European Journal of Clinical and Experimental Medicine

ONLINE FIRST

Authors: Helen Williams, Srinivasan Ranganathan

Article type: Original Article

Received: 13 January 2024

Accepted: 18 March 2024

Published online: 26 April 2024

eISSN: 2544-1361

Eur J Clin Exp Med

doi: 10.15584/ejcem.2024.3.4

A cross-sectional study on knowledge, attitude, and practice among type 2 diabetes mellitus patients attending a primary health care center in the rural region of Tamil Nadu

Helen Williams [1], Srinivasan Ranganathan [2]

[1] Department of Pharmacy Practice, Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India

[2] Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India

Corresponding author: Helen Williams, e-mail: whelen2712@gmail.com

ORCID

HW: https://orcid.org/0000-0003-3467-3054

SR: https://orcid.org/0000-0002-1931-3283

ABSTRACT

Introduction and aim. Diabetes mellitus (DM) is a basic metabolic disease of inadequate control of blood glucose levels. Hyperglycemia is exacerbated, and type 2 diabetes mellitus (T2DM) progresses both insulin resistance and β-cell dysfunction. Management of T2DM involves both lifestyle modification and pharmacological therapy. To achieve optimized health outcomes, the patient requires adequate knowledge, attitude, and practice, so educating the patients on these diseases is an effective strategy to reduce complications of T2DM.

Material and methods. This is a cross-sectional study which was conducted from August 2022 to January 2023. A total of 200 participants were enrolled with inclusion criteria to determine the knowledge, attitude, and practice of type 2 diabetes mellitus patients.

Results. The mean knowledge, attitude and practice (KAP) was 71.5%, 87.5%, and 40% respectively. There is a significant association between knowledge, attitude, practice questions, and socio-demographic characteristics. Education was strongly associated with having higher knowledge scores (p=0.001).

Conclusion. The study's conclusions made clear the necessity of well-planned interventions to raise T2DM awareness among patients with low levels of education. Patients with T2DM may benefit from well-designed educational programs that encourage healthy behavior and these interventions can improve the quality of life of patients in rural region of Tamil Nadu.

Keywords. attitude, cross-sectional study, knowledge, practice, type 2 diabetes mellitus

Introduction

Diabetes mellitus (DM) is a basic metabolic disease of inadequate control of blood glucose levels. The main subtypes of DM are type 1 DM and type 2 DM which classically result from defective insulin secretion (T1DM) and action (T2DM).[1] Type 2 diabetes mellitus is thought to affect middle-aged and older individuals who have chronic hyperglycemia as a result of poor lifestyles and nutritional choices. Whereas, T1DM is thought to manifest in children or teenagers. Since the pathophysiology of T1DM and T2DM are very diverse from one another, each type has a separate etiology, presentation, and course of treatment. In India, 77 million people were estimated to have diabetes in 2019, and by 2045, that number is projected to reach over 134 million.[2,3] Rising incidence in India is linked to changes in lifestyle as well as urbanization and fast industrialization. Diabetes and its mostly preventable consequences are progressing at an accelerated rate due to several factors, including poor awareness and habits among diabetic individuals. Diabetes prevalence ranged from 5.4% in north-eastern states to as high as 15.5% in the southern Indian state of Tamil Nadu, according to epidemiological research carried out across the nation.[5] Due to their lower socioeconomic status and lack of education, the majority of individuals are still susceptible to lifestyle disorders like diabetes and hypertension. Diabetes patients have a higher incidence of stroke and coronary heart disease than the general population. Complications such as diabetic kidney disease, diabetic retinopathy, and diabetic neuropathy, which are common in patients with inadequate glycemic control, worsen their quality of life. Approximately, 57% of these individuals remain undiagnosed.[6-8] Type 2 diabetes mellitus, which accounts for the majority of the cases, can have multi-organ complications, broadly divided into microvascular and macrovascular complications. Blood glucose levels become usually high when the feedback loops between insulin action and insulin production are not working properly. As a result of decreased insulin secretion caused by cell malfunction, the body's ability to maintain physiological glucose levels is constrained. On the other side, insulin resistance helps to reduce glucose uptake in adipose tissues, muscles, and the liver while increasing glucose synthesis in the liver. Even while all these processes occur early in the pathophysiology and help to cause the disease to manifest, β-cell dysfunction is typically more severe than insulin resistance. However, hyperglycemia is exacerbated, and T2DM progresses if both insulin resistance and β-cell dysfunction are present.[7,8] Management of T2DM involves both lifestyle modification and pharmacological therapy.[9]

Several studies that were conducted to assess the knowledge, attitude, and practice of patients with T2DM emphasized the need for patients to have a greater understanding of the disease's prevention, diagnosis, mitigation of risk factors, and reduction of consequences. It has been suggested that educating patients on their condition is an effective approach for lowering T2DM complications and achieving

better blood glucose control.[10] Increased understanding most likely could enhance patients' attitudes and practices regarding their conditions.[11] Prior research has demonstrated that patients with better knowledge of their type 2 diabetes and its complications reported better treatment adherence when compared to those with inadequate understanding of the condition. It's been suggested that T2DM patients might have better blood glucose management if they were aware of their condition.[12] The patient's health and quality of life may be enhanced by this. Furthermore, negative attitudes were linked to poor blood glucose control and a higher likelihood of complications. Prior research has demonstrated differences in the knowledge, attitude, and practices of T2DM patients in primary and tertiary healthcare settings in India, Saudi Arabia, Sri Lanka, and Ethiopia.[14,16] Evaluating diabetes knowledge has always been a critical component of assessing diabetes patients overall. A study by Al-Qazaz et al. found that patients are more likely to adhere to their treatment regimen and have fewer issues linked to their illness if they are better informed about their condition and its implications.[17] Despite the large number of studies that has been done worldwide, people in rural regions still don't know enough about diabetes. Hence, to achieve optimized health outcomes, the patient requires adequate knowledge, attitude, and practice, it has been argued that educating patients on these diseases was an effective strategy to reduce complications of T2DM and achieve improved control over blood glucose.[20] Therefore, this study assesses the knowledge, attitude, and practice among type 2 diabetes mellitus patients in a rural region in Tamil Nadu about their disease.

