Effects of health literacy on type 2 diabetic patients' glycemic control, self-management, and quality of life

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ABSTRACT

الأهداف: فحص المسار الذي يؤثر فيه المعرفة الصحية على نوعية الحياة حيث تتوسط مهارات الرعاية الذاتية والتحكم في نسبة السكر في الدم (الهيموغلوبين) بشرح هذه العلاقة.

المنهجية: خلال الفترة من أبريل 2019م وسبتمبر 2019م، تم ضم عينة ملائمة للمشاركين المصابين بداء السكري من النوع الثاني 2 من ثلاثة مراكز رعاية صحية أولية في المملكة العربية السعودية. جمعنا البيانات باستخدام المقابلات وجمع مستويات من الملفات الطبية.

النتائج: من بين 256 مشاركًا، كان لدى 27.3% معرفة صحية هامشية و35.5% لديهم معرفة صحية غير كافية. تؤثر المعرفة الصحية على مهارات الرعاية الذاتية ونسبة السكر في الدم (الهيموغلوبين). تؤثر المعرفة الصحية أيضاً على نوعية الحياة بشكل مباشر وغير مباشر، وتتوسط الرعاية الذاتية هذه العلاقة جزئيًا.

الخلاصة: يحتاج مقدمو الرعاية الصحية إلى تقييم المعرفة الصحية وتطوير برامج تعزز المعرفة الصحية لمرضى السكري لأنها تؤثر على مهارات الرعاية الذاتية والتحكم في نسبة السكر في الدم ونوعية الحياة. يؤدي تعزيز التثقيف الصحي إلى تحسين إدارة الرعاية الذاتية، مما يؤدي إلى تحسين نوعية الحياة لمرضى السكري. ينبغي النظر إلى المعرفة الصحية على أنها مفتاح التثقيف الصحي والرعاية الصحية.

Objectives: To examine the pathway in which health literacy affects diabetic patients' quality of life (QoL) with self-care management skills and glycemic control levels (hemoglobin A1c [HbA1c]) mediating the relationship.

Methods: A cross-sectional study carried out between April 2019 and September 2019. A convenience sample of participants with type 2 diabetes mellitus were recruited from 3 primary healthcare centers, Al Ahsa, Saudi Arabia. Data were collected using structured interviews and HbA1c levels were collected from medical files. Structural equation modeling was also used.

Results: Among the 256 participants, 27.3% had a marginal level of health literacy and 35.5% had an inadequate level of health literacy. Health literacy positively affects self-care management, glycemic control (HbA1c), and QoL directly and indirectly. Self-care management partially mediates this relationship.

Conclusion: Healthcare providers need to assess health literacy and develop interventions that enhance diabetic patients' health literacy because it influences self-care management skills, glycemic control, and patients' QoL. Health literacy should be considered as a key for health education and healthcare encounter to improve health outcomes.

Keywords: diabetes, health literacy, self-care management, quality of life, glycemic control, structural equation modeling

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Health literacy is a critical concept in healthcare settings and is defined as an individual's ability to access, comprehend, interpret, and apply information relating to their health.[1,2] Increased demands on individuals to take on more responsibility for their health have contributed to the necessity of having adequate education regarding their health.[3] Recently, health literacy has been considered as a means by which to attain health and wellbeing, a factor that can reduce health inequality within target populations, and a powerful determinant of the quality of human life in various areas.[4-6] Diabetes mellitus (DM) is one of the major chronic diseases that affects approximately

463 million people aged 20-79 years worldwide.[7] Type 2 DM is the most common type, as it accounts for 95% of DM cases worldwide (International Diabetes Federation, 2017). If type 2 DM is left unaddressed to the point of becoming unmanageable for the patient, it will lead to serious health complications, such as blindness, nephropathy, neuropathy, and cardiovascular disease.[8] There is a 4.5% increase in health expenses relating to diabetes among adults in this category.[7] Health information provided by healthcare providers regarding diabetes and time constraints related to making appointments can overwhelm the patient. Therefore, evidence highlights the importance of health literacy as a positive influence on patients with diabetes and their overall health, including any comorbid conditions from which they may be suffering.[9,10] Globally, 34.3% of patients with diabetes have limited education regarding health in general.[11] In clinical and research settings, health literacy among patients with type 2 DM has received special attention.[12] Yet, the pathway in which health literacy can lead to different health outcomes among patients with diabetes requires further studying.

