RELATIONSHIP BETWEEN KNOWLEDGE, ATTITUDE, PRACTICE, PATIENT-LEVEL, AND CLINIC-LEVEL FACTORS OF DIABETIC KIDNEY DISEASE AMONG TYPE 2 DIABETES MELLITUS PATIENTS

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By

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ولا تكلنا إلى أنفسنا طرفة عين

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LIST OF ABBREVIATION

ACE-i	Angiotensin Converting Enzyme inhibitor
Adj. OR	Adjusted Odds Ratio
AIC	Akaike Information Criterion
ARB	Angiotensin receptor blocker
BIC	Bayesian Information Criterion
CCM	Chronic Care Model
CFA	Confirmatory Factor Analysis
CFI	Comparative fit index
CI	Confidence interval
CKD	Chronic Kidney Disease
CPG	Clinical Practice Guideline
CR	Composite Reliability
DE	Diabetic Educator
df	Degree of freedom
DFU	Diabetic Foot Ulcer
DKD	Diabetic Kidney Disease
DM	Diabetes Mellitus
eGFR	Glomerular Filtrate Rate
EMR	Electronic Medical Record
FDC	Family Doctor Concept
FMS	Family Medicine Specialist
HbA1c	Glycated haemoglobin A1c
HCW	Healthcare worker
ICC	Intra-Class Correlation
IHD	Ischaemic heart disease
IRT	Item Response Theory
KAP	Knowledge, attitude, practise

KDIGO	Kidney Disease: Improving Global Outcomes
KRK	Klinik Rawatan Keluarga
OR	Odd ratio
PHC	Primary Health Care
PS	Power and sample size calculation
RMSEA	Root means square error of approximation
SD	Standard Deviation
SE	Standard Error
SLR	Simple Logistic Regression
SRMR	Standardized Root Mean Square Residual
T2DM	Type 2 Diabetes Mellitus
TLI	Tucker Lewis Index
UK	United Kingdom
VIF	Variance Inflation Factor
VPC	Variance Partition Coefficient
HPUSM	Hospital Pakar Universiti Sains Malaysia
WHO	World Health Organization

LIST OF SYMBOLS

>	More than
<	Less than
=	Equal to
≥	More than and equal to
≤	Less than and equal to
α	Alpha (type I error)
β	Beta (type II error)
%	Percentage
χ	Chi-square

HUBUNGAN ANTARA PENGETAHUAN, SIKAP, AMALAN, FAKTOR PESAKIT, DAN FAKTOR KLINIK TERHADAP PENYAKIT BUAH PINGGANG DIABETIK DALAM KALANGAN PESAKIT DIABETES MELLITUS JENIS 2

ABSTRAK

Latar Belakang: Penyakit Buah Pinggang Diabetik (DKD) dikenal pasti sebagai komplikasi utama Diabetes Mellitus Jenis 2 (T2DM), yang menyumbang dengan ketara kepada peningkatan beban Penyakit Buah Pinggang Kronik (CKD) di Malaysia. Walaupun pengaruh pengetahuan, sikap, dan amalan (KAP) terhadap pencegahan CKD telah didokumentasikan dengan baik, soalselidik yang disahkan untuk mengukur aspek-aspek ini khusus bagi pencegahan DKD dalam kalangan pesakit T2DM masih terhad. Dengan berpaksikan kepada teori penjagaan penyakit kronik (CCM), Kajian ini bertujuan untuk menentukan faktor-faktor pada peringkat pesakit dan klinik yang berkaitan dengan DKD dan hubungkait antara KAP dan DKD.

Objektif: Objektif kajian ini adalah untuk mengesahkan soalselidik skala KAP pencegahan DKD versi Bahasa Melayu, menentukan tahap KAP yang rendah dalam kalangan pesakit T2DM di Kelantan, mengenal pasti faktor-faktor yang berkaitan dengan tahap KAP yang rendah, dan menilai hubungan antara tahap KAP dan DKD dengan mengambil kira faktor di peringkat pesakit dan klinik.

Metodologi: Kajian ini dijalankan dalam dua fasa. Fasa 1 memberi tumpuan kepada pengesahan skala KAP pencegahan DKD versi Bahasa Melayu bagi memastikan kebolehpercayaan dan relevansinya. Kesahan kandungan ditentukan melalui panel pakar yang terdiri daripada enam orang pakar dalam bidang perubatan keluarga, kesihatan awam, nefrologi, dan perubatan dalaman. Item-item yang mempunyai

Indeks Kesahan Kandungan (I-CVI) di bawah 0.83 telah dikeluarkan. Kumpulan perintis yang terdiri daripada 10 pesakit T2DM menilai kejelasan dan kefahaman item, yang membawa kepada penambahbaikan skala berdasarkan skor Indeks Kesahan Muka (FVI). Kesahan konstruk dinilai menggunakan Teori Respons Item Dua Parameter (2PL-IRT) untuk domain Pengetahuan dan Analisis Faktor Pengesahan (CFA) untuk domain Sikap dan Amalan. Fasa ini melibatkan 260 peserta yang dipilih secara rawak sistematik dari Klinik Rawatan Keluarga (KRK) Hospital Pakar Universiti Sains Malaysia (HPUSM) di Kubang Kerian.

Fasa 2 bertujuan untuk menentukan tahap KAP dan mengenal pasti faktor-faktor yang berkaitan dengan tahap KAP yang rendah serta faktor yang berkaitan dengan pencegahan DKD dalam kalangan pesakit T2DM di seluruh Kelantan. Fasa 2 ini juga meneroka hubungan antara tahap KAP dengan DKD. Kajian keratan rentas ini melibatkan 600 pesakit T2DM dari pelbagai klinik. Data yang dikumpulkan merangkumi pemboleh ubah di peringkat pesakit dan peringkat klinik. Regresi logistik binari berperingkat (*multilevel binary logistic regression*) digunakan untuk menilai hubungkait antara KAP dan DKD, dengan mengambil kira faktor di peringkat individu dan peringkat klinik.

Keputusan: Skala KAP pencegahan DKD versi Bahasa Melayu yang disahkan menunjukkan sifat psikometrik yang kukuh. Domain Pengetahuan menunjukkan satu dimensi dan indeks diskriminan yang mencukupi, manakala domain Sikap dan Amalan mencapai indeks kesesuaian yang memuaskan selepas penambahbaikan model. Kebolehpercayaan komposit menggunakan Raykov's Rho mengesahkan konsistensi dalaman. Dalam kalangan peserta, 77% mempunyai tahap KAP yang rendah dalam pengetahuan, 58.2% dalam sikap, dan 50.78% dalam amalan terhadap pencegahan DKD. Faktor utama yang meramalkan tahap pengetahuan yang rendah adalah status

perkahwinan (bujang, balu, atau bercerai), tahap pendidikan rendah, dan status komplikasi diabetes, manakala peserta yang tidak bekerja mempunyai kebarangkalian lebih rendah untuk tahap pengetahuan yang rendah. Tahap sikap yang rendah dikaitkan dengan pendidikan rendah dan pengangguran, manakala tahap amalan yang rendah berkaitan dengan pendidikan rendah, etnik, dan tahap sikap yang rendah. Untuk diagnosis DKD, peserta yang tidak bekerja mempunyai hampir dua kali ganda kebarangkalian untuk mempunyai DKD berbanding mereka yang bekerja. Mikroalbuminuria, makroalbuminuria, dan albuminuria berterusan meningkatkan DKD dengan ketara, begitu juga dengan tahap serum kreatinin dan ulser kaki diabetik. Dalam domain KAP, hanya tahap amalan yang menunjukkan hubungan yang signifikan dengan DKD, dengan tahap amalan yang rendah dikaitkan dengan kebarangkalian yang lebih rendah untuk DKD.

Kesimpulan: Skala KAP pencegahan DKD yang disahkan adalah alat soalselidik yang sah dan boleh dipercayai untuk menilai pengetahuan, sikap, dan amalan berkaitan pencegahan DKD dalam kalangan pesakit T2DM di Malaysia. Penemuan kajian ini juga menekankan peranan faktor di peringkat pesakit—seperti status pekerjaan, status albuminuria, tahap serum kreatinin, dan ulser kaki diabetik—dalam meramalkan kejadian DKD. Tahap amalan pencegahan yang rendah dikaitkan dengan DKD yang lebih rendah di mana hubungkait kompleksnya telah dijelaskan. Kajian ini menyokong pentingnya strategi pencegahan DKD yang disesuaikan dengan profil sosiodemografi dan klinikal pesakit T2DM.

RELATIONSHIP BETWEEN KNOWLEDGE, ATTITUDE, PRACTICE, PATIENT-LEVEL, AND CLINIC-LEVEL FACTORS OF DIABETIC KIDNEY DISEASE AMONG TYPE 2 DIABETES MELLITUS PATIENTS

ABSTRACT

Background: DKD was recognized as a major complication of Type 2 Diabetes Mellitus (T2DM), significantly contributing to the growing burden of chronic kidney disease (CKD) in Malaysia. Although the influence of Knowledge, Attitude, and Practice (KAP) on CKD prevention was well-documented, validated tools to measure these aspects specifically for DKD prevention among T2DM patients were limited. Using the Chronic Care Model as the framework, this study examined the patient-level and clinic-level factors associated with DKD and the relationship between KAP toward DKD.

Objective: The objectives were to validate the Malay-translated KAP DKD prevention scale, measure poor KAP levels among T2DM patients in Kelantan, identify factors associated with poor KAP, and assess the relationship between KAP and DKD, considering both patient- and clinic-level factors.

Methodology: The study was conducted in two phases. Phase 1 focused on validating the Malay-translated KAP DKD prevention scale for reliability and relevance. Content validity was established by an expert panel of six specialists in family medicine, public health, nephrology, and internal medicine. Items with a Content Validity Index (I-CVI) below 0.83 were removed. A pilot group of 10 T2DM patients evaluated item clarity and comprehensibility, which led to further refinement based on Face Validity Index (FVI) scores. Construct validity was assessed using Two-Parameter Logistic Item Response Theory (2PL-IRT) for the Knowledge domain and Confirmatory Factor

Analysis (CFA) for the Attitude and Practice domains. This phase included 260 participants selected systematically from KRK HPUSM clinics in Kubang Kerian.

Phase 2 aimed to determine KAP levels and identify factors associated with poor KAP DKD prevention among T2DM patients across Kelantan, as well as to explore the relationship between KAP levels and DKD. This cross-sectional study included 600 T2DM patients from multiple clinics. Data collected included patient-level variables and clinic-level variables. Multilevel binary logistic regression was used to assess the associations between KAP and DKD, accounting for individual and clinic-level factors.

Results: The validated KAP DKD prevention scale demonstrated strong psychometric properties. The Knowledge domain showed unidimensionality and adequate discriminant indices, while the Attitude and Practice domains achieved satisfactory fit indices after model refinement. