ethical approvals were obtained from the Institutional Review Board (IRB) of the University of Jordan and the targeted hospital before data collection. The purpose of the study and voluntary participation in this study were explained to the patients; consent was taken from all participants. Data were kept strictly confidential and were used only for scientific purposes.

2.4. Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 25, IBM Corporation, Armonk, New York, United States). Continuous variables were described using the mean and standard deviation, whereas categorical variables were described using percentages. The Chi-square (χ^2) test was performed to compare the differences between categorical variables. Binary logistic regression analysis was used to determine odds ratios (ORs) for factors associated with poor glycemic control. *P*-values <0.05 were deemed statistically significant.

3. Results

3.1. Participants' characteristics

This study included 516 patients with T2D, with a mean age of 54.85 (10.6) years. The majority of them (54.3%) were women, married (86.6%), and had completed secondary and higher education (53.9%). Only 45.3% earned <500 JD (US\$700) monthly. Table 1 shows the sociodemographic characteristics of the participants.

In terms of clinical data, the majority of participants (81%) had poor glycemic control, had T2DM for a long time (58.7%), were obese with a BMI of 30 (59.9%), and 30.4% were current smokers. Most patients (59.7%) were taking oral diabetes medications. Regarding diabetes comorbidities, 76% and 61.4% of the study sample had dyslipidemia and hypertension, respectively.

| Variable | <i>n</i> | Percentage (%) |
|-------------------------------------|----------|----------------|
| Age (years) | | |
| ≤60 | 369 | 71.5 |
| >60 | 147 | 28.5 |
| Gender | | |
| Male | 236 | 45.7 |
| Female | 280 | 54.3 |
| Education | | |
| Less than secondary school | 238 | 46.1 |
| Secondary school | 164 | 31.8 |
| Higher than secondary | 114 | 22.1 |
| Marital status | | |
| Married | 447 | 86.6 |
| Single | 19 | 3.7 |
| Divorce/widow | 50 | 9.7 |
| Income | | |
| <500 JD (US\$700) | 234 | 45.3 |
| >500 JD (US\$700) | 282 | 54.7 |
| Smoking status | | |
| Current | 157 | 30.4 |
| Ex-smoker | 79 | 15.3 |
| Non-smoker | 280 | 54.3 |
| Dyslipidemia | | |
| Yes | 392 | 76 |
| No | 124 | 24 |
| Hypertension | | |
| Yes | 317 | 61.4 |
| No | 199 | 38.6 |
| CVD | | |
| Yes | 137 | 26.6 |
| No | 379 | 73.4 |
| Neuropathy | | |
| Yes | 201 | 39 |
| No | 315 | 61 |
| Retinopathy | | |
| Yes | 72 | 14 |
| No | 444 | 86 |
| Diabetes medication | | |
| OHA | 308 | 59.7 |
| Insulin | 208 | 40.3 |
| Duration of diabetes (years) | | |
| ≤10 | 303 | 58.7 |
| >10 | 213 | 41.3 |
| Glycated hemoglobin (%) | | |
| ≥7 | 418 | 81 |

(Continued)

Table 1. Continued

| Variable | <i>n</i> | Percentage (%) |
|-------------------------------------|----------|----------------|
| <7 | 98 | 19 |
| BMI (kg/m²) | | |
| Normal | 59 | 11.4 |
| Overweight | 148 | 28.7 |
| Obese | 309 | 59.9 |
| Renal function | | |
| GFR ≥ 60 mL/min/1.73 m ² | 462 | 89.5 |
| GFR < 60 mL/min/1.73 m ² | 54 | 10.5 |

Note: BMI, body mass index; CVD, cardiovascular disease; GFR, glomerular filtration rate; OHA, oral hypoglycemic agents; T2DM, type 2 diabetes mellitus.

Table 1. Socio-demographic and clinical characteristics of adult patients with T2DM (*n* = 516).

Cardiovascular disease (CVD, neuropathy, and retinopathy) were the most common DM complications, accounting for 26.6%, 39%, and 14%, respectively. Furthermore, 10.5% of the participants had chronic kidney disease in the third stage, with a glomerular filtration rate (GFR) of 60 mL/min. Clinical characteristics are presented in Table 1.

3.2. Prevalence of poor glycemic control

As indicated in Table 2, individuals with DM for 10 years or more had substantially worse glycemic control (89.2% VS 76.2%; *P* < 0.05). Non-married participant had worse glycemic control than married (91.3% VS 80.1%; *P* < 0.05). Poor glycemic control was higher among males than females (84.3% VS 79.3%; *P* < 0.05), with no significant statistical difference. Poor glycemic control was higher among the age group ≥60 years, with no significant statistical difference from the younger age group (84.4% VS 80.5%; *P* < 0.05).