Diabetes encompasses a wide range of self-care activities (such as, self-glucose monitoring, insulin injection, foot care, diet calorie calculation, and adherence to medical therapy) to prevent complications and comorbid conditions from developing.[13] Based on the Paasche-Orlow and Wolf theoretical model, health literacy enables patients to acquire self-care management skills.[14] Despite the growing evidence supporting how the direct link between health literacy and self-care management skills has a positive outcome for patients, a previous study contradicted these findings, stating that the relationship between self-care management skills and health literacy was inconclusive.[15-17] In addition, systematic reviews have revealed that limited evidence existed to support the relationship between health literacy and diabetic patients' self-care activities, medication adherence, and glycemic control.[10,18,19] The hemoglobin A1c (HbA1c) level is an indicator of glycemic control, and maintaining target levels for a long period is associated with a decrease in the incidence of cardiovascular death, nephropathy, neuropathy, and retinopathy.[13] Compared with adequate health literacy, inadequate health literacy is independently linked to worse glycemic control with odds ratio ranges of 2.03-4.76.[20,21] However, a previous study reported no significant or moderate relationship between health literacy and HbA1c level control.[22] Thus, the relationship between health literacy with HbA1c is still inconclusive and requires further studies.[23] Moreover, quality of life (QoL) in relation to health plays a crucial role in the health outcomes of patients with diabetes and is thought to be the psychological indicator for controlling the disease; because people make their own judgments regarding their health and wellbeing.[24-26] Increased evidence has linked DM with a lower QoL, and health literacy explained 47.5% of the variance that existed in the QoL related to one's health in patients with diabetes.[27,28] However, inconsistent findings have been produced across the board that link poor health literacy and lower health-related QoL among patients with diabetes.[29]

Various cultural context and health care systems could shape the effect of health literacy on diabetic patients' health outcomes in different ways.[30] The interaction between patients and healthcare systems influences both the patient's health literacy and health outcomes by providing context for their health in particular.[31] Saudi Arabia is among the top 10 countries with the highest rate of diabetes with an incidence of 31.4 per 100,000 individuals.[7] Only a few studies have examined health literacy among patients with diabetes, but they have not studied the impact of health literacy on the QoL related to health, self-care management skills, and glycemic control.[32,33] Understanding the effect of health literacy on patients with diabetes could provide information and direction for the development of effective interventions. Given the aforementioned gap and need, the present study aims to examine the impact of health literacy on the health outcomes of patients with type 2 DM in Saudi Arabia. The study hypothesizes that among patients with type 2 DM, health literacy affects the QoL related to health, and both self-care management skills and glycemic control (HbA1c) mediate the relationship.

Methods. Using a cross-sectional design, 3 primary healthcare centers, Al Ahsa, Saudi Arabia, were accessed. These primary healthcare centers are operated under the Saudi Ministry of Health to deliver free preventive and curative services at primary, secondary, and tertiary levels. All these centers are considered the first point of contact for patients within the healthcare system. A convenience sampling method was used to recruit participants during their follow-up appointments between April 2019 and September 2019. The inclusion

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criteria were male/female adults (aged 18-65 years), diagnosed with type 2 diabetes, and not pregnant. Patients aged 65 years or older were excluded; because of their health conditions and the fact that their needs were different from those of younger patients. The minimum sample size for structural equation modeling (SEM) is 200.[34] Thus, 300 participants were approached initially in primary healthcare centers. Of the 300 participants, 269 individuals agreed to participate in the study, resulting in a response rate of 89.7%. The final number of participants included in the analysis was 256; because 13 participants had missing data that were too substantial.

