Original Article :

The Relationship Between Informal Caregivers' Knowledge of Type 2 Diabetes Mellitus Management and Patients' HbA1c Levels Among Older Adults in Saudi Arabia

Jamilah Fallatah[1], Lisa Ann Kirk Wiese[2], Howard Karl Butcher[3], Maysaa Barakat[4]

1. Assistant professor, Nursing Department, King Saud Bin AbdulAziz University of Health Sciences, King Abdullah International Medical Research Centre (KAIMRC).
2. Associate Professor, C.E. Lynn College of Nursing Florida Atlantic University, Boca Raton, FL
3. C.E. Lynn College of Nursing Florida Atlantic University, Boca Raton, FL
4. Associate Professor, Department of Educational Leadership and Research Methodology, Florida Atlantic University

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Corresponding Author:
Jamilah Fallatah, Ph.D, Assistant professor, Nursing Department, King Saud Bin AbdulAziz University of Health Sciences, King Abdullah International Medical Research Centre (KAIMRC).
Email: Fallatahja111@gmail.com

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Abstract

Background and Aims:
Almost seven million persons in Saudi Arabia are diagnosed with Type 2 Diabetes Mellitus (T2DM). Limited knowledge among informal caregivers may adversely influence diabetes management and patient outcomes, yet structured caregiver education remains insufficient. There is a need to discover T2DM informal caregivers' knowledge and its relation to patients' T2DM management. This study aimed to assess the level of T2DM knowledge among informal caregivers of Saudi patients and to examine its association with patients' glycemic control (HbA1C levels). The study was guided by Nursing theories.

Methods:
A quantitative, correlational design was used. Convenience sampling of 37 caregiver–patient dyads (N = 74) was conducted at primary health centers in Jeddah, Saudi Arabia. Data were collected using self-reported HbA1C values and the Brief Diabetes Knowledge Test. Pearson's correlation and multiple linear regression analyses were performed.

Result:
The mean diabetes knowledge score among caregivers was low (M = 8.03), indicating average knowledge. No significant correlation was found between caregiver T2DM knowledge and patients' HbA1C levels. Multiple regression analysis showed that caregivers aged 31–45 years and those employed as students were significant positive predictors of higher diabetes knowledge scores.

Conclusion:
The findings demonstrate that informal caregivers possess only moderate knowledge of T2DM management. Further research, including qualitative inquiry, is recommended to explore how caregivers acquire and apply diabetes-related knowledge and how this knowledge may influence patients' glycemic outcomes.

Keywords:
Type 2 Diabetes, HBA1C Levels, Caregivers, Saudi Arabia

Introduction:

Globally, an estimated of 462 million individuals are affected by T2DM; thisnumber represents 6.28% of the world's population.[1] The International Diabetes Federation (IDF) stated that the global increase of diabetes cases is expected to increase from 171 million in 2000 to 578 million in 2030. In July 2020, the number of people with DM is calculated to be approximately 463 million worldwide.[2] Saudi Arabia ranks the second highest in the Middle East for DM and is ranked seventh in the world for its increasing rate of DM cases. T2DM inSaudi Arabia is now emerging as an epidemic. [3,4]

The estimated annual cost of DM in Saudi Arabia is 17 billion Riyals ($0.45 billion), which is estimated to increase to 27 billion Riyals ($0.71billion) when those who are undiagnosed are included in the treatment pool.[5] The Saudi Arabian Ministry of Health reported that in 2015, approximately 4660 patients with DM attended the family and medical clinics across Saudi Arabia.[6]

Almost seven million (24%) of the Saudi population are diabetic, and three million are pre-diabetic.[7] In particular, Type 2 DM (T2DM) affects productivity and the quality of life for Saudi patients, as well as their families[8], due to their sedentary movement and lifestyle, and increased digestion of higher-fat diets. The prevalence of T2DM in Saudi Arabia is particularly prevalent in the county's urban regions.[9] Social norms in Saudi Arabia reflect that patients will usually be cared for by family members at home. In addition, cultural and historical backgrounds strongly influence their perceptions and beliefs about DM as a disease, such as the use of herbs instead of the prescribed medications.[10,11] Furthermore, management of DM includes some practices that reveal a lack of knowledge and awareness among the people with this disease and their informal caregivers.