Aim

The current study is to determine the knowledge, attitude, and practice of type 2 diabetes mellitus patients and the secondary objective is to find out the association between socio-demographic characteristics and KAP questions by categorizing the questions by good score and poor score.

Material and method

Study design, study period, and study population

We adopted a cross-sectional study design to evaluate the knowledge, attitudes, and practices of type 2 diabetes mellitus patients for a period of 6 months (From August 2022 to January 2023) in a primary health care hospital in a rural region, Chennai, Tamil Nadu, India. The study population was type 2 diabetic mellitus patients who visited the outpatient department during the study period and fulfilled the inclusion criteria.

Study variables

The dependent variables were knowledge, attitude, and practice, and the independent variables were age, gender, marital status, employed status, and educational status.

Sample size

The required sample size was calculated by using a single population proportion formula. Therefore, the proportion was taken at 50%, and the sample size calculation was made as the following proportion of the study with 95% confidence intervals (CI) and 5% margin error. $n=z^2\, p(1–p)/w^2$, where n=sample size, p=proportion (50%), w=margin error (5%), z=1.96 confidence level, and $n=1.96^2(0.5(1−0.5)/(0.05)(0.05)=194.6$. Considering the 5% nonresponse rate, the sample size was 200. Totally, 200 participants were enrolled meeting the criteria.

Inclusion and exclusion criteria

Type 2 diabetes mellitus patients who are taking oral hypoglycemic drugs and willing to take part in the study, and giving consent were included in the study. The type 1 diabetes mellitus patients, patients with serious co-morbidity conditions such as heart disease, and chronic kidney disease, patients taking insulin, patients with hearing impairment, mental health problems, and those unable to supply the necessary information were excluded from the study.

Data collection

Sociodemographic variables

The first section of the survey included questions about the participant's demographics, such as their age, gender, marital status, employed status and educational status, monthly income, duration of diabetes, fasting blood glucose, postprandial blood glucose, HbA1c, and body mass index.

Knowledge, attitude, and practice (KAP) questionnaire

The second section consisted of the knowledge, attitude, and practice (KAP) questionnaire. The KAP questionnaire comprised 18 questions (knowledge: 7; attitude: 5; and practice: 6). KAP scores were calculated such that correct answers were assigned a score of 1 (one), whereas wrong answers were assigned a score of 0 (zero). Participants who correctly responded to more than 50% of knowledge, attitude and practice assessing questions were considered as having good knowledge, attitude and practice towards type 2 diabetes mellitus whereas those who scored ≤50% were considered as having poor knowledge, attitude, and practice towards type 2 diabetes mellitus.

Translation validity

In Tamil Nadu, Tamil is the primary language spoken. Thus, utilizing a standardized forward-backward translation process, the English survey questionnaire was first translated forward into Tamil and then backward into English. The English version was translated into Tamil by two separate bilingual translators working independently. To produce a translation that more closely mimics the original

instrument, one translator was aware of the topics the questionnaire aimed to measure. The other translator was unable to identify any discrepancies between the two translations because she was unaware of the subject matter. The two translators discussed and resolved any discrepancies that had been raised.

Face validity, pilot testing, internal consistency, and reliability

Three experts with prior experience with T2DM examined the study tool. Using a Likert scale of 1 to 5, the researchers – physicians (n=1) and pharmacists (n=2) – rated each item's relevance (1 being completely irrelevant, and 5 being highly relevant). Excluded were items that received ratings of either not relevant at all or not relevant from all researchers. All researchers assessed the items as highly relevant or relevant, so they were kept. Discussion and agreement were used to settle ambiguous issues. Twenty patients participated in pilot research to examine the study tool's readability and comprehension of the questions. The test-retest approach was employed to evaluate the stability of the scores across a brief time frame. Each questions were asked to the 20 patients twice. There was a brief break of thirty minutes to an hour between each round. Pearson's correlation was used to establish a link between the scores from the two rounds. A Pearson's correlation coefficient of 95% (95%CI=91.2 to 98.7%) with a p-value of less than 0.001 suggested excellent score stability. >80% was the predetermined threshold for acceptable coefficients, as it was in earlier research. The study tool's items were evaluated for internal consistency using Cronbach's alpha statistics. A Cronbach's alpha of 74.2% suggests that the test items had strong internal consistency. Between 70 and 95% were the acceptable coefficients that were predetermined.

Data collection procedure

The data were collected by the structured questionnaire, which contains different items like sociodemographic and KAP. Participants signed a written informed consent form after receiving a thorough explanation of the study's aims and objectives before the data collection. A face-to-face interview was undertaken to collect the data.

Statistical analysis

This study was analyzed using the student t-test with a 95% level of significance and a p-value of <0.05 is considered significant. The obtained data will be statistically analyzed with the help of SPSS software (IBM< Armonk, NY, USA) to find out the association between socio-demographic characteristics and KAP questions. A continuous and categorical analysis was conducted on the following variables: age, duration of diabetes, BMI, fasting plasma glucose, postprandial plasma glucose, and HbA1c. The Mann-Whitney U test and the Kruskal-Wallis test were used to compare categorical data. The correlation

between variables was evaluated using Spearman's rank correlation. We used multivariate linear regression to compensate for confounding variables. The model kept every variable that was used in the Kruskal-Wallis and Mann-Whitney U tests. The following were included as continuous variables: age, time from diagnosis, BMI, plasma glucose levels during fasting and postprandial periods, and HbA1c. The coefficients were expressed as changes per unit of change.

Ethical considerations

The study was ethically approved by the institutional ethics committee (approval number 2148/2022). Every procedure used in this investigation that involved human participants complied with the 1964 Helsinki Declaration and its later revisions or similar ethical standards, as well as the ethical norms of the institutional and/or national research committee.

Results

Sociodemographic and clinical characteristics

Among 200 participants, table 1 shows that most of the participants were from the age group - >55 years (65.5%); Gender – male (50%); Marital status – married (91.5%); Employment status – employed (60%); Educational status – educated (87%). 105 (52.5%) had their usual fasting plasma glucose level of more than 140 mg/dL, 102 (51%) had their usual postprandial plasma glucose level of more than 200 mg/dL, 101 (50.5%) had their HbA1c level more than 7%, and 108 (54%) had a BMI of more than 25 kg/m^2 .

Table 1. Sociodemographic and clinical characteristics

Socio-demographic and clinical characteristics	**N**	**Percentage (%)**
Age (years)		
<55	69	34.5
≥55	131	65.5
Gender		
Male	110	50
Female	90	45
Marital status		
Single	12	6
Married	183	91.5
Divorced/widowed	5	3

Employment status		
Unemployed	80	40
Employed	120	60
Educational status		
Educated	174	87
Uneducated	26	13
Monthly income (in rupees)		
≤20,000	158	79
Up to 50,000	42	21
>50,000	2	1
Duration of diabetes (years)		
≤7	103	52
>7	97	49
Fasting plasma glucose (mg/dL)		
<140	95	47.5
≥140	105	52.5
Postprandial plasma glucose (mg/dL)		
<200	98	49
≥200	102	51
HbA1c (%)		
<7	99	49.5
≥7	101	50.5
Body mass index (kg/m^2)		
<25	92	46
≥25	108	54

Knowledge, attitudes, and practices concerning type – 2 diabetes mellitus

Table 2 shows the knowledge of the participants where the mean score is 143 (71.5%) of the participants gave the correct answer. Among these 7 knowledge questions majority of the participants, n=143 (71.5%) answered correctly for question 5 (What are the various symptoms of diabetes?).

Table 2. Knowledge of the participants

	No. of participants with correct answer (n)	**Percentage (%)**

Whether I am aware that diabetes is a disease	192	96
What type of diabetes do you have	56	28
What is the level of blood sugar to diagnose diabetes	143	71.5
Is there positive family history necessary for development of diabetes	189	94.5
What are the various symptoms of diabetes	196	98
What occur if diabetes is not treated	127	63.5
What are the complications of diabetes	99	49.5
Mean score	143	71.5

Table 3 shows the attitude of the participants where the mean score is 175 (87.5%) of the participants gave the correct answer. Among these 5 attitude questions majority of the participants, n=198 (99%) answered correctly for question 4 (Do you think an estimation of blood sugar level is important?).

Table 3. Attitude of the participants

	No. of participants with correct answer(n)	**Percentage (%)**
Should the patient follow a controlled and planned diet to prevent diabetes	198	99
Should we visit to physician regularly	190	95
Do you think regular oral hypoglycemic medication is important in diabetes	172	86
Do you think an estimation of blood sugar level is important	191	95.5
Should we exercise regularly for healthy life	124	62
Mean score	175	87.5

Table 4 shows the practice of the participants where the mean score is 80 (87.5%) of the participants gave the correct answer. Among these 6 practice questions majority of the participants, n=186 (93%) answered correctly for question 5 (when was your blood sugar level checked last?).

Table 4. Practice of the participants

	No. of participants with correct answer(n)	Percentage (%)
When was your blood pressure measured last	53	26.5
When was your last consultation with your physician	94	47
When was your last urine examination done	67	33.5
When did you have your last lipid profile checked	50	25
When was your blood sugar level checked last	186	93
When did you have gone for exercise last	30	15
Mean score	80	40

Table 5. Correlation between knowledge, attitude, and practice scores with socioeconomic and clinical variables of the patients

Variable		**Knowledge score**	**Attitude score**	**Practice score**	**Age**	**Monthly income**	**Duration of diabetes**	**HbA1c**	**FBS**	**PPBS**	**BMI**
Knowledge score	Rho	-	0.26	0.45	−0.22	0.16	−0.17	−0.13	−0.17	−0.08	−0.01
	p		<0.001	<0.001	<0.001	0.001	0.006	0.001	0.05	0.019	0.05
Attitude Score	Rho	0.29	-	0.35	0.001	0.05	0.005	−0.2	−0.19	−0.13	−0.18
	p	<0.001		<0.001	0.741	0.145	0.354	0.001	<0.37	0.001	0.002
Practice score	Rho	0.37	0.48	-	—0.10	0.12	—0.02	—0.20	—0.16	—0.21	—0.21
	p	<0.001	<0.001		0.001	0.11	<0.001	<0.001	<0.14	0.001	0.001

