Assessment of Educational and Behavioral Characteristics of Patients with Diabetes Mellitus Type-II Towards Diabetes Mellitus and Related Risk Factors and Complications in Yemen

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Abstract: Background: Diabetes mellitus (DM), a metabolic disorder, and severity continue to rise worldwide. Yemen has a rising diabetes rate. Successful treatment requires knowledge and awareness. Illiteracy rates are higher in Yemen, and diabetes knowledge is low. This study aims to evaluate the knowledge and awareness among Yemeni diabetic patients of diabetes mellitus, including its risk factors, complications, and monitoring measures. **Methods:** This cross-sectional study was conducted in Sana'a City in 2024. The study enrolled 400 type 2 diabetes patients. The checklist included sociodemographic characteristics, disease information, and questions about signs and symptoms of hypo/hyperglycemia, risk factors, complications, and monitoring measures of diabetes mellitus. The data was collected through a one-time survey in four different hospitals. The data was analyzed using SPSS v21 for descriptive and linear regression. **Results:** The majority, 219 (54.8%), of the patients were between 46 and 65 years old with a mean of 54.8 years; 207 (51.75%) of the patients were female. The overall level of knowledge and awareness among diabetic patients is moderate with a mean score of 2.16 (STD ± 0.13). Education level has a significant positive relationship with the level of knowledge and awareness of the patients (r= 0.158, p < 0.005). The level of knowledge and awareness was found to have a moderate negative correlation to the HbA1c level of 0.429 (p-value < 0.001). **Conclusion:** The diabetic patients have a moderate level of knowledge and awareness. Educational degrees affect patient knowledge and awareness. The unfavorable connection between patient knowledge and awareness and glycemic control. The study recommended implementing comprehensive diabetes education programs in clinical sites that cover various aspects of diabetes mellitus.

Keywords: Awareness, Complications, Diabetes Mellitus, Knowledge, Risk factors.

Introduction

Diabetes mellitus (DM) is a metabolic disease causing elevated blood glucose levels that affects 463 million people globally, with type 2 diabetes mellitus (T2DM) accounting for 90–95% of cases [1]. It is an important public health problem that causes increased morbidity, mortality, healthcare utilization, and costs [2]. Documentation of diabetes-related complications ranges from acute issues like hypoglycemia and hyperglycemia to chronic and severe issues like microvascular and macrovascular complications. These complications include heart disease, blindness, kidney failure, stroke, and more [3-11].

The prevalence of diabetes has not been determined correctly in Yemen [12]. In 2000, the prevalence of diabetes in Yemen increased to 6.57% [13]. Additionally, the overall prevalence of type 2 diabetes in urban Yemen in 2004 was approximately 9.4% (7.4% of men and 2% of women). Additionally, the incidence of impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) is 2% and 2.2%, respectively [14]. In 2008, Gunaid and Assabri reported that the incidence of diabetes in Yemen had increased to 10.4% [12].

It is a prevalent chronic disease, yet there is a lack of knowledge and awareness among diabetic patients about its risk factors, complications, and monitoring measures. This lack of understanding can lead to poor management, reduced quality of life, and healthcare provider struggles. [15]

Self-management education is crucial for diabetic patients to make informed choices, support personal behavior change, and reduce the risk of related problems. [15]. Behavior and lifestyle changes are important for successful self-management of diabetes [16]. It has been reported in many studies that diabetes-related knowledge is inadequate in developed and underdeveloped countries [17–19], and this knowledge needs to be improved through regular education among medical professionals such as pharmacists, physicians, nurses, and doctors. This study aims to evaluate the knowledge and awareness among Yemeni diabetic patients of diabetes mellitus, including its risk factors, complications, and monitoring measures.

Materials and Methods

Study design and population: This study was conducted during the period from December 2023 to May 2024 in four different hospitals (The Modern European Hospital, The Science and Technology Hospital, The Republican Teaching Authority Hospital, and AL-Thawra General Hospital). in Sana'a City, Yemen. A field survey was carried out by the researchers at Al Thawra General Hospital. A well-designed and pilot-tested checklist was used to collect data. The designed checklist was tested among 30 subjects as a pilot study for the validity of the checklist. The investigators have made the necessary corrections and modifications after considering the minor differences and discrepancies that were found during the pilot study. Pilot study steps were provided in the supplementary file and not included in the sample because of the modifications as

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grammatical issues. This study included patients who met the inclusion criteria and were admitted to the hospitals during the study period in Sana'a City, Yemen. This study enrolled 400 participants. All participants were collected based on their diagnosis that all participants were diabetic patients with type two admitted to four different hospitals during the study period.

The inclusion criteria included all male and female patients with T2DM whose ages were above 18 years old who were admitted to the hospitals during the study period were enrolled in the study. Exclusion criteria included all male and female patients with DM type one or gestational DM at any time who were admitted to the hospitals during the study period were excluded from the study. Patients with T2DM who were younger than 18 years old and who were admitted to the hospitals during the study period were excluded from the study. The sampling method was a random sample using a structured checklist. A total of 400 patients were selected in this study. This size of sample is calculated according to the Cochran formula (sample size formula for an infinite population) where, n= sample size, z = at confidence level (95%) (z = 1.96), p = estimated proportion(0.5); e = estimation error (0.05).

Data collecting: The required data was collected using a predesigned checklist. The checklist consisted of the sociodemographic characteristics of participants and information about their disease. It also contained questions regarding participants' general background, signs and symptoms of hypoglycemia and hyperglycemia, risk factors of diabetes mellitus, complications of diabetes mellitus, and monitoring measures of diabetes mellitus and its complications. The participants were interviewed and asked whether they "agree," "disagree," or "don't know" about the questions; a Likert 3-point scale was used. The checklist was written in Arabic to ease and facilitate the process of the interview. After data were collected, the questions and variables were translated into English.We conducted a one-time survey in the targeted hospitals. Qualified personnel (clinical pharmacy super-senior students) collected the data. Before the field visit, we provided proper training for data collection. We filled out the checklist by interviewing diabetic patients with type two DMin each hospital.

Data Analysis: The data were statistically analyzed using the statistical package for Social Sciences(SPSS v21) to determine frequency, percentage, means, and standard deviations. Variables were classified as interval, ordinal, and nominal. To find connections, differences, and links between the variables, we used the chi-square test, the Phi test, the ANOVA test, and linear regression. Using a Likert 3-point scale, levels of awareness and knowledge were classified as low (mean, 1–1.66), intermediate (mean, 1.67–2.33), and high (mean, 2.34–3) based on the mean of the responses[28].

Ethical consideration

The study was approved under IRB number November/2023 by the faculty of Clinical Pharmacy at 21 September University for Medical & Applied Sciences and from thementioned hospitals' ethical committees, which are targeted by this research. The purpose of the research was explained to the participants. We used the participants' data solely for research purposes, treated them confidentially, and disseminated no indicative information. Our study rigorously adheres to the ethical principles established by the Declaration of Helsinki, ensuring compliance with its standards throughout the research process.

Results and Discussion

Sociodemographic Characteristics

A total of 400 patients were examined; 207 (51.8%) were found to be female and 193 (48.2%) were male. The majority, 219 (54.8%), of the patients were between 46 and 65 years old, followed by those whose age was more than 65 years old, 97 (24.2%). 80 (20%) of the patients were between 26 and 45 years old, and only 4 (1%) of the patients were between 18 and 25 years old. Regarding the Body Mass Index (BMI) readings of the participants, it was found that 190 (47.5%) of the patients had a BMI of less than 25 kg/m2, and patients who fell between 25 kg/m2 and 29 kg/m2 were found to be 170 (42.5%). As for those who were found to have a BMI of 30 kg/m2or higher, were 40 (10%). This study also measured the patients' marital status. It was found that 7 (1.7%) of the patients were single, 363 (90.8%) were married, and 30 (7.5%) were divorced or widowed. Moreover, patients' education level was analyzed, and the majority, 156 (39%) of the patients were ignorant, followed by those who can read and write, 88 (22%), elementary and secondary school graduates were 44 (11%) and 46 (11.5%), respectively. As for those who have a college degree or above education, there were 66 patients, which represents 16.5%. Furthermore, analyzing participants' occupations, it was found that the majority, 183 (45.7%), of the participants were housewives, followed by those retired, 69 (17.3%). Also, 51 (12.7%) were laborers, 50 (12.5%) were private employees, 44 (11%) were public employees, and only 4 (0.8%) were students [Table 1].

Table (1): The distribution of the marital status, education level, and occupation of the participants.

Factors		Number	%
Marital Status	Single	7	1.7
	Married	363	90.8
	Other/Divorced or Widowed	30	7.5
	Total	400	100
Education level	Ignorant	156	39.0
	Read&write	88	22.0
	Elementary school	44	11.0
	Secondary school	46	11.5
	University education and above	66	16.5
	Total	400	100
Occupation	Private employee	50	12.5
	Public employee	44	11.0
	Housewife	183	45.7
	Laborer	51	12.7
	Retired	69	17.3
	Student	3	0.8

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	Total	400	100

Patients' awareness, the overall level of awareness

When the overall mean and standard deviation of the five sections (general background, awareness of signs and symptoms of DM, awareness of DM risk factors, awareness of complications of DM, and awareness of monitoring measures of DM) were measured, it was found that it was 2.16 with a standard deviation of 0.13, respectively. This indicates the trend of the overall patients' awareness is "moderate", as a general trend according to the 3-point Likert scale.When analyzing the relationship between the overall level of awareness of the participants and their level of education, Spearman's rho correlation coefficient was found to be positive and significant (r= 0.158, p< 0.005). The data were collected from four different hospitals: Al-Thawra Modern General Hospital (TMGH), Republican Teaching Hospital Authority (GTH), University of Science and Technology Hospital (USTH), and Modern European Hospital (MEH). Therefore, this study also tests whether the overall level of awareness differs among hospitals.

The ANOVA results indicates that the overall level of awareness of diabetic patients at Al-Thawra Modern General Hospital (TMGH) was higher than the overall level of awareness of diabetic patients at the Republican Teaching Hospital Authority (GTH) and also higher than the overall level of awareness of diabetic patients at Modern European Hospital (MEH). The overall mean for the level of awareness differs significantly among hospitals ($F_{3,396} = 4.759$, $p<0.05$).

Patients' general background of diabetes mellitus

Participants were asked for general information about diabetes mellitus in order to assess their general background in diabetes mellitus. They were asked to either agree, disagree, or don't know (neutral). The mean and standard deviation of their responses are calculated.

The results show that the highest average rank was given to question 11 (You should be given classes and educated about diabetes) with a mean of 2.75 and a standard deviation of 0.57, followed by question 3 (Excessive intake of sugars is one of the causes of diabetes) with a mean of 2.63 and a standard deviation of 0.69. The question that had the lowest average of rank was question 9 (Diabetics must pay attention to not wearing tight shoes and cleanliness of their feet and toes and protect themselves from wounds) with a mean of 1.57 and a standard deviation of 0.801, followed by question 13 (Diabetes is a disease that affects any part of the body) with a mean of 1.71 and a standard deviation of 0.844.

The weighted average of patients' general background of diabetes mellitus was 2.1042 with a standard deviation of 0.17611, which indicates the trend of (patients' general background of diabetes mellitus) is "moderate", as a general trend according to the 3-point Likert scale.

Patients' awareness of signs and symptoms of hyperglycemia and hypoglycemia

Participants were asked about the signs and symptoms of hyperglycemia and hypoglycemia in order to assess their awareness of the most common signs and symptoms that they may have. They were asked to either agree, disagree, or don't know (neutral). The mean and standard deviation of the participants' responses regarding the signs and symptoms of hyperglycemia.

The result shows that the highest average of rank was given to question 6 (excess thirst) with a mean of 2.69 and a standard deviation of 0.584, followed by question 3 (feeling of tiredness) with a mean of 2.61 and a standard deviation of 0.651. The questions that had the lowest average of rank were question 5 (weight loss) with a mean of 1.88 and a standard deviation of 0.573, followed by question 8 (slow healing of cuts and wounds) with a mean of 2.19 and a standard deviation of 0.649.

The weighted average of patients' awareness of signs and symptoms of hyperglycemia was 2.3641 with a standard deviation of 0.22406, which indicates the trend of (patients' awareness of signs and symptoms of hyperglycemia is "high".

Patients' awareness of signs and symptoms of hypoglycemia

The mean and standard deviation of the participants' responses regarding the signs and symptoms of hypoglycemia. The results show that the highest average rank was given to question 2 (sweating) with a mean of 2.60 and a standard deviation of 0.54, followed by question1 (shivering) with a mean of 2.57 and a standard deviation of 0.53. The questions that had the lowest average of rank were; question 3 (tremor) with a mean of 2.11 and a standard deviation of 0.54, followed by question 5 (tachycardia) with a mean of 2.21 and a standard deviation of 0.50. The weighted average of patients' awareness of signs and symptoms of hypoglycemia was 2.37 with a standard deviation of 0.275, which indicates the trend of (patients' awareness of signs and symptoms of hypoglycemia) is "high".

Patients' awareness of the risk factors of diabetes mellitus

Participants were asked some questions regarding the risk factors of diabetes mellitus in order to assess their awareness of what might lead to diabetes mellitus. They were asked to either agree, disagree, or don't know (neutral). The mean and standard deviation of their responses

The results show that the highest average rank was given to question 3 (obesity) with a mean of 2.45 and a standard deviation of 0.75, followed by question 4 (sedentary lifestyle) with a mean of 2.39 and a standard deviation of 0.84. The questions that had the lowest average rank were question 9, polycystic ovarian syndrome (PCOS) with a mean of 1.70 and a standard deviation of 0.54, followed by question 11 (the presence of traces of wrinkles, ulcers, and dark skin (skin pigmentation) around the neck and armpits (acanthosis nigricans) with a mean of 1.81 and a standard deviation of 0.82.

The weighted average of patients' awareness of the risk factors of diabetes mellitus was 2.0900 with a standard deviation of 0.21220, which indicates the trend of (Patients' awareness of the risk factors of diabetes mellitus) is "Moderate".

Patients' awareness of the complications of diabetes mellitus

Participants were asked some questions regarding the complications of diabetes mellitus in order to assess their awareness of what diabetes mellitus can lead to. They were asked to either agree, disagree, or don't know (neutral). The mean and standard deviation of their responses are illustrated.

The results show that the highest average of rank was given to question1 (can cause eye problems or even blindness (retinopathy) with a mean of 2.34 and a standard deviation of 0.74, followed by question 2 (can cause kidney failure

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(nephropathy)) with a mean of 2.337 and a standard deviation of 0.70. The questions that had the lowest average rank were; question 7 (can cause oral ulcers, bad odor) with a mean of 1.97 and a standard deviation of 0.61, followed by question 8 (can cause hearing loss) with a mean of 2.01 and a standard deviation of 0.69.

The weighted average of patients' awareness of the complications of diabetes mellitus was 2.1310 with a standard deviation of 0.19605, which indicates the trend of (patients' awareness of the complications of diabetes mellitus) is "moderate".

Patients' awareness of the monitoring procedures of diabetes mellitus

Participants were asked some questions regarding the monitoring measures of diabetes mellitus in order to assess their awareness of what and how they should monitor diabetes mellitus. They were asked to either agree, disagree, or don't know (neutral). The result shows that the highest average rank was given to question 1 (it is important for a diabetic patient to have a home testing device) with a mean of 2.64 and a standard deviation of 0.64, followed by question 3 (diabetics must continue their cumulative test every 3 months until it reaches normal levels) with a mean of 2.63 and a standard deviation of 0.60. The questions that had the lowest average rank were question 9 (it is important to have ophthalmological examination annually) with a mean of 1.54 and a standard deviation of 0.64, followed by question 6 (it is important to check blood pressure annually) with a mean of 1.54 and a standard deviation of 0.60. The weighted average of patients' awareness of the monitoring procedures of diabetes mellitus was 2.0742 with a standard deviation of 0.24290, which indicates the trend of (patients' awareness of the monitoring procedures of diabetes mellitus) is "moderate"

Patient diabetes mellitus history

Duration of the disease: The majority, 156 (39%), of them had the disease for 1-5 years, followed by those who had the disease for longer than 10 years, which were 137 (34.3%). Also, 66 (16.5%) of the patients had had the disease for 6-9 years, and 41 (10.3%) of them had had the disease for less than 1 year.

Glycemic control of patients: When participants' HbA1c readings were analyzed, their HbA1c varied among the participants between 5.2% and 15%. The mean HbA1c was 8.4% (STD±1.79). Analyzing the participants' glycemic control based on their available HbA1c levels, it was found that only 76 (20%) of them had controlled glycemic levels (HbA1c < 7%), and 304 (80%) had uncontrolled glycemic levels (HbA1c ≥ 7%).

Follow-up: Results show that 170 (42.5%) check their HbA1c every 1-3 months, 132 (33.0%) check their HbA1c every 3-6 months, and 98 (24.5%) of them check their HbA1c every more than 6 months.

Regularity of treatment: Results show that 132 (33%) of them had stopped taking their medication, and 268 (67%) of them were found to be using their medications regularly.

Factors that affect glycemic control

Level of awareness: Analyzing the participants' HbA1c level, using a two-tailed Pearson correlation coefficient, it was found that the level of HbA1c had a moderate negative correlation to the level of awareness with a correlation coefficient of -0.429 (p-value < 0.001). This means that as the overall level of awareness decreases, the HbA1c increases. Follow-up: Furthermore, the

relationship between glycemic control and follow-up frequency was analyzed. A chi-square test was conducted to examine the relationship between glycemic control and follow-up frequency ($\chi^2 = 10.769$, df = 2, p < 0.01). The results indicate a significant association between glycemic control and the frequency of follow-up.

Regularity of treatment: Moreover, the relationship between glycemic control and regularity of treatment was analyzed. A chi-square test was conducted to examine the relationship between glycemic control and regularity of treatment ($\chi^2 = 4.652$, df = 1, p < 0.05). The results indicate a significant association between glycemic control and regularity of treatment.

The mean and standard deviation of their responses are illustrated in tables in [supplementary files].

Discussion:

Diabetes has been linked to a number of documented complications, from short-term issues like hypo- and hyperglycemia to long-term, major issues like micro- and macrovascular problems. Heart attacks, vision loss, renal failure, stroke, and other conditions are among these persistent and dangerous side effects [3–11]. Diabetes cases are increasing quickly, and Yemen is not an exception [12]. Effective diabetes management requires knowledge and awareness, and the cornerstone of treatment for all individuals with diabetes is self-management education [15]. The study utilized a 3-point Likert scale to assess patients' knowledge and awareness of diabetes mellitus; signs and symptoms of hyperglycemia and hypoglycemia, risk factors, complications, and monitoring measures. The Likert scale included three response options: "low", "moderate" and "high" levels of knowledge and awareness present the mean range of each level.

Participants demonstrated moderate levels of general background and knowledge regarding diabetes mellitus, with a mean score of 2.10 on a scale of 1 to 3. The standard deviation was 0.176, indicating consistent responses. Also, participants demonstrated moderate levels of knowledge and awareness regarding diabetes mellitus risk factors, complications, and monitoring measures with mean scores of 2.09 (STD ± 0.21), 2.13 (STD ± 0.196), and 2.07 (STD ± 0.24), respectively. However, the participants demonstrated high levels of knowledge and awareness regarding signs and symptoms of hypoglycemia and signs and symptoms of hyperglycemia with mean scores of 2.36 (STD ± 0.22) and 2.37 (STD ± 0.28), respectively; this could be because they have experienced and been educated about such signs and symptoms. Overall, participants demonstrated moderate levels of knowledge and awareness regarding diabetes mellitus, with a mean score of 2.16, ranging from 1.71 to 2.45, on a scale of 1 to 3. The standard deviation was 0.13, indicating consistent responses. These findings were supported by Almualm, Yk. In his study, it was reported that the majority of participants had poor general knowledge of diabetes and its management [21]. Consequently, the results of this study support the theory that patients with diabetes mellitus type two don't have enough knowledge of diabetes mellitus risk factors, complications, and monitoring measures.

The overall mean for the level of awareness differs significantly among hospitals ($F_{3,396} = 4.759$, p < 0.05). Interestingly, the overall level of awareness of diabetic patients at Al-Thawra Modern General Hospital (TMGH) was higher than the overall level of awareness of diabetic patients at other

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hospitals. Al-Thawra Modern General Hospital is considered one of the large governmental hospital in Yemen, that provide special care and have many specialized healthcare providers in diabetes, therefore these factors might explain the difference between hospitals.

This study found a significant relationship between the level of knowledge and awareness and the educational level of the participants ($r= 0.158$, $p < 0.005$). This is also supported by ShiferawWS. *et al*, who conducted a systematic review and meta-analysis of randomized controlled trials in 2021. They stated that education had a significant increase in participants' knowledge of type two diabetes (standardized mean difference: 1.16; 95% CI: 0.71 to 1.60; I2=93%) [22].

The data demonstrate that there is a moderate negative relationship between the overall level of awareness and HbA1c levels ($r = -0.429$, $p<0.001$). This suggests that those who have a better knowledge of diabetes mellitus tend to have lower HbA1c levels. These findings build on existing evidence of this relationship as Al-Qazaz, H.K, *et al*. have stated that, in their study, a significantly higher score for knowledge ($p< 0.05$) was found in those patients with lower HbA1C [23]. Add to that, this study found that there is a significant positive relationship between HbA1c level and the duration of diabetes mellitus ($r = 0.207$, $p < 0.001$). These findings fit with what Saghir, S. et al. and Dinavari, M.F., concluded in their studies. They stated that diabetic patients were more likely to have poorly controlled diabetes if they had a longer diabetes duration [24,25].

When analyzing the factors that are associated with poor glycemic control, the results indicate that glycemic control was associated with both regularity of treatment and follow-up frequency. This indicates that those who have good regularity to their treatment had better glycemic control ($\chi2 = 4.652$, df = 1, $p < 0.05$), and those who do their follow-up and check their HbA1c more frequently had better glycemic control as well ($\chi2 = 10.769$, df = 2, $p < 0.01$). These findings were also supported by Fu, C. *et al*. and Afroz, A. *et al*. Fu, C. *et al* stated that, less than 1/3 (339/1157) had received 2 or more HbA1c tests per year, and they had a significantly lower average of HbA1c than those having only 1 or no test per year (F=5.012, p=0.007) [26], and Afroz, A.*et al*. reported that, 82% of participants had inadequate glycemic control (HbA1c ≥ 7%) and 54.7% had very poor control (HbA1c ≥ 9%). Low education level, rural residence, unhealthy eating habits, insulin use, infrequent follow-up check-ups, and history of coronary artery diseases were found associated with inadequate and very poor controls [27].

Limitations

Despite the outstanding cooperation from the administration of Modern European Hospital, Science and Technology Hospital, Republican Teaching Authority Hospital, and Thawra General Hospital. Who provided access to hospitals for data collection, but during the gathering of information, we had some limitations, including limited access to healthcare facilities, loss to follow-up, cultural factors, and health literacy.

Conclusion

The study emphasizes that individuals with type 2 diabetes mellitus possess moderate levels of knowledge and awareness concerning the condition, its risk factors, complications, and monitoring protocols. While participants exhibit better recognition of hypo- and hyperglycemia symptoms, indicating potential prior education or personal experience, there exists a notable gap in understanding broader aspects of diabetes management. The research underscores the significance of tailored educational interventions to elevate knowledge levels among those with type 2 diabetes, particularly highlighting the link between educational attainment and heightened awareness. Furthermore, the study underscores the critical role of treatment regulation and follow-up frequency in achieving optimal glycemic control in diabetic patients. The study emphasizes the positive relationship between regular HbA1c testing and improved glycemic outcomes. Factors such as low education level, rural residence, unhealthy dietary habits, insulin use, infrequent follow-up visits, and a history of coronary artery disease were identified as contributors to inadequate or very poor glycemic control.

According to the findings of the study, we recommend: implementing comprehensive diabetes education programs that cover various aspects of diabetes mellitus, including disease management, lifestyle modifications, medication adherence, and complication prevention. Healthcare professionals from various settings should deliver these programs. Additionally, multidisciplinary approaches to diabetes education should be incorporated, involving healthcare providers from various specialties, such as endocrinologists, dietitians, nurses, and psychologists. Lastly, the provision of educational resources and the monitoring of patient outcomes, including HbA1c levels, medication adherence, and self-care practices, are crucial in assessing the effectiveness of educational interventions in diabetes management.

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