ORIGINAL RESEARCH ARTICLE

Knowledge, Attitude, And Practice in Diabetic Kidney Disease Prevention and Its Associated Factor Among Type 2 Diabetes Mellitus Patients in Northeast Peninsular Malaysia

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ABSTRACT

Introduction: Diabetic kidney disease (DKD) is a major complication among Type 2 Diabetes Mellitus (T2DM) patients. Understanding their knowledge, attitude, and practice (KAP) of DKD prevention is crucial for guiding effective interventions. This study aimed to assess the level of KAP in DKD prevention and identify the factors associated with poor KAP among T2DM patients in Northeast Peninsular Malaysia.

Methods: A cross-sectional study was conducted among 600 T2DM patients from government health clinics in Kelantan, Malaysia. Data were collected using a validated questionnaire, and logistic regression analyses identified factors associated with poor KAP, considering socio-demographic and clinical characteristics.

Results: Findings showed 77.0% had poor knowledge, 58.2% poor attitude, and 37.7% poor practice. Poor knowledge was associated with single/divorced marital status, lower education, and diabetic complications, while unemployed participants had lower odds of poor knowledge. Poor attitude was linked to poor knowledge, lower education, and unemployment, while poor practice was associated with non-Malay ethnicity, lower education, and poor attitude.

Conclusion: Targeted educational interventions are needed, focusing on vulnerable groups with lower education and specific socio-demographic factors to enhance DKD prevention and improve T2DM patient outcomes.

Keywords: Diabetic Kidney Disease, Factors, KAP, Type 2 Diabetes Mellitus

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INTRODUCTION

Diabetic kidney disease (DKD) is a serious complication of diabetes and a leading cause of end-stage renal disease (ESRD) globally, accounting for over 40% of patients on dialysis.[1,2] In Malaysia, the National Diabetes Registry Report indicates that 14.6% of type 2 diabetes mellitus (T2DM) patients are diagnosed with DKD, with Kelantan, a north-eastern state of Peninsular Malaysia, reporting a higher prevalence at 15.5%.[3] This condition significantly impacts patients' quality of life and places a substantial financial burden on the healthcare system, particularly in Malaysia, where public healthcare is fully tax-funded.[4]

Preventing and managing DKD requires a comprehensive understanding of patients' knowledge, attitudes, and practices (KAP) regarding the disease. Awareness and knowledge influence early detection and adherence to preventive measures, while attitudes shape health-seeking behaviour and willingness to adopt lifestyle modifications.[5] However, limited studies have specifically assessed KAP related to DKD prevention, raising concerns about the validity and applicability of existing assessment tools.

Studies on chronic kidney disease (CKD) prevention have highlighted several sociodemographic factors influencing KAP levels. Research in Singapore and Malaysia found that age, education level, occupation, and income significantly impact CKD knowledge, yet attitudes and practices were not assessed.[6] Similarly, studies in Tanzania, and Bangladesh linked education, age, and socioeconomic status to knowledge, but comprehensive KAP assessments remained scarce.[6,7] A study in Jordan found that gender, family history of diabetes, and knowledge levels were associated with better practices.[8] While research in Palestine examined all three KAP domains, it focused on hypertensive rather than T2DM patients.[9]

Given these gaps, this study aims to assess the knowledge, attitudes, and practices (KAP) related to DKD prevention among T2DM patients in Kelantan, Malaysia. Additionally, it seeks to identify factors associated with poor KAP scores to inform targeted interventions. By addressing gaps in patient awareness and behaviour, this research aims to support healthcare providers in developing effective education and prevention strategies, ultimately improving DKD management and patient outcomes.

METHODOLOGY

Study design: This cross-sectional study was conducted among T2DM patients attending 20 randomly selected government health clinics across 10 districts in Kelantan, Malaysia. The sample size was calculated using a two-proportion formula, incorporating factors associated with poor KAP and a 10% dropout rate, resulting in a final sample size of 600 patients. Patient selection was carried out using systematic random sampling, where every second patient was chosen until 30 patients per clinic were recruited.

Participants: Patients recruited must be Malaysian citizens, aged 18-80 years old, be followed up in the government health clinic for at least one year and be able to read and understand the Malay language. Systematic random sampling was done to recruit the patients in each clinic. Those who were pregnant were excluded from this study. The questionnaires were self-administered to consented patients for them to answer. Upon completion, the forms were returned to the researcher. Secondary data such as the patient's clinical data were taken from their clinic records.

Data Collection and Research Tools: This KAP DKD Prevention scale was adapted from the CKD Screening Index developed by Khalil et al.[10] This questionnaire was chosen given the comprehensiveness that covered all knowledge, attitude and practise domains and it was widely used in research to determine the KAP on CKD.[9,11–14] The KAP DKD prevention scale was further validated, demonstrating good precision and reliability.[15]

The questionnaire consisted of 44 items, divided into three domains: knowledge (25 items), attitude (11 items), and practice (8 items). The knowledge items were answered with ‘yes,’ ‘no,’ and ‘unsure.’ Correct answers were awarded 1 mark, while incorrect or unsure responses received 0 marks. The attitude domain utilized a 5-point Likert scale ranging from 'very disagree' to 'very agree,' with total scores ranging from 11 to 55. The practice domain was scored on a 4-point Likert scale: 'always,' 'sometimes,' 'rarely,' and 'never,' with total scores ranging from 8 to 40. KAP scores were categorized as ‘good’ if participants scored ≥80% and ‘poor’ if they scored <80%, based on Bloom’s cut-off criteria.[16] The outcome of interest in this study was poor KAP.

Factors being studied, besides the KAP level itself, were categorized into sociodemographic (such as age, sex, marital, education and working status) and clinical factor (such as duration of DM, family history of diabetes mellitus (DM) or CKD, comorbidities and diabetic complication status).

Statistical Analysis: All statistical analyses were performed using R software. Numerical data were reported in mean and standard deviation (SD). Categorical data were reported in frequency and percentage, n (%). As for the factors associated with poor KAP, simple logistic regression was employed to explore the variables, those with p-value <0.25 were chosen for variable selection. The preliminary model was checked for interaction. VIF less than 10 indicate no multicollinearity. The area under the Receiver Operating Characteristic (ROC) must be more than 0.6 to have acceptable discrimination.[17] The final model was checked for model fitness by the Hosmer Lemeshow test and finalized in the multiple logistic regression analysis.

Ethics approval: This study was approved by the Human Research Ethics Committee of Universiti Sains Malaysia (USM/JEPeM/KK/23010069) and it was registered with the National Medical Research Registry under the identification number NMRR ID-23-00307-U9X.

RESULTS

At the end of the data collection, 600 patients participated and completed the questionnaire in this study. The study participants had a mean age of 55.65 years and an average duration of diabetes mellitus of 7.20 years. The majority were female (71.0%), married (80.5%), and had a lower level of education (81.8%). A significant portion of the participants were classified as obese (73.3%), with high prevalence rates of hypertension (75.3%) and dyslipidemia (69.3%). Chronic kidney disease was absent in 77.7% of participants, yet 36.0% showed signs of macroalbuminuria. Table 3.1 summarizes these characteristics, offering a detailed description of the participants.

Participants' Knowledge of DKD Prevention: Participants demonstrated a varied understanding of kidney functions, with the majority correctly identifying that kidneys control body water content (73.7%), eliminate toxins (66.8%), and regulate electrolytes (54.0%). However, fewer participants correctly recognized the kidneys' role in hormone production for blood pressure regulation (44.2%) and red blood cell production (35.2%). Regarding risk factors for chronic kidney disease (CKD), a significant proportion were aware that hypertension (76.8%) and diabetes (90.2%) increase the risk, but fewer identified smoking (52.5%) and obesity (61.3%) as risks.

Knowledge of CKD symptoms varied, with high recognition for fatigue (79.0%), reduced appetite (68.8%), and leg swelling (81.3%). Conversely, understanding was lower for symptoms like muscle cramps (47.2%) and skin issues (54.3%). Knowledge about early detection and management was mixed; 74.3% recognized the importance of routine urine protein testing, but misconceptions persisted about CKD's curability (30.3%) and uniform management plans across all CKD stages (28.3%).

Table 1: Sociodemographic, Clinical and Laboratory Characteristics of the Participants (n = 600)

Characteristics	n(%)	Knowledge,(%)		Attitude, (%)		Practice, (%)	
		Good	Poor	Good	Poor	Good	Poor
Age (years)*	55.65±11.15	55.62±11.60	55.66±11.33	54.33±10.47	56.60±11.54	55.25±11.12	56.31±11.20
Ethnicity							
Malay	586(98.0)	138(100)	448(97.0)	248(98.8)	338(96.8)	362(96.8)	159(70.4)
Non-Malay	14(2.3)	0(0)	14(3.0)	3(1.2)	11(3.2)	12(3.2	2(0.9)
Duration of DM (years)*	7.20±5.31)	7.49±5.78)	7.11±5.17)	6.84±4.99)	7.46±5.53)	6.95±5.26)	7.61±5.39)
Sex							
Female	426(71.0)	103(74.6)	323(69.9)	185(73.7)	241(69.1)	267(71.4)	159(70.4)
Male	174(29.0)	35(25.4)	139(30.1)	66(26.3)	108(30.9)	107(28.6)	67(29.6)
Marital status							
Married	483(80.5)	121(87.7)	362(78.4)	206(82.1)	277(79.4)	303(81.0)	180(79.6)
Single/Widowed/Divorced	117(19.5)	17(12.3)	100(21.6)	45(17.9)	72(20.6)	71(19.0)	46(20.4)
Education status							
Higher education	109(18.2)	32(23.2)	77(16.7)	68(27.1)	41(11.7)	84(22.5)	25(11.1)
Lower education	491(81.8)	106(76.8)	385(83.3)	183(72.9)	308(88.3)	290(77.5)	201(88.9)
Working status							
Working	242(40.3)	48(34.8)	194(42.0)	124(49.4)	118(33.8)	165(44.1)	77(34.1)
Not working	358(59.7)	90(65.2)	268(58.0)	127(50.6)	231(66.2)	209(55.9)	149(65.9)
Smoking status							
Non-smoker	498(83.0)	119(86.2)	379(82.0)	211(84.1)	287(82.2)	317(84.8)	181(80.1)
Ex-Smoker	59(9.8)	9(6.5)	50(10.8)	23(9.2)	36(10.3)	33(8.8)	26(11.5)
Current Smoker	43(7.2)	10(7.2)	33(7.1)	17(6.8)	26(7.4)	24(6.4)	19(8.4)
Family History of Diabetes							
No	173(28.8)	32(23.2)	141(30.5)	71(28.3)	102(29.2)	114(30.5)	59(26.1)
Yes	427(71.2)	106(76.8)	321(69.5)	180(71.7)	247(70.8)	260(69.5)	167(73.9)
BMI Category							
Normal Weight	79(13.2)	16(11.6)	63(13.6)	24(9.6)	55(15.8)	52(13.9)	27(11.9)
Underweight	7(1.2)	3(2.2)	4(0.9)	4(1.6)	3(0.9)	5(1.3)	2(0.9)
Overweight	74(12.3)	13(9.4)	61(13.2)	32(12.7)	42(12.0)	45(12.0)	29(12.8)
Obese	440(73.3)	106(76.8)	334(72.3)	191(76.1)	249(71.3)	272(72.7)	168(74.3)
Hypertension							
No	148(24.7)	34(24.6)	114(24.7)	63(25.1)	85(24.4)	93(24.9)	55(24.3)
Yes	452(75.3)	104(75.4)	348(75.3)	188(74.9)	264(75.6)	281(75.1)	171(75.7)
Dyslipidemia							
No	184(30.7)	46(33.3)	138(29.9)	74(29.5)	110(31.5)	73(32.3)	111(29.7)
Yes	416(69.3)	92(66.7)	324(70.1)	177(70.5)	239(68.5)	153(67.7)	263(70.3)
Macro/ Microvascular Complication							
No complication	358(59.7)	93(67.4)	265(57.4)	165(65.7)	193(55.3)	225(60.2)	133(58.8)
At least 1 complication	242(40.3)	45(32.6)	197(42.6)	86(34.3)	156(44.7)	149(39.8)	93(41.2)

*Values are in mean ± SD

Table 2: Participants' answers to questions on knowledge of DKD Prevention (n=600)

Statement	True (%)	False (%)	Not sure (%)
The kidneys function to regulate the water content in my body.	442(73.7)	23(3.8)	135(22.5)
The kidneys function to regulate the content of electrolytes such as sodium, potassium, phosphorus, and calcium in my body.	324(54.0)	28(4.7)	248(41.3)
The kidneys function to eliminate toxins that enter my body.	401(66.8)	26(4.3)	173(28.8)
The kidneys function to produce hormones in the blood to control blood pressure.	265(44.2)	63(10.5)	272(45.3)
The kidneys function to produce hormones to generate red blood cells.	211(35.2)	81(13.5)	308(51.3)
The following risk factors will increase the risk of chronic kidney disease			
i. Hypertension	461(76.8)	31(5.2)	108(18.0)
ii. Diabetes	541(90.2)	6(1.0)	53(8.8)
iii. Smoking	315(52.5)	82(13.7)	203(33.8)
iv. Excessive body weight	368(61.3)	57(9.5)	175(29.2)
v. Recurrent kidney stones	259(43.2)	91(15.2)	250(41.7)
vi. Recurrent urinary tract infections	285(47.5)	80(13.3)	235(39.2)
v. Having a family member with chronic kidney disease	221(36.8)	163(27.2)	216(36.0)
Symptoms of chronic kidney disease are			
i. Fatigue	474(79.0)	22(3.7)	104(17.3)
ii. Concentration problems	286(47.7)	68(11.3)	246(41.0)
iii. Loss of appetite	413(68.8)	42(7.0)	145(24.2)
iv. Difficulty sleeping	337(56.2)	67(11.2)	196(32.7)
v. Muscle cramps	283(47.2)	69(11.5)	248(41.3)
vi. Leg swelling	488(81.3)	24(4.0)	88(14.7)
vii. Dry skin	378(63.0)	42(7.0)	180(30.0)
viii. Itchy skin	326(54.3)	56(9.3)	218(36.3)
Regular urine protein testing allows early detection of chronic kidney disease.	446(74.3)	21(3.5)	133(22.2)
Chronic kidney disease is a curable disease.	182(30.3)	144(24.0)	274(45.7)
All stages of kidney disease have the same management plan.	170(28.3)	110(18.3)	320(53.3)
There are five stages of chronic kidney disease.	312(52.0)	22(3.7)	266(44.3)
Stage 5 chronic kidney disease patients require lifelong dialysis treatment.	445(74.2)	18(3.0)	137(22.8)

Table 3: Participants' answers to attitude on DKD prevention (n=600)

Statement	Strongly Disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)
I would be surprised if I was diagnosed with chronic kidney disease.	27(4.5)	26(4.3)	83(13.8)	287(47.8)	177(29.5)
I will discuss with my friends about chronic kidney disease.	19(3.2)	58(9.7)	119(19.8)	315(52.5)	89(14.8)
I will discuss with my family about chronic kidney disease.	17(2.8)	18(3.0)	46(7.7)	386(64.3)	133(22.2)
I will see a doctor if I experience signs and symptoms of chronic kidney disease.	12(2.0)	4(0.7)	24(4.0)	332(55.3)	228(38.0)
I believe maintaining good blood sugar levels is very important to prevent chronic kidney disease.	15(2.5)	8(1.3)	44(7.3)	314(52.3)	219(36.5)
Doing physical activities that can improve my health is important.	11(1.8)	7(1.2)	35(5.8)	337(56.2)	210(35.0)
I want to detect my health problems at an early stage.	11(1.8)	5(0.8)	28(4.7)	324(54.0)	232(38.7)
I will get kidney disease in the future if my diabetes is not controlled.	10(1.7)	14(2.3)	67(11.2)	303(50.5)	206(34.3)
Doctors and nurses should give me more information about chronic kidney disease.	13(2.2)	2(0.3)	35(5.8)	347(57.8)	203(33.8)
Diabetic patients can prevent chronic kidney disease.	20(3.3)	32(5.3)	104(17.3)	286(47.7)	158(26.3)
Prevention of kidney disease requires commitment from diabetic patients.	13(2.2)	9(1.5)	89(14.8)	316(52.7)	173(28.8)

Table 4: Participants' answers to practise on DKD prevention (n=600)

Statement	Never (%)	Rarely (%)	Sometimes (%)	Always (%)
Eating a balanced diet.	14(2.3)	86(14.3)	133(22.2)	367(61.2)
Doing moderate-intensity exercises such as walking and jogging.	44(7.3)	138(23.0)	152(25.3)	266(44.3)
Maintaining normal body weight.	32(5.3)	95(15.8)	141(23.5)	332(55.3)
Limiting salt intake in my diet.	22(3.7)	95(15.8)	141(23.5)	342(57.0)
Limiting sugar intake in my diet.	20(3.3)	74(12.3)	113(18.8)	393(65.5)
Recognizing signs of chronic kidney disease.	95(15.8)	77(12.8)	134(22.3)	294(49.0)
Seeking medical treatment if I experience signs of chronic kidney disease.	63(10.5)	51(8.5)	90(15.0)	396(66.0)
Seeking family support if I get chronic kidney disease.	47(7.8)	58(9.7)	92(15.3)	403(67.2)

Table 2 provides a detailed breakdown of participants' responses to each knowledge question.

Participants' Attitude on DKD Prevention: In terms of attitude toward DKD prevention, most participants are willing to discuss CKD with family (86.5%) and friends (67.3%). A high percentage would seek medical help if experiencing symptoms (93.3%) and believe in the importance of maintaining good blood sugar levels (88.8%) and engaging in physical activities (91.2%) for CKD prevention. Par-

ticipants show a proactive attitude towards early health problem detection (92.7%) and acknowledge the risk of CKD if diabetes is uncontrolled (84.8%). They feel healthcare providers should offer more information on CKD (91.6%). Overall, participants exhibit a positive attitude towards DKD prevention, emphasizing discussions, medical consultations, good health practices, early detection, and the need for more information from healthcare providers. The summary of the attitude domain is presented in Table 3.

Participants' Practise on DKD Prevention: In terms of DKD prevention practice among 600 participants, most participants consistently engaged in balanced eating (61.2%), limited salt (57.0%) and sugar intake (65.5%), and performed moderate-intensity exercises like walking and jogging (44.3%). Additionally, 55.3% maintained a normal weight. Regarding CKD awareness and response, 49.0% always recognized CKD symptoms, 66.0% sought medical treatment when experiencing symptoms, and 67.2% received family support if diagnosed. Overall, the data shows a high level of adherence to DKD preventive practices, with opportunities for improvement in awareness and engagement. Table 4 highlights the scores for practices of DKD prevention.