Table 5 shows the knowledge, attitude, and practice scores showed a moderately positive connection (p-value < 0.001) when the continuous variables were correlated. The results showed that knowledge scores had a positive correlation with monthly income (Spearman's rho=0.16, p=0.001) and a negative correlation with age (Spearman's rho=−0.22, p<0.001), duration of diabetes (Spearman's rho=−0.17, p=0.006), fasting plasma glucose (Spearman's rho=−0.17, p=0.05), postprandial glucose (Spearman's rho=−0.08, p=0.019), and HbA1c (Spearman's rho=−0.13, p<0.001). Positive attitude scores were inversely linked with plasma glucose levels during fasting (Spearman's rho=−0.19, p<0.37), after meals (Spearman's rho=−0.13, p= 0.001), HbA1c (Spearman's rho=−0.2, p=0.001), and body mass index (Spearman's rho=−0.18, p=0.002). Practice scores correlated negatively with age (Spearman's rho=−0.10, p<0.001), duration of diabetes (Spearman's rho=−0.02, p<0.001), fasting plasma glucose (Spearman's rho=−0.16, p=0.14), postprandial plasma glucose (Spearman's rho=−0.21, p=0.001), HbA1c (Spearman's rho=−0.20, p<0.001), and BMI (Spearman's rho=−0.21, p=0.001).

Table 6. The association between the sociodemographic and clinical characteristics and KAP questions

Sociodemographic and clinical characteristics	**Knowledge (n)**		**Attitude (n)**		**Practice (n)**	
	Good	Poor	Good	Poor	Good	Poor
Age (years)						
<55	87	46	67	47	23	45
≥55	44	23	36	68	112	20
p	0.002	0.016	0.003	0.012	0.008	0.005
Gender						
Male	45	77	62	42	40	69
Female	56	22	66	30	78	13
p	0.005	0.007	0.004	0.001	0.009	0.018
Marital status						
Single	5	2	4	3	3	3
Married	89	78	116	52	122	46
Divorced/widowed	19	7	15	10	12	14
p	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Employment status						

Unemployed	76	21	45	65	18	12
Employed	97	6	79	11	126	44
p	0.0041	0.0034	0.0078	0.0013	0.0065	0.0032
Educational status						
Educated	100	3	112	10	119	23
Uneducated	29	68	45	33	19	39
p	0.009	<0.0001	0.0052	0.003	0.001	0.003
Monthly income (in rupees)						
≤20,000	90	27	50	75	35	101
Up to 50,000	45	36	21	53	24	39
>50,000	1	1	1	0	1	0
Duration of diabetes (years)						
≤7	64	43	32	76	29	45
>7	23	70	45	47	44	82
Fasting plasma glucose (mg/dL)						
<140	98	8	25	106	20	125
≥140	22	72	32	37	17	38
p	<0.0001	0.04	0.001	<0.0001	0.02	<0.0001
Postprandial plasma glucose (mg/dL)						
<200	106	24	12	99	36	87
≥200	63	7	22	67	18	59
p	<0.0001	0.03	0.002	0.001	0.009	0.006
HbA1c (%)						
<7	80	41	34	67	16	58
≥7	42	37	29	70	52	74
p	<0.0001	0.005	0.004	<0.0001	0.001	0.001
Body mass index (kg/m^2)						
<25	78	22	27	77	20	80
≥25	51	49	23	73	39	61
p	<0.0001	0.009	0.002	0.005	0.001	<0.0001

Table 6 shows that the overall KAP questions assessment where shows age group <55, gender – female, marital status – married, employed status – employed, educational status – educated, fasting blood sugar <140 mg/dL, postprandial plasma glucose <200 mg/dL, HbA1c <7%, body mass index <25 kg/m^2 have the good significant score comparing to another batch of socio-demographic and clinical characteristics

and was analyzed using the student t-test with a 95% level of significance and a $p<0.05$ is considered significant.

Table 7. Multiple linear regression between sociodemographic and clinical variables of the patients with knowledge, attitude, and practice scores

Variable	Unadjusted coefficients	SE	Adjusted coefficients	t	p
Knowledge score					
Age	−0.02	0.30	−0.03	— 0.09	**0.589**
Gender	−0.06	0.22	0.0001	−0.2	**0.457**
Marital status	0.17	0.32	0.01	0.20	**0.396**
Employment status	−0.10	0.26	−0.06	— 0.72	**0.264**
Educational status	1.24	0.14	0.32	1.89	**0.133**
Monthly income	0.39	0.21	0.12	0.56	**0.436**
Duration of diabetes	−0.50	0.33	— 0.07	−1.04	**0.734**
Fasting plasma glucose	0.23	0.44	0.02	0.16	**0.378**
Postprandial plasma glucose	−0.02	0.03	−0.18	−1.76	**0.053**
HbA1c	0.04	0.02	0.09	0.92	**0.346**
BMI	0.01	0.01	0.001	0.001	**0.285**
Attitude score					
Age	−0.16	0.25	— 0.07	— 0.92	**0.624**
Gender	0.12	0.43	0.03	0.50	**0.165**
Marital status	0.09	0.51	0.001	0.02	**0.851**
Employment status	−0.07	0.25	−0.05	−0.51	**0.954**
Educational status	0.36	0.66	0.09	0.08	**0.856**
Monthly income	0.0001	0.14	0.001	−0.01	**0.943**
Duration of diabetes	−0.04	0.19	−0.03	— 0.40	**0.385**
Fasting plasma glucose	0.06	0.74	0.02	0.90	**0.541**
Postprandial plasma glucose	0.001	0.01	0.001	−0.02	**0.854**
HbA1c	0.02	0.01	0.09	0.70	**0.388**
BMI	−0.01	0.01	−0.04	−1.20	**0.841**
Practice score					