T2DM accounts for more than 90% of patients with diabetes. The resulting elevation of the blood level of glucose over time leads to severe damage to the heart, blood vessels, eyes, kidneys, and nerves.[12] The disease causes deterioration in overall health over time, and the risk of complications increase, especially with poor glycemic control.[13] Persons living with Type 2 DM (PwT2DM) also experience emotional stress and suffer from sleep dysfunction as a result of the continuous requirements of their care.[14] The increase of T2DM prevalence is projected to place

heavy burdens on families who are assumed to take on the role of the main care-provider for older family members.[15] Therefore, PwT2DM may be better served at home with a knowledgeable and trained informal caregiver.[16]

An informal caregiver is defined as a family member or a friend who provides unpaid help.[17] Informal caregivers play an essential role in maintaining the health and wellness of older adults who maintain chronic diseases, such as T2DM.[18] It is important to note that to care for a PwT2DM it is essential that this person be vigilant in recognizing and managing diabetes complications in older adult caregivers, such as vascular diseases.[19] Caregivers' knowledge about T2DM can reduce medical costs, as it may prevent hospitalization, thereby reducing the risk of morbidity and mortality. Additionally, a large percentage of older adults tend to be dependent on care from others as they age.

Thirty-seven percent of older adults with T2DM often receive self-management support from adult children, with 37.5%, 21.8% from siblings, 26.3% from close friends residing outside of their home, 5.5% from partners, and 10.2% from parents.[20] Similarly, a group of researchers found that the relationship that exists between the caregivers and the patients varied; 38% of the participants were siblings, 15% were children, and 8% were spouses.[21]

Previous studies of current knowledge among the public in Saudi Arabia supported the need for greater awareness of prevention, diagnosis, and risk factor control in diabetes.[22,23]

Further, Wolde et al.[24] reported that family members of individuals with diabetes in Ethiopia demonstrated generally low levels of diabetes knowledge, highlighting gaps across both prevention and disease management. The authors emphasized the need for targeted educational interventions to strengthen caregivers' understanding. Similarly, several studies from Saudi Arabia have documented low to moderate knowledge levels regarding diabetes epidemiology and illness management.[23,25] Alanazi et al.[25] found that many participants lacked adequate knowledge on key aspects of diabetes, including its causes, complications, and appropriate management and preventive measures.

Across the literature, investigators consistently note limited diabetes knowledge among the general population and informal caregivers, suggesting that caregivers of older adults may not possess the necessary understanding to provide

optimal support.[24,26] Theoretical frameworks further support the importance of caregiver knowledge. Informal caregivers' attempts to understand and engage with their loved ones' experiences align with the core principles of Nursing as Caring Theory (NAC)[27], in which caring responses foster motivation to learn and support the person's unique needs. Likewise, the Individual and Family Self-Management Theory (IFSMT)[28] asserts that disease-specific knowledge is fundamental to effective self-management. According to this model, accurate knowledge strengthens confidence and self-efficacy, enabling individuals and families to participate more actively in care. The theory also highlights individual and family characteristics, such as age, gender, education, income, and prior diabetes education as important contextual factors influencing caregiving.

Evidence from Saudi Arabia reinforces the need to enhance public awareness and understanding of diabetes.[23,25] Given that informal caregivers are central to home-based diabetes management, strengthening their disease-specific knowledge is essential for improving care quality and patient outcomes.

Significance of the Study:

Diabetes Mellitus (DM) imposes substantial clinical, economic, and social burdens on individuals, families, and healthcare systems worldwide. The increasing prevalence of Type 2 Diabetes Mellitus (T2DM) and its associated complications have intensified pressure on healthcare infrastructures, drawing the urgent attention of policymakers, public health authorities, and government health organizations.[23,25] These rising challenges underscore the importance of conducting research that addresses the essential role of families in chronic illness management.

