

The Relationship between Diabetic Patients' Health Literacy and HbA1c Level in Jordan

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ABSTRACT

Objective: This study aimed to explore how diabetic health literacy influences glycosylated hemoglobin HbA1c levels—a crucial marker of long-term blood sugar control—in Jordanian patients with type 2 diabetes.

Methods: Over a four-month period at a major public hospital in Amman, we enrolled 400 patients with type 2 diabetes mellitus in this cross-sectional study. The study used the Jordanian Diabetic Health Literacy Questionnaire (JDHLQ). This validated tool assesses health literacy among Arabic-speaking individuals.

Results: The findings revealed a significant link between higher health literacy scores and lower HbA1c levels. Specifically, each additional point on the JDHLQ was associated with a 0.040 decrease in HbA1c (95% CI [-0.078, -0.003], $p=0.035$). Patients taking more medications and those without insurance also had significantly higher HbA1c levels.

Conclusion: These results highlight the vital role of health literacy in managing diabetes effectively and support the implementation of targeted educational programs to improve patient outcomes in Jordan. The study emphasizes the need for policy improvements in diabetes care.

Practice Implications: Understanding the key factors that influence disease control in type 2 diabetes patients—including the impact of health literacy—is essential for developing targeted interventions, enhancing patient outcomes, and reducing the strain of diabetes on the healthcare system.

Keywords: Health literacy; Diabetes Mellitus; Jordan; HbA1c, glycemic control.

1. INTRODUCTION

Diabetes mellitus (DM) is primarily characterized by abnormally high blood glucose levels [1], which significantly increase the risk of microvascular

complications such as neuropathy, nephropathy, and retinopathy. In addition, DM is linked to a higher likelihood of macrovascular complications, including peripheral vascular disease, stroke, and ischemic heart disease. These health issues contribute to substantial morbidity, a decreased life expectancy, and a diminished quality of life for those affected [2–4].

Based on four population-based surveys conducted in 1994, 2004, 2009, and 2017, the prevalence rate of DM in

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Jordan was 12.9%, 17.4%, 20.8%, and 22.4%, respectively. Thus, the prevalence is increasing at an alarming rate [5]. This increase represents a significant burden on healthcare services in Jordan. Globally, DM constitutes a serious public health problem that has significant economic consequences in addition to adverse health impacts [6]. In 2010, the global prevalence of DM among adults was 285 million patients. It is estimated to rise to 439 million by 2030. The projected increase between these two years is 20% in developed countries and 69% in developing countries [7].

Health literacy (HL) is extremely important and plays an essential role in the development of health, economic, and social sectors [8]. Diabetic HL is the patient's ability to search for, perceive, analyze, and apply DM-related information in both daily lives and healthcare settings [9]. Findings from a cross-sectional study conducted in May 2019 in Ethiopia revealed that adequate diabetic HL is strongly correlated with better glycemic control. Moreover, after adjusting for all variables including high diabetic HL, younger age, and adequate adherence, these factors were found to be associated with achieving optimal glycemic control [10]. In addition, results from a US cross-sectional study conducted in 2000 indicated that poor HL was independently associated with greater rates of retinopathy and poor glycemic control [11].

Addressing the factors that influence glycemic control is central to preventing complications associated with diabetes [12]. A cross-sectional study conducted across three hospitals in northern Jordan discovered that a significant number of participants had inadequate self-care behaviors and poor glycemic control [13]. Another Jordanian cross-sectional study found that the prevalence of poor glycemic control among participants was significantly high [14,15].

Healthcare professionals often use the hemoglobin A1c (HbA1c) test to assess glycemic control in patients with type 2 diabetes mellitus (T2DM), as HbA1c levels are critical indicators of potential diabetic complications

[16,17]. This test reflects an individual's average blood glucose levels over the preceding two to three months [18].