Age	−0.11	0.28	— 0.02	— 0.45	**0.414**
Gender	−0.03	0.12	−0.01	— 0.23	**0.985**
Marital status	−0.78	0.98	— 0.07	— 0.95	**0.855**
Employment status	0.02	0.23	0.03	0.12	**0.252**
Educational status	0.26	0.84	0.08	0.25	**0.849**
Monthly income	−0.01	0.95	−0.06	— 0.18	**0.741**
Duration of diabetes	−0.12	0.84	−0.02	— 0.57	**0.282**
Fasting plasma glucose	0.63	0.37	0.19	2.03	**0.056**
Postprandial plasma glucose	−0.04	0.02	−0.04	— 0.63	**0.036**
HbA1c	−0.05	0.01	−0.03	— 0.79	**0.066**
BMI	**−0.02**	**0.01**	**−0.12**	**−1.12**	**0.556**

Table 7 shows the excluded confounding variables and finds predictors of greater knowledge, attitude, and practice scores, a multiple linear regression model was applied. The model's R2 was 0.22, with a p-value less than 0.001. According to the model, education was highly correlated with greater knowledge scores ($p<0.001$).

Discussion

Diabetes is a chronic metabolic condition marked by high blood glucose (also known as blood sugar), which over time can seriously harm the heart, blood vessels, eyes, kidneys, and nerves. Type 2 diabetes is the most prevalent type and typically affects adults. It develops when the body stops producing enough insulin or grows resistant to it. Type 2 diabetes prevalence has massively increased during the last three decades in countries of all income levels.[19] Our goal was to find out the Knowledge, attitude, and practice among type 2 diabetes mellitus patients find the association between socio-demographic characteristics, and identify the obstacles to poor compliance.

The study conducted by Muhammed Alqahtani et.al, estimated about 70.9% of the participants had good knowledge scores approximately. In this study, approximately 71.5 % of the participants scored well on knowledge questions, demonstrating similar outcomes.[22] Ravi Kant et.al estimated that 75% of the participants had a good attitude score which is nearly the same as the present study. While the practice questions are considerably lower, the study conducted by Saadiaz et.al also reported lower practice and attitude among type–2 diabetes mellitus patients.[11,13] Overall the results of knowledge, attitude, and practice scores were found to be higher than those reported by Upadhyay et al.[6] A significant association between knowledge, attitude, and practice overall scores with sociodemographic and clinical

characteristics similar to that of a study conducted by Ng SH et al. also showed that there is a significant association between sociodemographic and clinical characteristics and KAP questions ($p<0.05$). [9]

The findings of the research brought into focus patients' problems in T2DM knowledge, attitudes, and practices. In this study, relationships and correlations between the patient's clinical and sociodemographic characteristics and knowledge, attitude, and practice were found. Furthermore, indicators of increased knowledge, decreased attitude, and practice were found. The results of this study may help those in the authority of making decisions, medical professionals, and patient advocate organizations who may need to create treatments to enhance the health of T2DM patients. Remarkably, scores for knowledge, attitude, and practice showed a moderately favorable association. This could, at least in part, corroborate the idea that individuals with type 2 diabetes may be more likely to adopt a positive mindset and appropriate behavior if they have an education. However, our results showed that 71.5% of patients practiced T2DM with a lower attitude and good knowledge. Patients who met certain criteria performed better on the knowledge test: they were under 55 years old, married, educated, employed, and had a higher income. They also had normal fasting plasma glucose levels of less than 140 mg/mL, an HbA1c of less than 7%, and a BMI of less than 25 kg/m^2. According to Hearth et al.'s pilot study carried out in Sri Lanka, 77% of T2DM patients have moderate to above-average awareness of their condition. Studies conducted in various contexts have revealed that T2DM patients in Mongolia, Sri Lanka, Bangladesh, India, Jordan, and Lebanon had varying levels of understanding.[31-35] Higher knowledge scores were substantially correlated with education when potential confounding variables were taken into account. The results of this study may suggest that patients with higher levels of education are more likely to understand their condition and strategies for controlling their blood sugar. Hearth et al.'s study demonstrated a positive correlation between education and patients increased T2DM knowledge in Sri Lanka. In a similar study, Karaoui et al. demonstrated that among patients in Lebanon, a higher degree of education was positively connected with a greater understanding of type 2 diabetes.[36] Fatema et al.'s research in Bangladesh revealed that male T2DM patients knew a great deal more about their condition than their female counterparts.[37]

The study demonstrated that 87.5% of the patients had negative opinions regarding their illness. The ability to maintain a typical fasting plasma glucose level below 140 mg/dL, postprandial plasma glucose level below 200 mg/dL, HbA1c below 7%, and BMI below 25 kg/m^2 were all positively correlated with attitude ratings. Attitude scores had no correlation with potential confounding variables when we accounted for them. The results of this study conflicted with those published by Belsti et al. in Ethiopia, where the patients' attitudes were linked to their income and educational attainment.[38] Prior research indicated that compared to patients with lower incomes, those with greater incomes may have better access to healthcare services, be able to attend routine checks and engage in physical activity.