Informal caregivers including family members serve as the primary support system for older adults living with T2DM. Their level of knowledge directly influences patients' daily self-management practices, treatment adherence, and complication prevention.[24,26] Evidence indicates that when caregivers are knowledgeable, they can help prevent acute and chronic complications, reduce avoidable emergency visits and hospitalizations, and ultimately lower healthcare costs while decreasing morbidity and mortality associated with poor glycemic control.[24,25]

In Saudi Arabia, where family involvement is central to caregiving, enhancing caregivers' diabetes-related knowledge becomes even more critical

for improving patient outcomes.[23,25] This study contributes important evidence needed to guide culturally appropriate caregiver education and family-centered interventions. Such efforts align with national public health priorities and chronic disease initiatives outlined in Saudi Arabia.

The aim of the Study:

1. To assess the level of diabetes knowledge among informal caregivers of patients with T2DM in Saudi Arabia.
2. To examine the relationship between caregivers' diabetes knowledge and patients' glycemic control (HbA1C levels).
3. To identify predictors of diabetes knowledge among informal caregivers based on their sociodemographic characteristics.

Research Questions:

1. Is there a relationship between the DKT2 knowledge score of informal caregivers in Saudi Arabia and patients' HbA1C levels?
2. What are the factors that may predict DM knowledge, including age, gender, education, and employment status?

Hypothesis:

H0: There is no statistically significant relationship between caregivers' diabetes knowledge and patients' HbA1C levels, and sociodemographic factors do not significantly predict caregivers' knowledge.

H1: There is a statistically significant relationship between informal caregivers' diabetes knowledge and patients' HbA1C levels, and sociodemographic factors do significantly predict caregivers' knowledge.

Conceptual- theoretical framework:

The caring relationship between patients with Type 2 Diabetes Mellitus (PwT2DM) and their informal caregivers is central to maintaining personhood and promoting health within a compassionate environment. Guided by NAC theory[27], caregiving is viewed as a mutual, respectful process in which both caregiver and patient engage in a "dance of caring" that honors each person's uniqueness. Complementing this, the IFSMT[28] explains how knowledge and confidence enable effective diabetes management. Successful individual and informal caregivers in DM management, with respect to all factors and facilitators, will be representative through the proximal outcomes, including diabetes stability by stable HBA1C. Together, these frameworks emphasize that informed, caring relationships enhance DM-management, stabilize HbA1C levels, and improve overall health. The Conceptual–Theoretical Model is proposed in Figure 1.

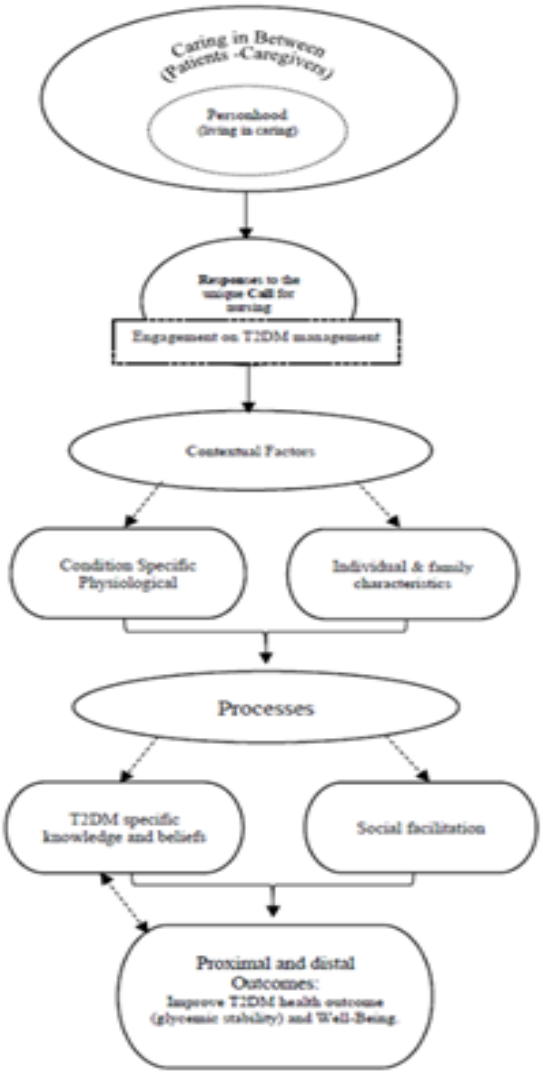


Figure 1: Conceptual–Theoretical Model of the Relationship Between PwT2DM and Their Informal Caregivers

Research Methodology:

Study Area/Setting:

This study was conducted in Jeddah, Saudi Arabia, at the primary health centers of King Abdulaziz Medical City (KAMC), under the Ministry of National Guard Health Affairs (MNGHA). These centers provide primary healthcare services to a large and diverse urban population, making them suitable settings for studying diabetes management and caregiver involvement.

Study Subjects:

The study population consisted of patient–caregiver dyads, including individuals diagnosed with Type 2 Diabetes Mellitus (T2DM) and their informal (family) caregivers who assisted in diabetes management at home. A total of 37 dyads (N = 74 participants) were enrolled. All participants provided informed consent and

completed the study questionnaires.

Study Design:

A quantitative, non-experimental, cross-sectional correlational design was employed in this study. This design was selected to examine the natural relationships between informal caregivers' knowledge of Type 2 Diabetes Mellitus (T2DM) and patients' glycemic control (HbA1C levels) without manipulating any variables. The cross-sectional approach, in particular, allows for data collection at a single point in time, making it efficient for describing existing conditions and identifying potential associations.[40] This design was chosen because it is well-suited for exploratory nursing and community health research, where ethical or practical constraints prevent experimental manipulation. It enables the assessment of caregivers' knowledge and patients' outcomes in their natural home-care and clinical environments.

Sample Size:

The final sample comprised 37 caregiver-patient dyads (N = 74), determined using G*Power analysis[29] to ensure adequate statistical power. The sample size was also influenced by feasibility and accessibility during the COVID-19 pandemic restrictions, which limited recruitment opportunities. Despite these constraints, the sample met the minimum requirements for Pearson's correlation and multiple regression analyses, consistent with recommendations for preliminary nursing research.

Sample Technique:

A convenience sampling technique was applied. This approach allowed inclusion of participants who were readily available and willing to participate, Eligible participants included informal caregivers aged ≥18 years providing care to Saudi adults over 50 with T2DM who consented to participate.

Data Collection methods:

The Revised Brief Diabetes Knowledge Test (DKT2)[30], to measure informal caregivers' knowledge about diabetes. The scale was developed by the University of Michigan's Diabetes Research and Training Center. The test was widely used to assess the degree of knowledge about both Type 1 and Type 2 diabetes.[31], A researcher added that The Diabetes Knowledge Scale provides researchers with a straightforward assessment of diabetes knowledge in the intended population.[3] The test contains 2 sections, a general knowledge segment (14 items) and the insulin use subscale (9 items). Each test segment can be used independently. The Flesch-Kincaid grade level was applied to measure the test's readability, which was calculated at the fourth-grade reading level.[31] The DKT2 was translated into Arabic and evaluates the psychometric properties of this new Arabic version. The Arabic DKT2 received

an internal consistency score of 0.75, which was within the recommended range of Cronbach's alpha test.[32]

Sociodemographic questionnaire forms administered to participants as presented in sociodemographic survey developed and modified by the researcher. This measure includes questions about the participants' age and gender for both PwT2DM and informal caregivers. Informal Caregivers' educational level, marital status, employment status and income. There were also questions about relationship with the patient, family history of DM, previous DM related education session and help received by others when caring for an older adult patient with T2DM.

