

## Original Research Article

# Factors associated with uncontrolled diabetes mellitus among diabetic patients in Jordan: A cross-sectional study

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## Abstract

**Purpose:** To investigate the factors associated with inadequate diabetes control among diabetic patients in Jordan.

**Methods:** A cross-sectional study was carried out involving 346 respondents. A review of the medical files of the participants was done, in addition to interviews, and the patients were asked to complete a structured questionnaire. Moreover, the participants' medical files were subjected to review. The relationships between uncontrolled DM (HbA1c  $\geq 7$ ) and various demographic and clinical factors were analyzed using univariate and multivariate logistic regressions. Statistical significance was set at  $p < 0.05$ .

**Results:** Out of 346 participants, females represented 54.6 %, while 178 participants (51.4 %) were unregulated DM cases. Hypertension was the most frequent comorbidity found in the subjects (24.3 %,  $n = 84$ ). The mean disease duration was  $6.49 \pm 4.76$  years. Most respondents ( $n = 306$ , i.e., 88.4 %) in the study were prescribed at least two diabetes medications daily. Analysis revealed that 122 (35.3 %), 319 (92.2 %) and 45 (13 %) of the respondents were non-adherent to diabetes medication, physical exercise, and recommended diet, respectively. Multivariate regression analysis indicated that older age (aOR: 1.96, 95 % CI: 1.195 – 3.214;  $p = 0.008$ ), male gender (aOR: 1.664, 95 % CI: 1.045 – 2.647;  $p = 0.032$ ), and non-compliance to prescribed medicines (aOR: 1.66, 95 % CI: 1.031 – 2.688;  $p = 0.037$ ) were significantly associated with uncontrolled diabetes.

**Conclusion:** Elderly patients, male sex and non-adherence to medications were factors that influenced the incidence of uncontrolled DM. Therefore, in managing uncontrolled DM, doctors should place greater emphasis on enhancing adherence strategies, particularly among older male DM patients.

**Keywords:** Uncontrolled diabetes, Non-adherence, Jordan

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## INTRODUCTION

Diabetes Mellitus (DM) is recognized as one of the leading non-communicable diseases (NCDs) targeted for global intervention [1]. In 2017, it was reported that the population of DM patients was 425,000,000, a figure which is projected to reach approximately 629 million in the year 2045

[2]. In Jordan, data from the nation's bureau for genetics, DM, and hormonal studies demonstrate a sharp rise in the incidence of diabetes in individuals aged  $\geq 25$  years, from 13.4 % in 1998 to 17.1 % in 2008 [3]. Uncontrolled DM is closely linked to cardiovascular, kidney, and cerebrovascular complications, as well as reduced quality of life

and increased healthcare costs. It is also frequently associated with depression [4].

Previous studies have shown that age, sex, treatment adherence, lifestyle, comorbidities and number of drugs comprise the main causes of poorly regulated DM [5]. Thus, in order to decrease the occurrence of unregulated DM in diabetics, it is vital to identify these predisposing influences. Therefore, this study was conducted to evaluate the clinical features and epidemiology of diabetic patients in Jordan and determine the factors linked to poor glycemic control.

## METHODS

### Study setting and design

Outpatient data were retrieved from the *endocrinology clinic* at Royal Medical Services (RMS), Amman, Jordan, between March 2023 and June 2023. The included patients were those with diagnosis of type 2 DM aged  $\geq 18$  years who were on oral medications or insulin. Patients in the following categories were excluded: patients with short life expectancy in terms of terminal illness or clinician-estimated life expectancy less than six months; patients on prolonged corticosteroid therapy; and terminal renal injury on long-term dialysis.

A structured questionnaire was developed, reviewed, and approved by an expert committee comprising pharmacists and a statistician from the University of Jordan. It was translated into Arabic and, thereafter, back into English to ensure validity. A sample size of 346 was determined using the Raosoft sample size calculator (margin of error: 5 %, confidence level: 95 %). Written informed consent was obtained from each participant.

A structured questionnaire was administered to the participants after obtaining verbal informed consent from them to participate in the study. Additionally, a consent statement was clearly written at the top of the questionnaire and was recited to each participant. Participants completed the questionnaire in the presence of the researcher, and each questionnaire was retrieved immediately.

The questionnaire contents were in four main sections: (1) demographic data, such as questions about age, sex, height and weight, with calculation of body mass index (BMI), and (2) lifestyle factors (smoking, diet adherence, and physical activity). The third section was about medical data, such as disease comorbidities (hypertension, dyslipidemia, kidney failure and

cerebrovascular accident); disease duration, number of diabetes medications, and glycemic control (HbA1c levels in the previous 6 months). Section 4 was on adherence to medication.