Table 5: Factors Associated with Poor Knowledge by Simple and Multiple Logistic Regression (n = 600)

Domain	Poor Knowledge			
Factor	**Crude OR (95% CI)**	**p-value**	**Adj. OR (95% CI)**	**p-value**
Marital status				
Married	Ref		Ref	
Single/ Widowed/ Divorced	1.97 (1.13,3.42)	0.017	1.93(1.13,3.47)	0.021
Education status				
Higher education	Ref		Ref	
Lower education	1.51 (0.95,2.40)	0.083	1.64 (1.00,2.65)	0.047
Working status				
Working	Ref		Ref	
Not working	0.74 (0.49,1.09)	0.131	0.63(0.41,0.95)	0.028
Macrovascular and/or Microvascular Complication				
No complication	Ref		Ref	
At least 1 complication/s	1.54 (1.03,2.29)	0.036	1.56 (1.04,2.35)	0.033

No interaction between variables; No multicollinearity (all variables VIF < 10); Hosmer Lemeshow tests were not significant.; Area under ROC: 0.61.

Table 6: Factors Associated with Poor Attitude by Simple and Multiple Logistic Regression (n = 600)

Domain	Poor Attitude			
Factor	**Crude OR (95%CI)**	**p-value**	**Adj. OR (95%CI)**	**p-value**
Education status				
Higher education			Ref	
Lower education	2.79 (1.82, 4.28)	<0.001	2.38 (1.53,3.71)	<0.001
Working status				
Working	Ref		Ref	
Not Working	1.91 (1.37, 2.66)	<0.001	1.71 (1.21,2.42)	0.002
Knowledge				
Good	Ref		Ref	
Poor	1.48 (1.01, 2.17)	0.044	1.49 (1.00,2.21)	0.049

No interaction between variables; No multicollinearity (all variables VIF < 10); Hosmer Lemeshow tests were not significant.; Area under ROC: 0.63

Table 7: Factors Associated with Poor Practise by Simple and Multiple Logistic Regression (n = 600)

Domain	Poor Practice			
Factor	**Crude OR (95%CI)**	**p-value**	**Adj. OR (95%CI)**	**p-value**
Ethnicity				
Malay	Ref		Ref	
Non-Malay	0.27 (0.06, 1.21)	0.088	0.20 (0.03, 0.74)	0.036
Education status				
Higher education	Ref			
Lower education	2.33 (1.44,3.77)	<0.001	2.00(1.23,3.33)	0.006
Attitude				
Good	Ref			
Poor	2.53 (1.78,3.60)	<0.001	2.39 (1.67,3.34)	<0.001
Knowledge				
Good	Ref			
Poor	1.58 (1.05, 2.38)	0.029		

No interaction between variables; No Multicollinearity (VIF < 10); Hosmer Lemeshow tests were not significant.; Area under ROC: 0.64

Level of KAP on DKD Prevention: The score for each domain was calculated. The mean knowledge score obtained in this study was 57.15 (95% CI: 55.14, 59.16), the mean attitude score was 42.93 (95% CI: 42.47, 43.40) and the mean practise score was 26.41 (95% CI: 25.95, 26.87). The cutoff point of 80% of the total score was used to categorize the scores for each domain of knowledge, attitude, and practice among the 600 participants. A total of 462 participants (77.0%) were categorized as having poor knowledge, while 138 participants (23.0%) had good knowledge. In terms of attitude, 349 participants (58.2%) had a poor attitude, whereas 251 participants (41.8%) had a good attitude. For the practice domain, 226 participants (37.7%) were categorized as having poor practice, while 374 participants (62.3%) demonstrated good practice.

The Factor Associated with Poor KAP on DKD Prevention: Simple logistic regression was employed for variable explorations. Variable with p-value < 0.25 was selected to proceed with multiple logistic analysis. The adjusted odds ratio (OR) for poor knowledge among single, widowed, or divorced participants was 1.93 (95% CI: 1.13,3.47), indicating that they had 93% higher odds of having poor knowledge compared to married participants. Participants with lower education had 64% higher odds of poor knowledge than those with higher education, as reflected by an adjusted OR of 1.64 (95% CI: 1.00,2.65). Additionally, participants who were working had 59% higher odds of having poor knowledge, with an adjusted OR of 1.59 (95% CI: 1.06,2.44). The presence of at least one macrovascular or microvascular complication was associated with 56% higher odds of poor knowledge, with an adjusted OR of 1.56 (95% CI: 1.04,2.35). Table 5 summarises the results for factors associated with poor knowledge.