Previous studies [19,20] have suggested a strong link between diabetic patients' health literacy, their level of knowledge, and the achievement of better disease control. However, to date, no research in Jordan has examined the relationship between health literacy and disease management, including HbA1c levels, among diabetic patients. It is essential to understand the key factors that influence disease control in the Jordanian population in order to develop targeted interventions, improving patient outcomes, and reducing the burden of diabetes on the healthcare system. Therefore, this study aimed to investigate the relationship between health literacy and disease control, including HbA1c levels, in T2DM patients in Jordan

2. METHODS

A total of 400 patients with diabetes mellitus who were attending the endocrinology outpatient clinic in a major public tertiary hospital in eastern Amman, Jordan, were recruited. Data collection took place between August and November 2023. Participants were required to be adults aged 18 or older, have a diagnosis of type 2 diabetes mellitus for at least one year, and provide written informed consent to join the study. The research team reviewed the medical records of patients scheduled for follow-up appointments the next day to identify those who met the inclusion criteria. Eligible patients were approached on the day of their appointment by trained researchers (Z.A & S.A). The researchers explained the study's objectives, assured them of the confidentiality of their data, and informed them of their right to withdraw from the study at any time. The self-administered questionnaire took about ten minutes, and participants were informed of this beforehand. All participants gave informed consent and signed a consent form. The study was conducted in accordance with the ethical guidelines of the Declaration of Helsinki. Ethical approval was obtained from the Al-Zaytoonah University of Jordan (Ref#18/09/2022–2023).

2.1. Data collection and study instruments

This study used the Jordanian Diabetic Health Literacy Questionnaire (JDHLQ), a validated instrument for assessing DM patients' health literacy in Arabic-speaking populations [21]. Additionally, sociodemographic information was collected, including gender, age, marital status, educational level, and monthly income. Other information was obtained from patients' medical files, including the medication used and HbA1c readings on the day of the visit.

The JDHLQ is composed of two main parts. The first part targets the informative aspect of health literacy, assessing how well patients with T2DM can understand, evaluate, and apply information related to their condition. The informative domain contains five items. The second section assesses the communicative domain of HL and is composed of three items evaluating DM patients' ability to explain their health condition to healthcare professionals, explain the importance of a special diabetic diet, and their ability to effectively ask healthcare professionals questions (Appendix A). according to the achieved scores of JDHLQ, participants were classified into "High" or "Low" health literacy based on 80% Bloom's cut-off point.

Adherence to medications was measured using the Medication Adherence Report Scale questionnaire (MARS-5); a self-report tool with validated Arabic version [22]. MARS-5 is a frequently utilized tool to assess adherence to medications in chronic diseases. It consists of five items: "I forget to take them", "I change the dose", "I stop taking them for a while", "I decide to skip a dose", and "I take medications less than instructed". Responses are designated as "always", "often", "sometimes", "rarely" and "never". The total score accordingly ranges from 5 to 25, with a higher score indicating better adherence to medication. (Appendix A).

Answers to the items in both sections are based on a four-point Likert scale with the highest possible score being 32. The higher the total score, the better the diabetic HL.

2.2. Sample size calculation.

The $50 + 8P$ equation [23] was employed to calculate

the minimum required sample size to generate a regression model with an adequate level of statistical power. P in the equation indicates the number of predictors. The current study investigated the association of 12 variables with the diabetic control score. Therefore, the minimum required sample size was 146 patients.

2.3. Statistical analysis

All statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) software version 26. Continuous variables were summarized as medians with interquartile ranges (25th to 75th percentiles), and categorical variables were presented as frequencies and percentages. To assess the relationship between the diabetic control score (the outcome variable) and various factors—including gender, age, marital status, education level, monthly income, insurance status, medications (Metformin, Insulin, Sulfonylureas, and DPP-4 inhibitors), and the JDHLQ score—we conducted a quantile regression analysis. A p -value of less than 0.05 was considered statistically significant.

3. RESULTS

We enrolled a total of 400 patients out of 442 (response rate was 90.5%) with diabetes mellitus in this study, with women comprising 68.8% of the participants. Detailed sociodemographic profiles are presented in Table 1. The median age of the participants was 58 years, ranging from 50 to 64 years, and the vast majority were married (89.2%). Most participants (79.0%) had health insurance, and a significant portion had completed only elementary education (42.5%). A large majority (81.2%) reported a monthly household income of less than 500 Jordanian Dinars (about 705 US dollars). Metformin was the most commonly used antidiabetic drug (86.7%), followed by insulin (37.7%). Thiazolidinediones (TZDs) were the least commonly used, with only 1.8% of participants taking them. The median score of the JDHLQ was 22 out of 32 (68.7%), with scores ranging from 18 to 25. The median of the MARS-5 adherence score was 21 (19-25).

Table1. Sociodemographic characteristics of diabetic patients (n=400).