Based on practice, our research revealed that forty percent of T2DM patients had less aggressive approaches to managing their condition. Lower practice scores were recorded by patients who were younger than 55 years old, educated, and had normal fasting glucose levels of less than 140 mg/dL, postprandial plasma glucose of less than 200 mg/dL, HbA1c greater than or equal to 7%, and BMI of less than or equal to 25 kg/m^2. Our findings aligned with those published in various contexts in Ethiopia, Bangladesh, Mongolia, Sri Lanka, and Lebanon.[31-37] According to these studies, which adjusted for potential confounding variables, attending a diabetic education program was somewhat linked to better practice scores. Our results may corroborate earlier research on the benefits of educational initiatives for enhancing health outcomes and patient self-management among T2DM patients living in rural region of Tamil Nadu.

Study limitations

First, this study was a cross-sectional study. An interventional design could have permitted enhancing knowledge, improved positive attitude, and promoted good practice among patients with T2DM about their disease. Second, the sample size used in this study was relatively small and it might not apply to the entire population because it was carried out at a single primary healthcare center located in a rural region in Chennai, Tamil Nadu, India. However, the sample size used in this study was comparable to those used in other studies. Third, since the study was only done for six months, it may be difficult to extrapolate the results to a larger population because there are fewer data. The results of this cross-sectional study cannot be applied to a larger population over an extended period. Fourth, a convenience sampling method was followed to recruit the sample needed for this study. It is noteworthy to mention that the sample recruited in this study was diversified by the inclusion of patients from both genders, different educational levels, and income levels. Finally, the number of items relevant to knowledge, attitude, and practice was relatively small. Despite the small number of items, we were able to expose the level of knowledge, attitude, and practice of patients with T2DM concerning their disease.

Conclusion

The current study provides insight into the knowledge attitudes, and practices of Tamil Nadu's rural T2DM population. The research found an association and correlation between the knowledge, attitude, and practice scores and the clinical and sociodemographic characteristics of T2DM patients at a primary healthcare facility in a rural area of Tamil Nadu. The study's conclusions made clear the necessity of well-planned interventions to raise patient's low educational attainment's understanding of type 2 diabetes. Patients with T2DM may benefit from well-designed educational programs that encourage healthy behavior. Future research is still required to determine whether these therapies could help T2DM patients in Tamil Nadu's rural areas achieve better health outcomes and a higher quality of life.

Declarations

Funding

The authors did not receive support from any organization for the submitted work. No funding was received to assist with the preparation of this manuscript, nor no funding was received for conducting this study.

Author contributions

Conceptualization, H.W. and S.R.; Methodology, H.W.; Software, H.W.; Validation, H.W. and S.R.; Formal Analysis, H.W.; Investigation, H.W.; Resources, H.W.; Data Curation, H.W.; Writing – Original Draft Preparation, H.W.; Writing – Review & Editing, H.W.; Visualization, H.W.; Supervision, H.W. and S.R.; Project Administration, H.W.

Conflicts of interest

The authors declare no conflict of interest.

Data availability

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

Ethical approval

The Bhaarath Medical College and Hospital research institution review board gave its approval for this study. The study period was August 2022 to January 2023 (approval number 2148/2022)

Reference

1. Palaniswamy LD. Knowledge, attitude and practice of exercise among patients with type 2 diabetes mellitus. *J Med Sci Res.* 2020;8(4):145-149. doi: 10.17727/JMSR.2020/8-19
2. Al-Maskari F, El-Sadig M, Al-Kaabi JM, Afandi B, Nagelkerke N, Yeatts KB. Knowledge, attitude and practices of diabetic patients in the United Arab Emirates. *PLoS One.* 2013;8(1):e52857. doi: 10.1371/journal.pone.0052857
3. El Arifeen S, Christou A, Reichenbach L, et al. Community-based approaches and partnerships: innovations in health-service delivery in Bangladesh. *Lancet.* 2013;382(9909):2012-2026. doi: 10.1016/S0140-6736(13)62149-2
4. Steyn NP, Mann J, Bennett P, et al. Diet, nutrition and the prevention of type 2 diabetes. *Public Health Nutr.* 2004;7(1a):147-165. doi: 10.1079/PHN2003586