Clinical information was verified from RMS-documented medical records, while the total DM drugs used were retrieved from pharmacy data.

### Ethical considerations

The study was conducted after obtaining ethical permission from the ethics committee of RMS Hospital (approval no. 40/10/2022) in accordance with the Declaration of Helsinki's guidelines for research [6].

### Adherence to medications

Medication adherence was assessed using the Morisky Medication Adherence Scale (MMAS-8). [7]. Patients were instructed to provide either affirmative (1 point) or negative (0 points) answers. The last question was in a normal 5-point Likert form. Points  $> 2$  corresponded to low medication adherence (non-adherence).

### Adherence to the recommended dietary regimen

Diet adherence was measured using a modified 10-item scale adapted from MMAS-8. A score  $\geq$  average point on a 10-component compliance evaluation scale was considered as non-adherence [8].

### Glycemic control

Glycemic control was defined according to ADA guidelines as HbA1c  $< 7$  % which is a reflection of glycemia in the previous three months.

### Physical exertion

Exercise was evaluated with respect to two parameters: percentage of 30-minute exercise out of all physical exertions in the previous 1 week, and the frequency of particular exercise within that period. A score  $< 8$  was considered indicative of non-adherence to exercise [9].

### Statistical analysis

Data was analyzed using IBM SPSS version 26.0. Descriptive statistics were computed, and the results are presented as frequencies and percentages. Continuous data are presented as mean  $\pm$  SD. The results were sequentially subjected to univariate and multivariate regression analyses.

**Table 1:** General characteristics of the participants

| Variable                          | Category                         | Frequency (%) |
|-----------------------------------|----------------------------------|---------------|
| Sex                               | Male                             | 157 (45.4)    |
|                                   | Female                           | 189 (54.6)    |
| Age                               | <60 years                        | 203 (58.7)    |
|                                   | ≥60 years                        | 143 (41.3)    |
| Diabetes medication adherence     | Non-adherent (low adherence)     | 122 (35.3)    |
|                                   | Adherent (medium–high adherence) | 224 (64.7)    |
| Adherence to physical activities  | Non-adherent                     | 319 (92.2)    |
|                                   | Adherent                         | 27 (7.8)      |
| Adherence to the recommended diet | Non-adherent                     | 45 (13.0)     |
|                                   | Adherent                         | 301 (87.0)    |
| Smoking                           | Yes                              | 151 (43.6)    |
|                                   | No                               | 195 (56.4)    |
| Hypertension                      | Yes                              | 84 (24.3)     |
|                                   | No                               | 262 (75.7)    |
| Dyslipidemia                      | Yes                              | 78 (22.5)     |
|                                   | No                               | 268 (77.5)    |
| Obesity                           | Yes                              | 73 (21.1)     |
|                                   | No                               | 273 (78.9)    |
| Coronary artery disease/stroke    | Yes                              | 68 (19.7)     |
|                                   | No                               | 278 (80.3)    |
| Chronic kidney disease            | Yes                              | 49 (14.2)     |
|                                   | No                               | 297 (85.8)    |
| Number of diabetes medications    | 1 therapy                        | 40 (11.6)     |
|                                   | ≥2 therapy                       | 306 (88.4)    |
| Duration of diabetes              | <20 years                        | 304 (87.9)    |
|                                   | ≥20 years                        | 42 (12.1)     |

In univariate analysis,  $p \leq 0.25$  was used to determine associations between uncontrolled diabetes and independent variables. Statistical significance was assumed at  $p < 0.05$ .

## RESULTS

A total of 346 individuals were enrolled, with females comprising 54.6 % and a mean age being  $57.8 (\pm 5.21)$  years. High blood pressure was the most rampant comorbidity (24.3 %). Next to it were dyslipidemia (22.5 %) and chronic kidney failure (14.2 %). Average duration of diabetes was  $6.49 \pm 4.76$  years (range: 1 - 24 years). Majority of patients (88.4 %) had prescriptions of two or more diabetes medications daily. Moreover, 122 (35.3 %), 319 (92.2 %) and 45 (13 %) of all respondents were non-adherent to diabetes medications, physical exercise and the recommended diet, respectively. Approximately half (56.4 %) of the participants were adherent to cessation of smoking. The general characteristics of the population are presented in Table 1. Analysis revealed that 178 participants (51.4 %) had unregulated diabetes, with a mean HbA1c of  $8.01 \pm 1.82$ , as presented in Table 2.