The final model for attitude revealed that the participants with lower education had two times higher odds of having a poor attitude compared to those with higher education, as indicated by an adjusted OR of 2.38 (95% CI: 1.53-3.71). Those who were not working had 71% higher odds of having a poor attitude, with an adjusted OR of 1.71 (95% CI: 1.21-2.42). Poor knowledge was associated with 49% higher odds of poor attitude, with an adjusted OR of 1.49 (95% CI: 1.00-2.21). Table 6 shows the result for factors associated with poor knowledge.

Lastly, for the practise domain, the analysis revealed that participants with lower education levels had significantly higher odds of engaging in poor practice compared to those with higher education, with an adjusted OR of 2.93 (95% CI: 1.64-5.53). Additionally, ex-smokers were found to have substantially higher odds of poor practice compared to non-smokers, with an adjusted OR of 12.5 (95% CI: 3.50-52.5). In contrast, the odds of poor practice among current smokers were not significantly different from non-smokers, as reflected by an adjusted OR of 1.50 (95% CI: 0.07-10.5). The study also found that participants with a poor attitude had more than twice the odds of engaging in poor practice compared to those with a good attitude, with an adjusted OR of 2.31 (95% CI: 1.60-3.34). Lower education remained a significant factor, with individuals having twice the odds of poor practice compared to those with higher education. Non-Malay participants had 80% lower odds of poor practice compared to Malays. Poor attitude also significantly increased 2 times the odds of poor practice. However, knowledge did not show a significant association in the adjusted model. Table 7 summarises the result of simple and multiple logistic regression analysis for the factors associated with practice.

Discussion

This study aimed to determine the level of KAP on DKD prevention among T2DM patients in Northeast Peninsular Malaysia and its associated factors. This study indicated a higher score in the knowledge levels among participants as 77% of them had poor knowledge compared to 30.1% and 47.9% reported in other studies.[13,18] While a majority demonstrated an adequate understanding of kidney functions and the role of hypertension and diabetes as risk factors for DKD, there were significant gaps in knowledge related to other risk factors such as smoking and obesity, as well as the kidneys' hormonal functions. A significant percentage of patients (76%) also incorrectly scored the item that the DKD can be cured. This is significantly higher compared to findings from other studies on the same item.[13] This misconception may cause the patient to think lightly when they are diagnosed with DKD hence may lead to poorer health outcomes.[19]

Factors associated with poor knowledge found in this study were lower education, being currently not married, and having at least one diabetic complication which aligns with other studies. People with lower education may struggle to understand their condition and necessary management strategies.[20] Patients who are not married have fewer opportunities to discuss their illness hence their knowledge retainment is lesser than those with spouses.[21] This study also found that patients who had at least 1 complication are associated with poor knowledge. Patients who lack an understanding of diabetic-related complications will have poorer control of their diabetes which increases susceptibility to having diabetic complications. This finding can be an important factor in tailoring targeted intervention whenever a patient appears to have any diabetic-related target organ complications.[5]

Interestingly, the study also revealed that individuals who working were associated with poor DKD knowledge compared to those who were not working. This aligns with findings from a study in India, which similarly reported lower CKD knowledge among the working population compared to their

non-working counterparts.[22] This finding could be attributed to less time among those who are working to gain health-related knowledge which also affects their health-seeking behaviour.[23] On the other hand, this finding aligns with a study showing that retired individuals had better knowledge, likely due to greater opportunities to participate in health empowerment programs on diabetes management and DKD prevention.[13] These results underscore the importance of more targeted health promotion efforts aimed at reaching the working population effectively.