5. Okonta HI, Ikombele JB, Ogunbanjo GA. Knowledge, attitude and practice regarding lifestyle modification in type 2 diabetic patients. *African J Primary Health Care Family Med.* 2014;6(1):6. doi: 10.4102/phcfm.v6i1.655
6. Upadhyay DK, Palaian S, Shankar PR, Mishra P, Pokhara N. Knowledge, attitude and practice about diabetes among diabetes patients in western Nepal. *Rawal Med J.* 2008;33(1):8-11. doi: 10.5812/RMJ.114088
7. Shah VN, Kamdar P, Shah N. Assessing the knowledge, attitudes and practice of type 2 diabetes among patients of Saurashtra region, Gujarat. *Int J Diab Developing Countries.* 2009;29(3):118. doi: 10.4103/0973-3930.54288
8. Ambigapathy R, Ambigapathy S, Ling H. A knowledge, attitude and practice (KAP) study of diabetes mellitus among patients attending Klinik Kesihatan Seri Manjung. *NCD Malaysia.* 2003;2(2):6-16. doi: 10.18203/2394-6040.ijcmph20183824
9. Ng SH, Chan KH, Lian ZY, Chuah YH, Noora A. Reality vs illusion: knowledge, attitude and practice among diabetic patients. *Int J Collab Res Internal Med.* 2012;4(5):723. doi: 10.14503/3745-7649.34109
10. Mohammadi S, Karim NA, Talib RA, Amani R. Knowledge, attitude and practices on diabetes among type 2 diabetic patients in Iran: A cross-sectional study. *Sci J Public Health.* 2015;3:520-524. doi: 10.11648/j.sjph.20150304.20
11. Rahaman KS, Majdzadeh R, Holakouie Naieni K, Raza O. Knowledge, attitude and practices (KAP) regarding chronic complications of diabetes among patients with type 2 diabetes in Dhaka. *Int J Endocrinol Metab.* 2017;15:e12555. doi: 10.5812/ijem.12555
12. Magbanua E, Lim-Alba R. Knowledge and practice of diabetic foot care in patients with diabetes at Chinese general hospital and medical center. *J ASEAN Federat Endocrine Soc.* 2017;32:1-19. doi: 10.15605/jafes.032.02.05
13. Karaoui LR, Deeb ME, Nasser L, Hallit S. Knowledge and practice of patients with diabetes mellitus in Lebanon: A cross-sectional study. *BMC Public Health.* 2018;18:525. doi: 10.1186/s12889-018-5416-7
14. Phuong CM, Hue DT, Thuy NH. Communication on health education to prevent pre-diabetes-diabetes. *J Pract Med.* 2011;11:6-9. doi: 10.11080/JPM.2011.02.555594
15. Nhung NT, Dao MA. Knowledge and practice of diabetes prevention among elderly people in two communes of Vu Ban, Nam Dinh province in 2001. *J Pract Med.* 2013;5:72-75. doi: 10.13073/JPM.2013.03.54862
16. Saadia Z, Rushdi S, Alsheha M, Saeed H, Rajab M. A study of knowledge attitude and practices of Saudi women towards diabetes mellitus. A (KAP) study in Al-Qassim Region. *Internet J Health.* 2009;11:1-7. doi: 10.5580/1d29

17. Singh R, Maharjan PL, Gupta N. Knowledge of diabetes among diabetic patients attending diabetes clinic in Kathmandu Nepal. *Int J Health Sci Res.* 2013;3(10):37-40. doi: 10.864-65/76540
18. Wong N, Wang SS, Lamoureux E, et al. Blood pressure control and awareness among patients with diabetes and hypertension attending a tertiary ophthalmic clinic. *Diabet Med.* 2009;26(1):34-39. doi: 10.1111/j.1464-5491.2008.02614.x
19. Zaheera S, Salah A, Muneera S, et al. A study of knowledge attitude and practices of Saudi women towards diabetes mellitus. A (KAP) study in Al-Qassim region. *Int J Health.* 2010;11(2):29. doi: 10.5580/1d29
20. Tan MY, Magarey J. Self-care practices of Malaysian adults with diabetes and sub-optimal glycaemic control. *Patient Education Counsel.* 2008;72(2):252-267. doi: 10.1016/j.pec.2008.03.017
21. Blasco-Blasco M, Puig-García M, Piay N, Lumbreras B, Hernández-Aguado I, Parker LA. Barriers and facilitators to successful management of type 2 diabetes mellitus in Latin America and the Caribbean: A systematic review. *PloS One*. 2020;15(9):e0237542. doi: 10.1371/journal.pone.0237542
22. Srinivasan NK, John D, Rebekah G, Kujur ES, Paul P, John SS. Diabetes and diabetic retinopathy: knowledge, attitude, practice (KAP) among diabetic patients in a tertiary eye care Centre. *J Clin Diagn Res*. 2017;11(7):NC01. doi: 10.7860/JCDR/2017/27027.10174
23. Rahaman KS, Majdzadeh R, Holakouie Naieni K, Raza O. Knowledge, attitude and practices (KAP) regarding chronic complications of diabetes among patients with type 2 diabetes in Dhaka. *Int J Endocrinol Metabol.* 2017;15(3):e12555. doi: 10.5812/ijem.12555
24. Belsti Y, Akalu Y, Animut Y. Attitude, practice and its associated factors towards diabetes complications among type 2 diabetic patients at Addis Zemen District hospital, Northwest Ethiopia. *BMC Public Health.* 2020;20(1):785. doi: 10.1186/s12889-020-08953-6
25. Butler R, McClinchy J, Morreale-Parker C, Marsh W, Rennie KL. BMI calculation in older people: the effect of using direct and surrogate measures of height in a community-based setting. *Clin Nutr*. 2017;22:112-115. doi: 10.1016/j.clnesp.2017.07.078
26. Shawahna R, Fahed B, Qadri D, Sharawi L, Soroghli M, Dweik M. Awareness and knowledge of autism Spectrum disorders among pharmacists: a cross sectional study in Palestinian pharmacy practice. *J Autism Dev Disord*. 2017;47(6):1618-1627. doi: 10.1007/s10803-017-3085-5
27. Shawahna R, Atrash A, Jebril A, Khalaf A, Shaheen E, Tahboosh H. Evaluation of pharmacists' knowledge of women's issues in epilepsy: a cross-sectional study in Palestinian pharmacy practice. *Seizure*. 2017;46:1-6. doi: 10.1016/j.seizure.2017.01.002
28. Shawahna R, Atrash A, Jebril A, Khalaf A, Shaheen E, Tahboosh H. Pharmacists' knowledge of issues in pharmacotherapy of epilepsy using antiepileptic drugs: a cross-sectional study in Palestinian pharmacy practice. *Epilepsy Behav.* 2017;67:39-44. doi: 10.1016/j.yebeh.2016.11.027