Multivariate logistic regression analysis showed that uncontrolled diabetes was markedly and positively correlated with non-compliance with prescription ( $p = 0.037$ , aOR: 1.66, 95 % CI:

1.031 – 2.688); male sex ( $p = 0.032$ , aOR: 1.664, 95 % CI: 1.045 – 2.647); age  $\geq 60$  years ( $p = 0.008$ , aOR: 1.96, 95 % CI: 1.195 – 3.214). Other variables, such as obesity, smoking, hypertension, dyslipidemia, kidney disease, physical inactivity, dietary adherence, duration of diabetes, and number of medications, showed no significant associations, as shown in Table 3.

**Table 2:** Glycemic control status

| HbA1c | Frequency | Percent |
|-------|-----------|---------|
| ≥7    | 178       | 51.4    |
| <7    | 168       | 48.6    |

## DISCUSSION

In this study on Jordanian diabetic patients, the predictors of poor glycemic control, such as gender, age, non-compliance with diabetes medicines, non-compliance with recommended diet, lack of exercise, comorbidities, and multiplicity of medicines, were investigated, as well as the relationship between these parameters and HbA1c.

According to a 2014 World Health Organization (WHO) report, diabetes accounted for approximately 1.5 million deaths worldwide in 2012 and contributed to 89 million disability-adjusted life years.

**Table 3:** Data on logistic regression analysis of factors linked to uncontrolled DM among diabetic patients

| Variable                                 | COR (95 % CI)       | AOR (95 % CI)       | P-value |
|------------------------------------------|---------------------|---------------------|---------|
| <b>Sex</b>                               |                     |                     |         |
| Male                                     | 1.866 (1.216–2.865) | 1.664 (1.045–2.647) | 0.032   |
| Female                                   | 1                   | 1                   |         |
| <b>Age</b>                               |                     |                     |         |
| ≥60 years                                | 1.920 (1.245–2.963) | 1.960 (1.195–3.214) | 0.008   |
| <60 years                                | 1                   | 1                   |         |
| <b>Diabetes medication adherence</b>     |                     |                     |         |
| Non-adherent                             | 0.608 (0.390–0.949) | 1.660 (1.031–2.688) | 0.037   |
| Adherent                                 | 1                   | 1                   |         |
| <b>Adherence to physical activities</b>  |                     |                     |         |
| Non-adherent                             | 1.196 (0.543–2.636) |                     |         |
| Adherent                                 | 1                   | 1                   |         |
| <b>Diabetic diet adherence</b>           |                     |                     |         |
| Non-adherent                             | 1.894 (1.010–3.606) | 1.325 (0.657–2.673) | 0.432   |
| Adherent                                 | 1                   | 1                   |         |
| <b>Smoking</b>                           |                     |                     |         |
| Yes                                      | 0.765 (0.500–1.172) | 0.815 (0.512–1.299) | 0.390   |
| No                                       | 1                   | 1                   |         |
| <b>Hypertension</b>                      |                     |                     |         |
| Yes                                      | 0.720 (0.439–1.179) | 0.761 (0.448–1.293) | 0.313   |
| No                                       | 1                   | 1                   |         |
| <b>Dyslipidemia</b>                      |                     |                     |         |
| Yes                                      | 0.927 (0.560–1.537) |                     |         |
| No                                       | 1                   |                     |         |
| <b>Obesity (BMI ≥30)</b>                 |                     |                     |         |
| Yes                                      | 0.781 (0.465–1.311) | 0.349               |         |
| No                                       | 1                   |                     |         |
| <b>Coronary artery disease or stroke</b> |                     |                     |         |
| Yes                                      | 0.747 (0.439–1.271) |                     |         |
| No                                       | 1                   |                     |         |
| <b>Chronic kidney disease</b>            |                     |                     |         |
| Yes                                      | 1.440 (0.780–2.660) | 1.682 (0.877–3.225) | 0.118   |
| No                                       | 1                   |                     |         |
| <b>Number of diabetes medications</b>    |                     |                     |         |
| 1 therapy                                | 1                   |                     |         |
| ≥2 therapy                               | 1.048 (0.542–2.029) | 0.887               |         |
| <b>Duration of diabetes</b>              |                     |                     |         |
| <20 years                                | 1                   |                     |         |
| ≥20 years                                | 0.675 (0.352–1.295) | 0.734 (0.370–1.456) | 0.376   |

BMI: body mass index; COR: crude odds ratio; AOR: adjusted odds ratio; CI: confidence interval

Within the Eastern Mediterranean region (including Jordan), the prevalence of diabetes is notably higher than the global average, with a value reaching 14 % [1]. Projections indicate that without effective interventions, the global diabetic population may rise to 578 million by 2030, with a likelihood of a 51 % increase by 2045 [10].