The HbA1C level of ≥ 7% [(53 mmol/mol] was considered to be an indicator of poor glycemic control in PwT2D, which increases the risk of diabetes related complications. In this study, most recent HbA1C levels were self-reported by the. PwT2DM, for obtaining the most recent HbA1C levels in percentages. Good glycemic control was defined as HbA1C values of <7%, and those with poor glycemic control with HbA1C values of ≥ 7%.[20,33,34]

Validity and Reliability of The Scales:

The DKT2 demonstrated satisfactory internal consistency (Cronbach's α = 0.75). The Arabic translation was reviewed by bilingual experts to ensure content validity and cultural appropriateness. Regarding the sociodemographic tool, its content validity was established through expert panel review by specialists in community health and nursing education to ensure cultural and contextual appropriateness. Also, the tool comprised standard demographic items consistent with prior diabetes and caregiving studies in the Saudi context, supporting its face and content validity.

Data Collection Procedure:

After obtaining Institutional Review Boards (IRB) and site approval, recruitment was conducted in the waiting areas of primary health centers. Eligible participants were informed about the study purpose and procedures. Following informed consent, caregivers and patients completed the questionnaires in a private setting, either independently or with researcher assistance if needed. Data collection took approximately 20–25 minutes per dyad.

Data Management and Analysis Plan:

Data analyses included descriptive statistics, preliminary Pearson correlations, and multiple linear regression using SPSS version 28.[35] Pearson's correlation coefficient was a parametric test of the relationship strength between two variables of interval or ratio measurement scale. Assessment of the association was determined between informal caregivers' diabetes disease knowledge (an ordinal

measure), and the patient's HbA1C level (a ratio measure). Multiple linear regression was used to examine potential predictors of DM knowledge. In essence, the independent variables (IV), which are the sociodemographic characteristics, may predict the dependent variable (DV) which was level of knowledge among informal caregivers. Linear regression procedures used to establish the relationship between two variables along a straight line.

Ethical considerations:

Approval was obtained from the KAIMRC's IRB (SP22J/056/04). All documents were provided in both Arabic and English versions. The DKT2 was translated and validated[6], and permission obtained to be used in this study. This study had minimal risk, as no invasive intervention was used. The KAIMRC Arabic and English consent form was used to obtain their agreement to participate. The informed consent for this study included the title of the study, purpose, risk, benefits, privacy rules, and the contact information. The participants were informed that they will be free to withdraw from the study at any time during the study. To emphasis on confidentiality and anonymity of information, data protected and stored securely. Electronic data analysis, transcription files, and other computer files secured on a password-protected computer.

Results:

All data variables were processed, and analysis was performed using SPSS version 28. The study was conducted at King Abudulaziz medical city (KAMC›s) primary care centers, i.e., diabetes clinics, and medical in-patient wards, separated into 'males, and females' sections, in Jeddah, Saudi Arabia. Saudi older adult patients with diabetes aged 50 years or older with no cognitive impairments, and their informal caregivers with any nationality who provides diabetes management at home were eligible for the study and aged 18 years or older. Demographic and clinical characteristics of both patients and caregivers are summarized in Table 1 and Table 2, respectively.

Table 1: Frequency Distribution of Patients' Nominal Variables.

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	50–59	3	8.1
	60–69	14	37.8
	70–79	13	35.1
	≥80	7	18.9
Gender	Female	22	59.5
	Male	15	40.5

Percentages are calculated based on the total number of patients (N = 37).

Table 2: Frequency Distribution of Informal Caregivers' Nominal Variables (N = 37).

Variable	Category	n	%	Mean
Age	18–30	14	37.84	
	31–45	18	48.65	0.68
	≥46	5	13.51	
Education	Below high school	7	18.92	
	High school	11	29.73	2.32
	Bachelor's degree or higher	19	51.35	
Employment Status	Full-time job	11	29.73	
	Part-time job	3	8.11	2.51
	Not employed	16	43.24	
	Student	7	18.92	
Gender	Female	21	56.76	0.43
	Male	16	43.24	
Marital Status	Single	20	54.05	1.56
	Married	15	40.54	
	Widow	2	5.41	
Relationship to Patient	Spouse	2	5.41	2.08
	Son/Daughter	31	83.78	
	Grandchild	3	8.11	
	Other	1	2.70	
Nationality	Saudi	36	97.30	1.02
	Non-Saudi	1	2.70	

Percentages (%) are calculated based on the total sample of informal caregivers (N = 37). Means and represent the coded numerical values assigned to each categorical variable for statistical analysis. Categories are mutually exclusive and collectively exhaustive.

The average DM knowledge was 8.03 (SD = 2.30), with a minimum score of 3.0 and Maximum score of 12. The results of this study showed an average score for DM knowledge among female of 8.38 (SD = 2.44), and the average male score was 7.56 (SD = 2.10). Total DM knowledge score Skewness = -0.38 and Kurtosis = -0.51, indicating that data are skewed left with a "light tailed" distribution.

The hypothesis for the first Research Question: Is there a relationship between the DKT2 knowledge score of informal caregivers in Saudi Arabia and patients' HbA1C levels? was tested using Pearson's correlation analysis to determine the direction of the relations among variables. The Pearson's correlation was examined based on an alpha value of .05. The variables were DM knowledge and Hb1A1c. DM knowledge was measured with a corresponding total score of the (DKT2).

The correlation analysis revealed that there was no significant association between the DM Knowledge and the HbA1C levels (r = -.144, p = .198).

The results of the overall multiple linear regression model were not significant, F(11,25) = 1.45, p = .214, R2 = .39, indicating that age, gender, marital status, relationship to the Pwt2DM, other family with DM, education, and employment status did not explain a significant proportion of variation in Score. However, examining the factors individually revealed that the age 31-45 category among informal caregivers significantly predicted DM knowledge, B = 3.37, t = 2.91, p <.007. This suggests that the mean value of DM knowledge increased by 3.37 units on average among caregivers aged 31-45.

The employment status did not significantly predict DM knowledge except for the "students" category. The student category of employment status significantly predicted DM knowledge, B = 3.46, t = 2.19, p = .038, indicating that the mean value of DM knowledge increased by 3.46 units on average among students. Table 3 summarize the results of the regression model.

Table 3: Multilinear Regression Predicting Informal Caregivers' Diabetes Knowledge (N = 37).

Variable	B	SE	95% CI	*β*	t	p
Intercept	3.68	2.45	–1.35 to 8.72	0.00	1.51	.145
Age (Ref: 18–30)						
31–45	3.37	1.16	0.99 to 5.76	0.74	2.91	.007
≥46	4.10	2.44	–0.92 to 9.13	0.62	1.68	.105
Gender						
Male	–0.97	0.93	–2.89 to 0.94	–0.21	–1.05	.305
Marital Status						
Married	0.23	1.08	–2.00 to 2.46	0.05	0.21	.832
Relationship to PwT2DM						
Son/Daughter	0.52	1.27	–2.09 to 3.13	0.08	0.41	.686
Education Level						
High school	1.16	1.80	–2.54 to 4.86	0.23	0.65	.524
Bachelor's degree or higher	1.47	1.68	–2.00 to 4.93	0.32	0.87	.391
Employment Status						
Part-time job	0.16	1.57	–3.08 to 3.39	0.02	0.10	.921
Not employed	–0.13	1.24	–2.68 to 2.41	–0.03	–0.11	.914
Student	3.46	1.58	0.21 to 6.71	0.60	2.19	.038

B = unstandardized coefficient; SE = standard error; CI = confidence interval; β = standardized coefficient. Reference categories: Age (18–30), Gender (Female), Marital Status (Single), Relationship to PwT2DM (Other), Education (Below high school), Employment (Full-time job), Bold values indicate statistically significant predictors at p < .05

Discussion:

TThe first objective of this study was to determine whether a relationship exists between the Type 2 Diabetes Mellitus (T2DM) knowledge scores of informal caregivers in Saudi Arabia and the HbA1C levels of the patients under their care. The first objective of this study was to determine whether a relationship exists between the Type 2 Diabetes Mellitus (T2DM) knowledge scores of informal caregivers in Saudi Arabia and the HbA1C levels of the patients under their care. Several studies have explored the relationship between patients' knowledge of glycemic control and HbA1C levels.[1,36]

However, limited research has examined caregivers' knowledge and its associations with HbA1C levels of the patients or disease outcomes. In this study, there was no correlation between patients' HbA1C and the level of knowledge among informal caregivers. his finding aligns with studies conducted his finding aligns with studies[36,37], in which found no correlation between the level of knowledge and the glycemic control.