In terms of DM comorbidities, individuals with dyslipidemia had worse glycemic control than those without dyslipidemia (84.7% VS 71.8%; *P* < 0.05). Poor glycemic control was also substantially more significant in individuals with neuropathy and CVD than in those without neuropathy (89.6% VS 76.2% and 87.8% VS 79.4%, respectively) (*P* < 0.05). Additionally, individuals with a GFR of 60 mL/min/1.73 m² had substantially worse glycemic control (86.8 VS 78.2%; *P* < 0.05). It was also greater in insulin-treated patients than in patients treated with oral hypoglycemic agents (OHA) (94.7% VS 72.7%); *P* < 0.05. Table 2 shows a distribution of poor glycemic control among study variables.

| Variables | <i>n</i> | Adequate glycemic control, <i>n</i> (%) | Poor glycemic control, <i>n</i> (%) | <i>P</i> |
|-------------------------------------|----------|---|-------------------------------------|----------|
| <i>Age (years)</i> | | | | 0.322 |
| ≤60 | 369 | 72 (19.5) | 297 (80.5) | |
| >60 | 147 | 23 (15.6) | 124 (84.4) | |
| <i>Gender</i> | | | | 0.141 |
| Male | 236 | 37 (15.7) | 199 (84.3) | |
| Female | 280 | 58 (20.7) | 222 (79.3) | |
| <i>Marital status</i> | | | | 0.042 |
| Married | 447 | 89 (19.9) | 358 (80.1) | |
| Unmarried | 69 | 6 (8.7) | 63 (91.3) | |
| <i>Education</i> | | | | 0.678 |
| Less than secondary | 238 | 40 (16.8) | 198 (83.2) | |
| Secondary | 164 | 32 (19.5) | 132 (80.5) | |
| Higher than secondary | 114 | 23 (20.2) | 91 (79.8) | |
| <i>Smoking status</i> | | | | 0.112 |
| Current | 157 | 21 (13.4) | 136 (86.6) | |
| Ex-smoker | 79 | 14 (17.7) | 65 (82.3) | |
| Non-smokers | 280 | 60 (21.4) | 220 (78.6) | |
| <i>Dyslipidemia</i> | | | | 0.001 |
| Yes | 392 | 60 (15.3) | 332 (84.7) | |
| No | 124 | 35 (28.2) | 89 (71.8) | |
| <i>Hypertension</i> | | | | 0.138 |
| Yes | 317 | 52 (16.4) | 265 (83.6) | |
| No | 199 | 43 (21.6) | 156 (78.4) | |
| <i>CVD</i> | | | | 0.034 |
| Yes | 137 | 17 (12.4) | 120 (87.6) | |
| No | 379 | 78 (20.6) | 301 (79.4) | |
| <i>Neuropathy</i> | | | | 0 |
| Yes | 201 | 21 (10.4) | 180 (89.6) | |
| No | 315 | 75 (23.8) | 240 (76.2) | |
| <i>Retinopathy</i> | | | | 0.286 |
| Yes | 72 | 10 (13.9) | 62 (86.1) | |
| No | 444 | 85 (19.1) | 359 (80.9) | |
| <i>Diabetes medication</i> | | | | 0 |
| OHA | 308 | 84 (27.3) | 224 (72.7) | |
| Insulin | 208 | 11 (5.3) | 197 (94.7) | |
| <i>Duration of diabetes (years)</i> | | | | 0 |
| ≤10 | 303 | 72 (23.8) | 231 (76.2) | |
| >10 | 213 | 23 (10.8) | 190 (89.2) | |

(Continued)

Table 2. Continued

| Variables | <i>n</i> | Adequate glycemic control, <i>n</i> (%) | Poor glycemic control, <i>n</i> (%) | <i>P</i> |
|-------------------------------|----------|---|-------------------------------------|----------|
| <i>BMI (kg/m²)</i> | | | | |
| Normal | 59 | 11 (18.6) | 48 (81.4) | 0.618 |
| Overweight | 148 | 31 (20.9) | 117 (79.1) | |
| Obese | 309 | 53 (17.2) | 256 (82.8) | |
| <i>Renal function</i> | | | | |
| GFR ≥ 60 mL/min | 462 | 68 (21.8) | 244 (78.2) | 0.014 |
| GFR < 60 mL/min | 54 | 27 (13.2) | 177 (86.8) | |

Note: BMI, body mass index; CVD, cardiovascular disease; GFR, glomerular filtration rate; OHA, oral hypoglycemic agents.