A notable proportion (58.2%) of participants exhibited poor attitudes. This study's findings align with others, showing that people with lower education or those who are not working tend to have more fatalistic attitudes about their health. This tendency may stem from socioeconomic and psychological challenges, including financial hardship, concerns over healthcare affordability, and economic stress, all of which can diminish motivation for positive health behaviours.[24] Consequently, these barriers may lead to poor medication adherence and an increased risk of complications, such as DKD.[25,26] Despite the overall trend, certain attitudes towards DKD prevention were notably positive. For instance, 67.3% to 93.3% of participants were willing to discuss kidney disease with family and friends and seek medical help when experiencing symptoms. A well-informed family, particularly caretakers, can significantly enhance the patient's quality of life by providing continuous support and motivation, ensuring that the disease remains well-controlled. This supportive environment is crucial for encouraging patients to adhere to treatment plans and engage in proactive health management.[27]

In terms of practice, the study found that the majority of participants engaged in preventive behaviours such as balanced eating, limiting salt and sugar intake, and performing moderate-intensity exercises. These practices are important to reduce the incidence of DKD among T2DM patients.[28] However, there is still room for improvement, especially in areas such as recognizing CKD symptoms and seeking timely medical treatment. The higher adherence to preventive practices observed in this study could be attributed to ongoing public health campaigns and the accessibility of healthcare services in the region.[29] Although non-Malay individuals made up only 2.3% of the sample, they were more likely to practise healthy lifestyle habits compared to Malays. This result should be interpreted cautiously due to the small number of non-Malay participants which was consistent with the demography of North-East Malaysia.[30] However, this finding was in line with other literature that reported non-Malay individuals were more likely to adopt better self-care habits compared to Malays and physical activity participation was particularly low among Malay women.[31] Lower education was associated with lower health literacy, hence, they may struggle to comprehend medical instructions, follow treatment recommendations, and engage in the preventive practice for DKD.[32]

The multivariable analysis revealed that poor knowledge and poor attitude were significantly associated. However, within the practice domain, only attitude showed a significant association. Knowledge was not significant when attitude was included in the model, suggesting a potential mediating role of attitude. This finding indicates that good knowledge alone may not prevent poor practice, as patients with a poor attitude might fail to take action despite having adequate knowledge.[11] Otherwise, this study underscores the interrelationship within the KAP model, highlighting the interconnected nature of these domains with the adequate discriminative ability of each model established for factors associated with poor KAP.[17] Given the limited studies employing multivariate analysis on the KAP model, this research emphasizes the critical importance of each KAP domain, suggesting that they should not be underestimated or addressed in isolation.[33]

One limitation of this study was that health literacy was not directly assessed, which may influence the interpretation of KAP levels. However, this limitation was likely minimised as the analysis accounted for key sociodemographic factors that were commonly associated with health literacy and related behaviours, such as education status. This study was also limited to Kelantan, so the findings may not reflect other areas with different socioeconomic or healthcare conditions. However, they may still be useful for similar low-resource settings. This study used a self-administered questionnaire, which may be subject to recall bias, particularly for knowledge and practice items. However, the findings suggest that the questionnaire was easily understood by participants, supporting its suitability for self-administration. This makes it a practical tool for use in resource-limited settings, such as district health offices, to assess population-level health behaviours efficiently. The findings of this study have several implications for public health policy and practice. Firstly, there is a need for more comprehensive and targeted educational programs that address the knowledge gaps identified in this study. Secondly, healthcare providers should focus on improving patient attitudes towards DKD prevention through personalised counselling and support. Lastly, promoting consistent and proactive preventive practices among T2DM patients should be a priority to mitigate the risk of DKD and improve patient outcomes.

Conclusion

This study provides valuable insights into the level of KAP regarding DKD prevention among T2DM patients in Northeast Peninsular Malaysia and factors associated with poor KAP levels. Poor knowledge was associated with being single, divorced, having lower education, and diabetic complications, while participants who were not working had better

knowledge. Poor attitudes were associated with poor knowledge, lower education, and not working status, and poor practices were associated with lower education, poor attitudes, and being non-Malay. This study's findings set a benchmark for future health interventions in DKD prevention.

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