Conversely,[38] found that improving DM knowledge among patients' informal caregivers will directly improve the HbA1C levels of PwT2DM. These inconsistencies highlight the multifactorial nature of glycemic control and suggest that knowledge alone may not be sufficient to influence disease outcomes. One possible reason for the lack of significant relationship between the knowledge and HbA1C found in this study could be the inadequate caregiver's knowledge about DM. One plausible explanation for the lack of association in the present study may be the inadequate level of diabetes knowledge among caregivers. The majority of participants demonstrated moderate (70.2%) to low (24.3%) DM knowledge levels. Limited understanding of diabetes management may restrict caregivers' ability to support patients effectively in areas such as dietary regulation, medication adherence, and physical activity. This interpretation is consistent with prior research in Saudi Arabia, where moderate levels of diabetes knowledge were observed in the general population despite awareness of specific benefits such as exercise for disease prevention.[39].

Similarly, studies from Jordan and other Middle Eastern contexts have reported only moderate knowledge levels among family caregivers and the general public[40,41] These findings collectively suggest that while awareness of diabetes is relatively widespread, in-depth knowledge that translates into effective disease management remains lacking.

Furthermore, family caregivers usually are

not involved in care interventions, which leads to poor disease-related knowledge.[42,43] The relationship between older adult PwT2DM and informal caregivers requires responsibility to self and others. Caregiving extends beyond knowledge acquisition to encompass intentional, compassionate engagement. Informal caregivers' understanding of diabetes represents only one aspect of caring; it is the translation of this knowledge into meaningful, responsive actions that supports patient well-being.[27]

The finding that the average HbA1C level among patients (M = 8.30) was above the normal range indicates generally poor glycemic management. This result indicates poor management among patients, which may relate to the lack of social facilitation which could have mediated the relationship between caregiver knowledge and patient HbA1C outcomes. In the theory of IFMT by Ryan and Sawin, social facilitation includes social influences, which depend upon receiving proper professional care and social support.[27] Previous studies have shown that when patients with T2DM receive high levels of social and emotional support from caregivers, their adherence to self-care practices and glycemic control improve significantly.[44,18]

Although there was no significant relationship between caregivers' sociodemographic characteristics and their diabetes knowledge overall, specific trends were observed. Female caregivers achieved slightly higher average knowledge scores (M = 8.38, SD = 2.44) compared to males (M = 7.56, SD = 2.10). This pattern may be explained by gendered caregiving roles within Saudi culture, where women often assume responsibility for health-related care within the family. Prior research also indicated that women generally demonstrate higher levels of health literacy and engagement in diabetes management activities.[14, 45]

Age was another factor with partial influence. Participants aged [31–45] exhibited a mean increase of 3.37 points in diabetes knowledge compared to other age groups. Younger caregivers may have greater access to digital resources, health campaigns, and educational materials, which enhances their health literacy. Studies from other regions similarly found that caregivers aged 40 and above reported lower diabetes knowledge compared to younger individuals, likely due to generational differences in exposure to more sources of information such as books and generational differences in technology use.[43, 46] Employment status also emerged as a predictor, with students demonstrating significantly higher diabetes knowledge (B = 3.46, p = .038). This finding may reflect their exposure to formal education, university-based health promotion activities,

and greater access to digital and academic information sources. This aligns with Saudi Vision 2030, which emphasizes digital health education and student involvement in community health promotion. However, other researchers found opposite findings showing that education can impact DM-related knowledge levels.[32,47].