Prior data collection and ethical approvals from the Ministry of Health and King Saud University, Riyadh, Saudi Arabia, were obtained. Potential participants were screened for eligibility, provided with an explanation of the study, and asked to meet the trained data collectors. Informed consents were obtained once participants were selected and face-to-face structured interviews were carried out in private rooms at each center. Subsequently, participants' medical files were accessed to obtain their HbA1c level data.

Participants were asked about their demographic data, including age, gender, marital status, highest level of education, employment status, income level, and living accommodations.

This study utilized the Brief Health Literacy Screening Tool (BRIEF) health literacy screening tool that measures individuals' functional health literacy.[35] The BRIEF is composed of 4 questions and uses a 5-point Likert scale. The first 3 questions identify patients with marginal and inadequate health literacy, and the fourth question bridges the lack of spoken health information measurements in the literature. The BRIEF scores range from 4-20. The total score can be used to categorize health literacy into 3 scoring groups, where scores from 4-12 indicate an inadequate level of health literacy, scores from 13-16 indicate marginal levels of health literacy, and scores from 17-20 indicate adequate levels of health literacy.[35] This tool is proven to accurately identify marginal/inadequate health literacy levels for study participants. Given its brevity, the scale has been used in different country.[36,37] Since the scale was not used in an Arab context before, an integrated method of adapting and translating the measurements was used.[38] Based on this process, 3 steps were carried out. First, an assessment of the conceptual equivalence of the scale was carried out by 5 bilingual and bicultural healthcare providers who were familiar with the concept of health literacy. They rated each item using a 10-point scale with respect to both the relevance and clarity (comprehension) for Arab context. Based on their rating, the content validity index ranged from 0.87-0.98. Thus, item modifications were not needed because all items were considered culturally relevant and understandable. Subsequently, the forward translation from English to Arabic was carried out by 2 translators. The final Arabic version was put through a pilot test with 30 Saudi patients with diabetes and showed that the Cronbach's alpha (α) was 0.77. In this study with 256 participants, the Cronbach's alpha was 0.76.

This study used the Summary of Diabetes Self-Care Activities (SDSCA) scale to measure a variety of self-care management skills.[39] Measures include 11 items in 5 subscales of self-care-diet (4 items), physical exercise (2 items), blood monitoring (2 items), foot care (2 items), and smoking (one item).[39] It asks questions that can be answered using an 8-point Likert scale (0-7) that reflects the number of days in the previous week when the given activity of self-care was carried out. The mean score for each dimension represents the rate of adherence. The scale was previously used in a different cultural context.[40,41] The Arabic SDSCA was adapted and used to include 8 items in 4 subscales: diet (2 items), physical exercise (2 items), self-monitoring of blood glucose (2 items), and foot care (2 items).[42] In the present study, the total scale's Cronbach's α for internal consistency was 0.83.

The study used the World Health Organization Quality of Life (WHOQOL)-BRIEF scale to measure individuals' general perception of their QoL.[43] The BRIEF measure of WHOQOL is composed of 24 items divided into 4 main domains; environmental (8 items), social relations (3 items), psychological health (6 items), and physical health (7 items), along with 2 items as general questions.[44] The scale score is calculated based on the domains, so each score was separately reported by computing the mean of a given domain. Higher domain scores indicated higher QoL in that particular area.[45] The BRIEF measure of WHOQOL has significant potential for easy cross-cultural use, as it has been developed and tested in diverse cultures with a Cronbach's α of >0.7.[46-48] For the purpose of the study, the Arabic version was used (44), and the Cronbach's α for the domains was 0.82 for physical health, 0.82 for psychological, 0.80 for environment, and 0.68 for social. In the analysis, QoL was considered as a latent variable with the 4 domains as indicators.