		Median (percentile 25-75)	Count (%)
Age		58(50-64)	
HbA1c		8.00 (6.80-10.00)	
Gender	Female		275 (68.8%)
	Male		125 (31.3%)
Education	Elementary		169 (42.5%)
	High school		142 (35.7%)
	College/university degree		87 (21.9%)
Marital status	Single		43 (10.8%)
	Married		355 (89.2%)
Monthly income	less than 500 JD		323 (81.2%)
	500 JD or more		75 (18.8%)
Do you have health Insurance?	No		84 (21.0%)
	Yes		316 (79.0%)
Medications^a	Insulin		150 (37.7%)
	Metformin		345 (86.7%)
	DPP-4 inhibitors ^b		59 (14.8%)
	GLP-1-and dual GLP-1 GIP receptor agonists ^c		15 (3.8%)
	SGLT2-Inhibitors ^d		12 (3%)
	Sulfonylureas		38 (9.5%)
	Thiazolidinediones (TZD) ^e		7 (1.8%)
JDHLQ score		22(18-25)	
JDHLQ category	High	89 (22.2)	
	Low	311 (77.8)	
MARS-5 score		21 (19-25)	
HbA1c		8 (6.7-9.93)	

a; recruited patients were on one or more hypoglycemic therapy

b: Dipeptidyl Peptidase IV inhibitors

c: Glucagon-like peptide-1 and Gastric inhibitory polypeptide receptor agonists

d: Sodium-Glucose Transport Protein 2 (SGLT2) Inhibitors

JD: Jordanian dinars, equivalent to \$1.41

A quantile regression was conducted to determine variables associated with the HbA1c levels. Results are displayed in Table 2. Higher JDHLQ scores were significantly associated with lower HbA1c (-0.050, 95% CI [-0.089, -0.011], $p=0.011$). In addition, patients taking a larger number of medications had significantly higher

HbA1c levels (1.131, 95% CI [0.445, 1.807], $p<0.001$). Moreover, patients who did not have insurance were found to have significantly higher HbA1c levels (0.615, 95% CI [0.118, 1.112], $p=0.015$). Finally, patients who did not take insulin had significantly lower HbA1c levels than those who took insulin (-1.433, 95%CI [-2.137, -0.692], $p<0.001$).

Table 2. Quantile regression analysis of variables influencing the diabetic control score.

Parameter		Coefficient	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
(Intercept)		5.996	<0.001	2.685	9.308
Age		-0.003	0.706	-0.020	0.013
JDHLQ		-0.050	0.011	-0.089	-0.011
Number of medications		1.131	0.001	0.455	1.807
Adherence score		0.029	0.269	-0.022	0.080
Gender	Female	0.038	0.867	-0.408	0.483
	Male	REF	.	.	.
Educational level	Elementary school	0.311	0.266	-0.238	0.861
	High school	0.129	0.644	-0.421	0.680
	Postgraduate education	REF	.	.	.
Marital status	Single	-0.050	0.884	-0.727	0.626
	Married	REF	.	.	.
Income	500JOD or less	0.591	0.031	0.056	1.126
	More than 500jOD	REF	.	.	.
Health insurance status	No	0.615	0.015	0.118	1.112
	Yes	REF	.	.	.
Insulin	High school	-1.433	<0.001	-2.173	-0.692
	Postgraduate education		.	.	.
Metformin	No	0.858	0.060	-0.036	1.751
	Yes	REF	.	.	.
DPP-4 inhibitors^a	No	0.633	0.154	-0.238	1.505
	Yes	REF	.	.	.
Sulfonylureas	No	0.478	0.308	-0.443	1.398
	Yes	REF	.	.	.

a: Dipeptidyl Peptidase IV inhibitors

REF=Reference group

4. DISCUSSION

The prevalence of DM is increasing worldwide due to factors such as poor diet, sedentary lifestyle, aging populations, and limited access to medical care and health-related information [24]. The increased incidence of DM is particularly pronounced in Jordan [25]. DM can contribute to various complications in addition to lower life expectancy. Therefore, identifying and managing factors that contribute to poor glycemic control in Jordanian patients is of central importance. This study aimed to investigate the relationship between Jordanian diabetic patients' health literacy (HL) and HbA1c levels, in addition to exploring other factors significantly associated with HbA1c level.