Table 2. Results of Chi-Square distribution of glycemic control status by participants' demographic and clinical variables (*n* = 516).

3.3. Factors associated with uncontrolled blood glucose

The binary logistic regression model demonstrated statistical significance ($\chi^2 (4) = 107.873, P = 0.000$). The model explained 31% (Nagelkerke R^2) of the variation in uncontrolled blood sugar levels and accurately identified 83.1% of cases. Male patients and non-employed patients had a 3 times higher risk of poor glycemic control ($P < 0.05$). Patients with dyslipidemia, current smokers, or neuropathy were twice as likely to have poor glycemic control. Insulin-only patients were 5 times more likely to have poor glycemic control than those on OHA ($P < 0.05$). Table 3 contains factors associated with poor glycemic control.

4. Discussion

According to the findings of this study, 81.0% of T2DM patients had poor glycemic control. Previous international investigations have found that poor glycemic control exists among persons with diabetes in Nigeria (83.3%),¹⁰ Kenya (81.6%),¹¹ and Ethiopia (80%).¹² While

poor glycemic control was relatively lower in certain countries, Saudi Arabia (74.9%),¹³ Ethiopia (73.8%),¹⁴ Ghana (70%),¹⁵ and the United States (69%)¹⁶ were among them.

Inadequate glycemic control among Jordanians with T2DM was found in studies as high as 72% to 58.5%.^{17–19} The current study's greater prevalence of poor glycemic control than prior studies might be attributed to patients being treated mainly at an internal medicine clinic instead of a specialized diabetes care clinic. Additional factors, such as the clinical and sociodemographic features of the research participants, also contributed to the observed variances. Moreover, DM patients in southern Jordan did not get specialist diabetes education at the time of diagnosis, and there is a paucity of diabetes education programs and resources.

The current investigation found that individuals with dyslipidemia, neuropathy, CVD, longer duration of diabetes diagnosis, and usage of insulin therapy had substantially worse glycemic control ($P < 0.05$). Additionally, compared to other diabetes patients, those who were male, unemployed, smokers, had neuropathy, dyslipidemia, or were receiving insulin were more likely to have poor glycemic control. Numerous studies found that having diabetes longer period was strongly related to poor glycemic control. Ethiopian research found that having diabetes for a more extended period (OR = 2.72 95% confidence interval [CI]:1.16–6.32) and being on insulin therapy (OR = 3.01 95% CI: 1.5–5.9) were substantially linked with poor glycemic control.¹² Another multicenter trial in Ghana found that having T2DM more extended period was associated with poor glycemic control.¹⁵ In addition, research in united states found that having T2DM for extended periods was related to poor glycemic control.¹⁶ Similarly, it has been documented that patients with T2DM

| Variable | OR | <i>P</i> value |
|--------------------|----|----------------|
| Gender | 3 | 0.001 |
| Smoking | 2 | 0.012 |
| Dyslipidemia | 2 | 0.016 |
| Neuropathy | 2 | 0.024 |
| Job none | 3 | 0.012 |
| Patient on insulin | 5 | 0.000 |

Note: OR, adjusted odds ratios.

Table 3. Adjusted ORs for factors associated with poor glycemic control.

diagnosed >10 years earlier were more likely to have poor glycemic control than other T2DM patients.¹⁴ The chronic progressive nature of T2DM and decreased insulin secretion owing to beta-cell failure may explain these findings.²⁰

According to the current study, individuals with one or more T2DM comorbidities, such as neuropathy, CVD, and renal impairment, had considerably worse glycemic control. This finding is in agreement with an Indian study that found that neuropathy was linked to poor glycemic control and that patients with neuropathy had a higher likelihood of having poor glycemic control (OR = 1.63). The study also found that neurological disorders, coronary heart disease, neuropathy, retinopathy, and renal failure were all linked to poor diabetes control.²¹ This finding might be explained by the fact that patients with T2DM problems and comorbidities had poor glycemic control, which could be owing to poor medication adherence caused by other factors.²²