The most recent HbA1c level was obtained from the patients' medical files. Hemoglobin A1c level was presented as a percentage, with the normal range being 4-6.4%.[13]

Statistical analysis. The Statistical Package for the Social Sciences, version 25.0 (IBM Corp., Armonk, NY, USA) and Mplus version 8 were used to analyze

the data. A descriptive analysis was carried out to analyze participants' demographic data and the study's variables. Spearman's correlation analysis was carried out to examine the relationship between health literacy and participants' demographic characteristics (age, education, and income), whereas the independent samples T-test was used to test the differences in health literacy between male and female participants. To assess the effect of health literacy on each possible health outcome (hypothesis), SEM was carried out using the fit indices that assess the model fit with the data. For an adequate fit, the index values were as followed: comparative fit index (CFI), Tucker-Lewis index (TLI) of ≥0.90, root-mean-square error of approximation (RMSEA), and standardized root-mean-square residual (SRMR) of <0.08.

Results. Table 1 presents the participants' background characteristics. Most participants were females (75.4%). With respect to age, 71.9% were aged 41-65 years. Participants had different levels of education, with 15.2% having a bachelor's degree and 28.5% being uneducated/illiterate. With respect to job status, 5.5% were retired, and 59.0% were unemployed. The percentage of family income levels for 28.5% of the participants was below 5000 Saudi Riyals (SR), whereas 4.7% of the participants' income level was above 20,000 SR. With respect to healthcare use during the past 12 months, 36.8% of the participants made at least one visit to the emergency department, and 60.5% were admitted at least once due to diabetes.

Among the 256 participants, 37.1% had adequate health literacy, 27.3% had marginal health literacy, and 35.5% had inadequate health literacy (Table 1). Looking specifically at each item, 38.3% always or often required assistance when reading hospital materials, 19.6% always or often had problems understanding written materials related to their medical condition, 8.6% always or often had problems understanding what was explained to them regarding their medical condition, and 43.4% had little to no confidence in filling out medical forms. A descriptive analysis of the study variables is presented in Table 2. For total functional health literacy, the mean score was 14.08±4.31. The mean score for diabetes self-care management skills was 33.06±7.39. The mean scores for QoL in the 4 domains were as followed: physical domain of 25.31±4.13, psychological domain of 21.84±3.31, social domain of 12.77±1.78, and environmental domain of 27.61±5.01. The mean score of HbA1c level was 8.22±1.15.

Significant correlations were observed between participants' health literacy and their demographic characteristics in Table 3. The highest positive correlation coefficient was for education (rs (254)=0.671, p=0.001), followed by family income (rs (254)=0.346, p=0.001), with a negative correlation coefficient for age (rs (254)= -0.375, p=0.001). Based on the independent samples t-test results, there was a significant difference between the mean health literacy scores of men and women (t (128.9)= -2.445, p=0.016), showing that women had lower health literacy (13.75±4.47) than men (15.11±3.62).

For hypothesis testing, SEM was carried out and showed an adequate fit with the data: χ^2 (10) =40.40, CFI=0.965, TLI=0.972, RMSEA=0.010 (90% CI= [0.07-0.14]), and SRMR=0.036. Figure 1 shows the standardized β regression coefficients for each path. With QoL as the latent measure, the loading

Table 1 - Demographic characteristics of the participants (N=256).

Characteristics	n (%)
Age (years)	
>65	31 (12.1)
41-65	184 (71.9)
25-40	40 (15.6)
<25	1 (0.4)
Gender	
Male	63 (24.6)
Female	193 (75.4)
Marital status	
Divorced	14 (5.5)
Married	195 (76.2)
Single	10 (3.9)
Widowed	37 (14.5)
Education	
Uneducated	73 (28.5)
Primary	32 (12.5)
Intermediate	23 (9.0)
Secondary	59 (23.0)
Diploma	30 (11.7)
Bachelor's degree	39 (15.2)
Occupation	
Unemployed	151 (59.0)
Employed	91 (35.5)
Retired	14 (5.5)
Housing	
Rented flat	30 (11.7)
Owned flat	11 (4.3)
Traditional house	115 (44.9)
Villa	100 (39.1)
Family income (SR)	
<5000	73 (28.5)
5000-10000	92 (35.9)
10000-20000	79 (30.9)
>20000	12 (4.7)
Health literacy categories	
Adequate health literacy	95 (37.1)
Marginal health literacy	70 (27.3)
Inadequate health literacy	91 (35.5)