In the current study, the proportion of female participants exceeded that of males. This could be explained by evidence showing that women are about 1.3 to 1.7 times more likely to develop diabetes mellitus than men [11].

Nearly half of the participants had uncontrolled diabetes, consistent with findings from Ethiopia (50 %) and Pakistan (38.9 %) [12], but lower than that reported by Zerriouh and Khader in Jordan [13]. The variations across studies may be attributed to differences in medication

adherence, lifestyle, urbanization, and study populations.

The present study showed that most diabetic participants had hypertension. A study by Akalu and Belsti showed that hypertension was the most common risk (59.5 %) among type 2 diabetes mellitus patients [14]. Older age was strongly linked to poor glycemic control. This is consistent with international evidence showing that elderly patients often face multiple comorbidities and challenges in managing diabetes. Factors such as cognitive decline, depression, and polypharmacy contribute to higher risks of non-adherence in this group. Male patients were also more likely to have uncontrolled diabetes, a finding supported by several clinical trials but not universally reported.

Older age  $\geq 60$  years was strongly linked to poor glycemic control. This is in agreement with a previous report, which indicated a higher incidence of type 2 DM in older individuals [15]. A study conducted by the American Diabetes Association (ADA) [16] revealed that diabetes management is strongly influenced by age, with individuals aged 60 years and above being more vulnerable to poor glycemic control. This was largely attributed to the coexistence of multiple health problems, particularly cardiovascular and renal conditions, which complicate treatment options and limit therapeutic effectiveness. Another potential reason for uncontrolled diabetes among elderly patients is high degree of non-compliance with prescribed drugs due to depressive symptoms and increasing reduction in cognition, apart from the established predisposing factors for non-compliance.

In this study, uncontrolled diabetes was significantly associated with male sex. In clinical trials, it has been demonstrated that men with DM had significantly higher HbA1c levels, and the risk of uncontrolled diabetes was significantly associated with male sex [17].

It was also found that poor adherence to diabetes medications was a major predictor of poor glycemic control. Patients who failed to follow the prescribed treatment regimen had higher susceptibility to unregulated diabetes than patients who adhered to the prescribed medications. Similar associations have been reported by Suprapti *et al* [18].

### Study limitations

This study has several limitations. First, it was not originally designed to assess all determinants of uncontrolled diabetes in Jordan. Therefore, some relevant variables, such as patients' knowledge about the disease, psychosocial factors, and health literacy, were not included. Second, the assessment of glycemic control relied only on HbA1c values from the preceding six months, which might have led to either over- or under-estimation of long-term diabetes control. Third, the data were obtained from a single hospital (RMS). This is likely to limit the validity and generalizability of the findings to the wider Jordanian population. In addition, a cross-sectional study was used. This will not allow for the identification of causal associations between poor glycemic control and risk factors. Self-reported measures such as adherence to diet and physical activity may also be subject to the capacity to recall or bias for social desirability. Furthermore, important clinical parameters such as dosage of medication, insulin titration

patterns, and socioeconomic variables were not comprehensively analyzed. This would have provided a deeper understanding of the factors that influence diabetes outcomes.

## CONCLUSION

Older patients, males, and those with poor adherence to diabetes medication were more likely to experience uncontrolled glycemic outcomes. Therefore, addressing medication adherence, particularly among elderly men, should be a priority in clinical practice. Public health interventions focused on adherence support have the potential to reduce the burden of diabetes-related complications and improve DM treatment outcomes in Jordan.

## DECLARATIONS

### Acknowledgement/Funding

None.

### Ethical approval

Ethical permission was obtained from the Ethics Committee of RMS Hospital, Amman, Jordan (approval no. 40/10/2022).

### Use of Artificial intelligence/Large language models

We also declare that we did not use Generative artificial intelligence (AI) and AI-assisted technologies in writing the manuscript.

### Use of research reporting tool

Stroke guidelines have been used for this research.

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Conflict of interest

No conflict of interest is associated with this work.

### Contribution of authors

We declare that this work was done by the author(s) named in this article, and all liabilities pertaining to claims relating to the content of this

article will be borne by the authors. Maisa K Abu-Kamar and Adnan A Abu-Qamar conceived the study questions, designed the study protocol, contributed to data collection, did data analysis, and wrote the manuscript. All authors agreed on the final version of the manuscript.

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