Our results showed that higher levels of diabetic health literacy are linked to lower HbA1c values, evidencing better glycemic control. Health literacy in diabetic patients influences their medication adherence, self-care behaviors, and health-seeking actions—all of which are central factors affecting disease progression and glycemic management [26]. These findings are consistent with previous studies, including cross-sectional research conducted in countries like the USA [11], Saudi Arabia [27], Ethiopia [26], Denmark [28], and South Korea [29]. Moreover, earlier literature has shown that interventions focused on improving health literacy have led to significant improvements in HbA1c levels [30].

Our study found that patients had inadequate diabetes health literacy, with a median score corresponding to 68.7%. Health literacy significantly impacts patients' behavior, including medication adherence and self-care practices. Therefore, evaluating and enhancing patients' health literacy through various strategies can substantially improve outcomes for individuals with DM. Developing and implementing culturally tailored programs to elevate diabetic-related health literacy is essential [21].

[18] In the present study, insulin usage was associated with higher HbA1c levels. This can be explained by the fact that, according to the guidelines, insulin is prescribed

to T2DM patients who are unable to achieve recommended glycemic control with first-line therapy. Therefore, insulin is generally reserved for more advanced and refractory cases of T2DM [31], as due to the progressive nature of the disease, multiple antidiabetic medications may be required to achieve recommended glycemic control [32].

Poor medication adherence is a crucial factor that leads to poor glycemic control and higher HbA1c levels [33]. Lower adherence to insulin therapy has been well-documented in previous studies [34]. Barriers that hinder DM patients' insulin adherence include being away from home, feeling embarrassed to inject insulin in public, fear of hypoglycemia, difficulty remembering to get refills from the clinician or to pick them up from the pharmacy, depression, health beliefs about medications, fear of pain, the burden of multiple daily dosages, cost, side effects, and the inherent complexity of insulin regimens [34,35]. However, implementing shared decision-making in developing an individualized treatment plan has been shown to enhance patient adherence [36]. Moreover, communicating these barriers to healthcare practitioners is a significant way to address them promptly [35].

In addition to medication adherence, healthcare professionals need to evaluate patients' adherence to self-care practices such as checking one's feet, following a healthy diet, engaging in physical activity, and monitoring blood glucose levels [37]. The observed relationship between the use of a higher number of oral glucose-lowering medications and insulin, and increased HbA1c levels, could be explained by a lack of regular assessments of adherence to self-care practices by healthcare providers before increasing the medication dosage.

The current study found that patients without health insurance had higher HbA1c levels compared to insured patients. This is in line with findings of a Canadian study [38], and a study conducted in the USA [39]. Thus, healthcare costs are a prominent barrier to medication adherence among DM patients which may impact treatment outcomes.

To summarize, the present study found that health literacy, insulin use, number of medications used, and health insurance status were factors significantly associated with patients' HbA1c levels, which cumulatively affected disease outcomes.

The present study has generated novel findings in the field of diabetic-related health literacy in Jordan. These findings are of great importance considering the lack of similar research in Jordan and the broader region. The findings shed light on the gaps in the field and address critical factors involved in diabetes management. Furthermore, the study provides recommendations tailored to the needs of the targeted population.

Nevertheless, some limitations need to be acknowledged. Apart from the information obtained from patient records, the present study relied on self-reported data, exposing the findings to recall and social desirability biases. Furthermore, it is possible that patients who found the study objectives interesting were more likely to participate, which could have led to selection bias, which may lead to skewness in the sample demographics, for example most of the current participants were females. Furthermore, the present study did not assess other factors that may impact glycemic levels, such as depression. Nevertheless, the main focus of this research was to assess the association between health literacy and glycemic levels. Additionally, although the data were collected from a single hospital, it was one of the country's largest medical facilities and served a substantial number of patients from various geographic regions. This diversity allowed for a broad sample, potentially enhancing the generalizability of our findings.

5. CONCLUSION

This study closely examined how diabetic health literacy influences glycemic control, specifically HbA1c levels, in Jordanian patients with T2DM. The results show that health literacy is a key factor in effectively managing T2DM. Patients who understood their condition better

tended to have lower HbA1c levels, indicating that improving health literacy could lead to better blood sugar control.

These findings are particularly important because there is limited research on this topic in Jordan and the surrounding region. They offer practical insights that healthcare providers and policymakers can use to develop strategies aimed at enhancing health literacy and improving diabetes management for patients in Jordan.

The limitations noted, such as the reliance on self-reported data and potential selection bias, suggest areas for further research. Future studies could incorporate more objective data collection methods and a broader participant base to confirm and expand upon these findings. Overall, enhancing diabetic health literacy remains a key strategy in the battle against diabetes in Jordan, with the potential to significantly reduce the burden of the disease on both patients and the healthcare system.

5.1. Practice implications

Investigating the prominent factors that have a significant role in disease control among T2DM patients in Jordan is essential for constructing well-structured targeted interventions in order to improve patient outcomes and reduce the burden of diabetes on the healthcare system.

Since health literacy greatly affects patients' behavior, assessing and improving patients' health literacy can significantly enhance diabetic patient outcomes. Therefore, applying culturally tailored programs to elevate diabetic-related health literacy levels is of great importance.

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CRediT authorship contribution statement

Abdel Qader Al Bawab: Writing – review & editing, Writing – original draft, Methodology, Conceptualization, Supervision. Walid Al-Qerem: Writing – review & editing, Writing – original draft, Methodology,

Investigation, Formal analysis, Data curation, Conceptualization, Supervision. Anan Jarab: Writing – review & editing, Investigation, Formal analysis, Conceptualization. Judith Eberhardt: Writing – review & editing, Investigation, Formal analysis. Fawaz Alasmari: Writing – review & editing, Formal analysis. Alaa Hammad: Writing – review & editing, Methodology, Conceptualization. Safa M. Alkaee: Writing – review & editing, Methodology, Conceptualization. Zein H. Alsabaa: Writing – review & editing, Methodology, Formal analysis, Conceptualization.

Institutional Review Board Statement:

The study followed the Declaration of Helsinki ethical guidelines. Ethical approval was secured from Al-

Zaytoonah University of Jordan (Ref#18/09/2022–2023).

Informed Consent Statement:

“Written informed consent has been obtained from the patient(s) to publish this paper”.

Data Availability Statement:

The dataset supporting the conclusions of this article is available in the Zenodo repository, <https://doi.org/10.5281/zenodo.11081022>

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العلاقة بين محو الأمية الصحية لمرضى السكري ومستوى HbA1c في الأردن

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ملخص

المقدمة: تهدف هذه الدراسة إلى استكشاف كيفية تأثير محو الأمية الصحية لمرضى السكري على مستويات الهيموجلوبين السكري - HbA1c وهي علامة حاسمة للتحكم في نسبة السكر في الدم على المدى الطويل لدى المرضى الأردنيين المصابين بداء السكري من النوع 2.

المنهجية: على مدى أربعة أشهر في مستشفى عام كبير في عمان، قمنا بتسجيل 400 مريض مصاب بداء السكري من النوع 2 في هذه الدراسة المقطعية. استخدمت الدراسة استبيان محو الأمية الصحية الأردني لمرضى السكري (JDHLQ). تقوم هذه الأداة التي تم التحقق من صحتها بتقييم محو الأمية الصحية بين الأفراد الناطقين باللغة العربية.

النتائج: كشفت النتائج عن وجود صلة كبيرة بين درجات محو الأمية الصحية المرتفعة وانخفاض مستويات HbA1c. على وجه التحديد، ارتبطت كل نقطة إضافية في JDHLQ بانخفاض 0.040 في 95% HbA1c [-0.078، CI -0.003]، $p = 0.035$. المرضى الذين يتناولون المزيد من الأدوية وأولئك الذين ليس لديهم تأمين لديهم أيضاً مستويات أعلى بكثير من HbA1c.

الخلاصة: تسلط هذه النتائج الضوء على الدور الحيوي لمحو الأمية الصحية في إدارة مرض السكري بشكل فعال ودعم تنفيذ البرامج التعليمية الهادفة لتحسين نتائج المرضى في الأردن. وتؤكد الدراسة على الحاجة إلى تحسين السياسات في رعاية مرضى السكري. الآثار المترتبة على الممارسة: يعد فهم العوامل الرئيسية التي تؤثر على السيطرة على المرض لدى مرضى السكري من النوع 2 بما في ذلك تأثير محو الأمية الصحية -أمراً ضرورياً لتطوير التدخلات المستهدفة، وتعزيز نتائج المرضى، وتقليل ضغط مرض السكري على نظام الرعاية الصحية.

الكلمات الدالة: محو الأمية الصحية، داء السكري من النوع الثاني، الأردن، التحكم في نسبة السكر في الدم.

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