In the current study findings, patients with dyslipidemia had worse glycemic control. Also, patients with dyslipidemia had a twofold increased risk of having poor glycemic control. In agreement with the present study, a study conducted in Ethiopia found that patients with hyperlipidemia were more likely to experience poor glycemic control.²³ Similarly, a Greek study stated that poor glycemic control was associated with elevated low-density lipoprotein (LDL) levels (OR: 1.53, 95% CI: 1.06–2.21) and low high-density lipoprotein (HDL) levels (OR: 2.12, 95% CI: 1.44–3.12).²⁴ Patients with dyslipidemia may have worse glycemic control due to insulin resistance, which is brought on by rising levels of free fatty acids in the bloodstream due to elevated levels of total cholesterol and triglycerides.²⁵ While Indian research contradicted the present study's findings, it found that dyslipidemia was not connected with poor glycemic control. Also, Jyoti et al.²⁶ observed no statistically significant relationship between glycemic control and comorbidities such as hypertension and dyslipidemia.

Individuals on insulin were 5 times more likely than those on OHA to have poorly regulated blood glucose. Other investigations supported this finding. According to Mamo et al.²² people on insulin alone were 4.48 times more likely to have poor glycemic control than patients on OHA. In addition, an Indian study found that individuals on insulin alone had a greater risk of poor glycemic control.²⁷ Furthermore, an Ethiopian study indicated that poor glycemic control was 3.07 times greater among insulin therapy patients than those on other treatment regimens.¹⁴ The fact that those receiving insulin had more severe diabetes than those receiving OHA may help to explain this finding. This suggests that patients receiving insulin alone had a higher uncontrolled HbA1c than patients receiving OHA alone. Long-term diabetic

patients lacked the knowledge and assistance they required about self-management and therapy.²⁰

Male patients were more likely to have poor glycemic control in the current study. This study supports a Jordanian study that found that male patients had a greater rate of poor glycemic control and that the only patient-related factor that could not be changed was sex.⁸ Similarly, other research found that the HbA1c values of male DM patients were higher.^{28,29} Also, a Nigerian study revealed that poor glycemic control was substantially related to the male sex ($P < 0.05$).³⁰ Female DM patients may have better glycemic control because they adhere to their medication regimens better. Female gender was negatively associated with effective glycemic control, according to a multicenter study conducted in Ghana.¹⁵ In addition, an Indian study found that male patients had better diabetes management than female patients and that female patients were associated with poor glycemic control.²¹ Furthermore, these results may be connected to the societal perception of women as inferior, which results in a lack of concern for them.

As for smoking status, the results of this study showed that smokers were twice as likely to have poor glycemic control. A Saudi study also found that smokers were more likely to have higher HbA1c.²⁸ According to another study,³¹ participants with rising HbA1c levels also had higher current smoking and glucose-lowering medication status. Other research, however, has not found a link between smoking and glycemic control.^{32,33}

4.1. Limitation

The current study's cross-sectional methodology restricts the capacity to establish a cause-and-effect relationship between poor glycemic control and risk factors. Additionally, this study was conducted at a single site in Jordan's southern area, and patients whom primary care institutions were not included in the analysis, which may explain the high prevalence of poor glycemic control.

4.2. Strength

This study's strengths include a large sample size, a high response rate, and using biomedical equipment to analyze physiological variables. Finally, the site where the data for this study was collected is a multi-origin population; the majority of its residents come from different governorates in Jordan (the north, center, and south), and the site is recognized as a melting pot of Jordanian society. As a consequence, the sample may reflect Jordanian society. Furthermore, this study may be the first to detail the characteristics of diabetes in Jordan's south.

4.3. Recommendation for future research

More study in different healthcare settings in southern Jordan is needed to improve the findings' generalizability. Also, additional correlational studies are needed to examine the degree of self-management practices and awareness among T2DM patients. Moreover, interventional studies evaluating the efficacy of diabetes self-management education and support on glycemic control in T2DM patients are required.

5. Conclusions

The majority of the individuals in this research had poor glycemic control. It was also considerably more significant in those who had dyslipidemia, neuropathy, or CVD who had been sick more extended period or used insulin. Furthermore, as compared to other diabetic patients, dyslipidemia and insulin treatment were shown to be strongly linked with poor glycemic control.

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Data availability statements

The datasets generated during the current study are available from the corresponding author on reasonable request.

Acknowledgement

This study was conducted as part of the requirements for a PhD in Nursing at The University of Jordan.

Ethical approval

Ethical approvals were obtained from the University of Jordan's Institutional Review Board (2519/2022/1) and the targeted hospital (2851/2023/9) before data collection.

Conflicts of interest

All contributing authors declare no conflicts of interest.

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