29. Shawahna R, Al-Rjoub M. Risk of error estimated from Palestine pharmacists' knowledge and certainty on the adverse effects and contraindications of active pharmaceutical ingredients and excipients. *J Educ Eval Health Prof.* 2016;13:1. doi: 10.3352/jeehp.2016.13.1
30. Shawahna R, Haddad A, Khawaja B, Raie R, Zaneen S, Edais T. Medication dispensing errors in Palestinian community pharmacy practice: a formal consensus using the Delphi technique. *Int J Clin Pharm*. 2016;38(5):1112-1123. doi: 10.1186/s12913-019-4485-3
31. Shawahna R, Zyoud A, Jallad D, Hadwan L, Ihssan N, Hilal H. Blood zinc levels in nursing women from different regions of the West Bank of Palestine. *Women Health*. 2018;58(7):822-833. doi: 10.1080/03630242.2017.1342743
32. Demaio AR, Otgontuya D, de Courten M, et al. Exploring knowledge, attitudes and practices related to diabetes in Mongolia: a national population-based survey. *BMC Public Health.* 2013;13:236. doi: 10.1186/1471-2458-13-236
33. Fatema K, Hossain S, Natasha K, et al. Knowledge attitude and practice regarding diabetes mellitus among nondiabetic and diabetic study participants in Bangladesh. *BMC Public Health*. 2017;17(1):364. doi: 10.1186/s12889-017-4285-9
34. Karaoui LR, Deeb ME, Nasser L, Hallit S. Knowledge and practice of patients with diabetes mellitus in Lebanon: a cross-sectional study. *BMC Public Health*. 2018;18(1):525. doi: 10.1186/s12889-018-5416-7
35. Alsous M, Abdel Jalil M, Odeh M, Al Kurdi R, Alnan M. Public knowledge, attitudes and practices toward diabetes mellitus: a cross-sectional study from Jordan. *PLoS One*. 2019;14(3):e0214479. doi: 10.1371/journal.pone.0214479
36. Saleh F, Mumu SJ, Ara F, Begum HA, Ali L. Knowledge and self-care practices regarding diabetes among newly diagnosed type 2 diabetics in Bangladesh: a cross-sectional study. *BMC Public Health*. 2012;12:1112. doi: 10.1186/1471-2458-12-1112
37. Deepa M, Bhansali A, Anjana RM, et al. Knowledge and awareness of diabetes in urban and rural India: the Indian Council of Medical Research India diabetes study (phase I): Indian Council of Medical Research India diabetes 4. *Indian J Endocrinol Metabol.* 2014;18(3):379-385. doi: 10.4103/2230-8210.131191
38. Chatterjee S, Davies MJ, Heller S, Speight J, Snoek FJ, Khunti K. Diabetes structured self-management education programmes: a narrative review and current innovations. *Lancet Diabet Endocrinol*. 2018;6(2):130-142. doi: 10.1016/S2213-8587(17)30239-5
39. Rashed OA, Sabbah HA, Younis MZ, Kisa A, Parkash J. Diabetes education program for people with type 2 diabetes: an international perspective. *Eval Program Plan*. 2016;56:64-68. doi: 10.1016/j.evalprogplan.2016.02.002.

40. Brassard D, Laramée C, Robitaille J, Lemieux S, Lamarche B. Differences in population-based dietary intake estimates obtained from an interviewer-administered and a self-administered web-based 24-h recall. *Front Nutr*. 2020;7:137. doi: 10.3389/fnut.2020.00137
41. Bakare P, Sethi S, Mushtaq I, et al. A study of knowledge attitude practices and identification of perceived barriers towards screening for diabetic retinopathy amongst diabetics in an industrial area in western Maharashtra. *Eur J Clin Exp Med.* 2023;21(3):539-545. doi: 10.1186/s12875-023-02068-8
42. Lalwani RK, Shah JD, Chatterjea T, Nadakuduru PR, Erande S. Prevalence of depression in Indian patients with type 2 diabetes mellitus and/or hypertension: DEPTH Study. *Eur J Clin Exp Med*. 2019;17(4):315-325. doi: 10.15584/ejcem.2019.4.5
43. Islam FMA, Chakrabarti R, Dirani M, Islam MT, Ormsby G, et al. Knowledge, Attitudes and Practice of Diabetes in Rural Bangladesh: The Bangladesh Population Based Diabetes and Eye Study (BPDES). *PLoS One*. 2014;9(10): e110368. doi: 10.1371/journal.pone.0110368
44. Thabit MF. Awareness regarding diabetes mellitus and its complication in Type 2 diabetic patients. *KMCJ*. 2013;9(2):25-28. doi: 10.12889/9876.8
45. Shrestha L, Nagra JS. Knowledge, attitude and practice (KAP) study on diabetes mellitus among Nepalese diabetic patients. *Nepal Med Coll J*. 2005;7(1):51-53. doi: 10.16539/NMC.2005.5.7
46. Smalls BL, Walker RJ, Hernandez-Tejada MA, et al. Associations between coping, diabetes knowledge, medication adherence and self-care behaviors in adults with type 2 diabetes. *Gen Hosp Psychiatry*. 2012;34(4):385-389. doi: 10.1016/j.genhosppsych.2012.03.018