Conclusions:

The findings of this study demonstrate that informal caregivers of individuals with Type 2 Diabetes Mellitus (T2DM) in Saudi Arabia possess only moderate levels of knowledge regarding diabetes management. This limited understanding may contribute to the lack of significant association found between caregivers' knowledge and patients' HbA1C levels. The results highlight that knowledge alone is insufficient to influence glycemic control without active engagement, behavioral support, and structured educational interventions.

These findings reinforce the need to integrate caregivers into diabetes education programs as active partners in care. Empowering caregivers through tailored, culturally sensitive educational strategies to enhance their ability to assist PWDM with DM care.

Future research should employ larger and more diverse samples to strengthen generalizability and may adopt longitudinal or interventional designs to assess the long-term effects of caregiver education on patient outcomes. Additionally, qualitative studies are recommended to explore how caregivers acquire, interpret, and apply DM-related knowledge.

Overall, this study underscores the importance of viewing diabetes management as a shared responsibility and reinforces family-centered approaches to achieve improved diabetes outcomes and a better quality of life for people living with T2DM, which supports national efforts toward healthier communities under Saudi Vision 2030.

Strengths:

This study adds valuable insight into an underexplored area of diabetes care in Saudi Arabia by examining the relationship between informal caregivers' knowledge and patients' HbA1C levels. The inclusion of 37 dyads (N = 74) of people with T2DM and their caregivers provided a meaningful foundation for understanding caregiver knowledge. Additionally, the findings emphasize the importance of caregiver education and awareness.

Limitation:

The cross-sectional design of this study limited the ability to determine causality between caregiver knowledge and patients' HbA1C levels. Furthermore, data were collected from only one government hospital serving Saudi patients, which

restricted population diversity and generalizability. In addition, the COVID-19 pandemic further constrained access to participants and reduced the number of available diabetes clinics. Consequently, the sample size was relatively small, which decreased statistical power and external validity. Moreover, self-reported HbA1C values from patients may have reduced data accuracy due to possible confusion with random blood sugar readings or recall errors. Nevertheless, despite these limitations, the study provides a valuable foundation for future research on caregiver education and its impact on diabetes outcomes in Saudi Arabia.

RECOMMENDATIONS:

Based on the findings, several recommendations are proposed:

For Practice:

Develop and implement tailored, culturally sensitive educational

For Future Research:

Future studies should employ interventional, longitudinal, and multi-institutional designs to further explore the causal relationship between volunteer motivation, social life satisfaction, and overall well-being. Research should also assess the effectiveness of structured volunteer training and mentorship programs in sustaining motivation and improving social connectedness among university students across different regions.

IMPLICATIONS OF THE STUDY

Implications for Nursing Practice:

It is important to promote volunteerism as part of community and public health nursing practice. Nursing professionals can play a key role in encouraging and guiding students to participate in structured volunteer programs, fostering civic responsibility, empathy, and social engagement.

Implications for Nursing Education:

Nursing curricula should include volunteerism and community engagement modules to strengthen students' understanding of social responsibility, teamwork, and holistic care. Also, establishing of educational programs that emphasize the personal and professional benefits of volunteering, such as leadership, communication, and cultural competence, can motivate students to participate. In addition to simulation-based and service-learning experiences may also help bridge theory with real-world community service.

Implication for Health Policy and Program Planning:

Policymakers and educational institutions should establish and support university-based volunteer centers and partnerships with community organizations to provide structured and sustainable volunteering opportunities. In addition, to national

programs aligned with Saudi Vision 2030 can further promote youth engagement in community service, contributing to both personal development and social cohesion.

Abbreviations:

COVID-19 – Coronavirus Disease 2019.

DKT2 – Revised Brief Diabetes Knowledge Test.

DM – Diabetes Mellitus.

DV – Dependent Variable.

FAU – Florida Atlantic University.

HbA1C – Glycated Hemoglobin.

IRB – Institutional Review Board.

IV – Independent Variable.

KAIMRC – King Abdullah International . Medical Research Center.

KAMC – King Abdulaziz Medical City.

MNGHA – Ministry of National Guard Health Affairs.

PwT2DM – Person with Type 2 Diabetes Mellitus.

T2DM – Type 2 Diabetes Mellitus.

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