Values are presented as numbers and precentages. SR: Saudi Riyals

factors were significant (0.480-0.899). Health literacy positively affects self-management skills (β=0.360; B=0.616; *p*=0.00) and negatively affects HbA1c level (β= -0.297; B= -0.079; *p*=0.00). Moreover, self-management skills positively affect QoL (β=0.670; B=0.313; *p*=0.00), whereas HbA1c levels do not significantly affect it (β=0.050; B=0.150; *p*=0.314). Health literacy directly (β=0.271; B=0.217; *p*=0.00) and indirectly (β=0.241; B=0.193; *p*=0.00) affects QoL through self-care management skills. In other words, only self-care management skills mediate the relationship between health literacy and QoL, whereas a significant correlation exists between self-management skills and HbA1c level (-0.340).

Discussion. The findings from this study are important because type 2 diabetes is the ninth leading cause of death, and 6.3% of the world's population

Table 2 - Descriptive statistics of study variables.

Variables	Mean±SD	Range	Skewness	Kurtosis
Total functional health literacy	14.08±4.31	4-20	-0.55	-0.69
Diabetes self-management skills	33.06±7.39	15-48	-0.52	-0.69
Quality of life				
Physical domain	25.31±4.13	13-34	-0.48	-0.36
Psychological domain	21.84±3.31	12-28	-0.59	-0.15
Social domain	12.77±1.78	5-15	-1.29	2.78
Environmental domain	27.60±5.01	12-37	-0.46	0.12
Hemoglobin A1c	8.22±1.15	5–11.9	4.2	0.90

SD: standard deviation

Table 3 - Spearman's correlation between health literacy and age, education, and income.

Demographic data	Spearman's correlation			
	Age	Education	Family income	Health literacy
Age	1.00			
Education	-0.56**	1.00		
Family income	-0.36**	0.64**	1.00	
Health literacy	-0.33**	0.63**	0.49**	1.00

**A *p*-value of <0.01, (2-tailed)

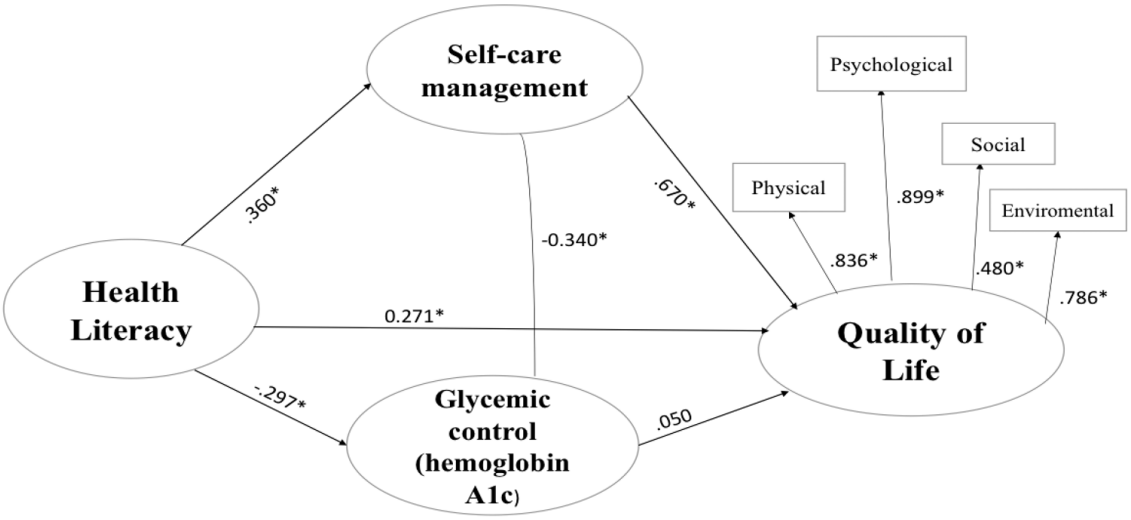

Figure 1 - Structure equation modeling with the standardized regression coefficients.*Significant

is composed of patients with diabetes. Our study contributes unique information by showing how health literacy affects health outcomes. The study showed that the mean score of health literacy was 14.08 out of 20. This finding was similar to a previous study in Australia that used the same health literacy screening tool and found that the mean score of the participants' health literacy was 14.67.[49] In addition, our study showed that 62.8% of patients with type 2 DM have suboptimal levels of health literacy (35.5% had inadequate health literacy, and 27.3% had marginal health literacy). This finding was partially consistent with previous studies carried out in different parts of the world where 32.9-64% of patients with diabetes had limited or marginal levels of health literacy. Low health literacy requires attention because inadequate and marginal health literacy levels put a significant financial burden on the healthcare system compared with adequate health literacy.[52] Healthcare providers are required to explore effective methods of providing patients with health education.

Identifying patients' demographic characteristics, which are linked to health literacy, is important for healthcare providers.[53] The present study demonstrated that health literacy was positively associated with education and income but negatively associated with age. Discovering that higher education and income levels resulted in higher health literacy scores was congruent with previous findings.[11,32] Higher income levels increase the accessibility of education and eventually enhance the skills required to read written materials regarding health management, interpret information, communicate with healthcare providers, and navigate the healthcare system.[54] Additionally, when people get older, their health literacy level decreases.[55] Healthcare providers should consider educating older patients in person rather than only providing written materials, speak a common language (no jargon), and break information down into smaller parts.[56] Although the literature for gender-related differences in health literacy is still inconclusive.[57] In our study, women had a lower level of health literacy. Yet, the majority of participants in this study were female, so the comparison may not be precised.

Although the relationship between health literacy and glycemic control is considered inconclusive, the present study found that health literacy affects HbA1c levels.[19] Our study also showed that health literacy positively affects self-care management skills for diabetes, which is negatively associated with HbA1c levels. Limited health literacy leads to poorer diabetes self-care management skills, which may affect the control of HbA1c levels. This finding was similar to a structural equation modeling study that found self-efficacy was directly affected by health literacy, which predicted glycemic control.[16] To ensure sufficient diabetes self-care management skills, it is necessary for patients with diabetes to possess a high level of health literacy. These skills are needed in day-to-day decision making, such as when measuring blood sugar levels and patients with diabetes need to respond with the appropriate action for the reading they receive.[58,59] Healthcare providers can improve the self-care management skills of patients with diabetes by enhancing their health literacy level through educational means, both face-to-face and through written information. This finding addresses the importance of not only treating the individual's disease but also assessing and strengthening his/her health literacy level.

The present study revealed the direct and indirect effects of health literacy on patients' QoL, which was measured based on 4 domains: physical, psychological, social, and environmental. The current analysis showed that self-care management skills mediated the relationship between health literacy and QoL. Patients with diabetes possessing an inadequate level of health literacy find it difficult to understand their health status, affecting their ability to manage their health needs and compromising their overall QoL.[60] To some extent, this finding was consistent with previous studies with patients with no diabetes.[60-62] Quality of life is a major aim for public health as healthcare planners are increasingly realizing that disease metrics alone are insufficient determinants of health status and subjective measures are needed to indicate wellbeing.[63] Interventions aimed at enhancing health literacy would positively improve self-care managements skills and patients' QoL. It is crucial for healthcare providers to consider the differences in the 4 QoL domains to effectively coordinate and create a care plan for their patients.

Study limitations. The cross-sectional design which does not enable the determination of causality of a predictive relationship. Moreover, relying on self-reported data can be subjected to biases, such as recall bias, respondent bias, or social acceptability bias. Furthermore, using convenient sampling might limit the generalization of the findings. The study only investigated one dimension of health literacy (namely, functional health literacy), which might limit our understanding of health literacy outcomes.

In conclusion, our study demonstrates the importance of health literacy in predicting glycemic control levels (HbA1c levels), diabetes self-care management skills, and QoL among patients with type 2 DM. Self-care management skills mediate the

relationship between health literacy and QoL. Patients with diabetes who are given a non-compliance label due to limited health literacy may require special attention. Further research is required to investigate the mediating and moderating effects of different concepts, which were not included in this current study.

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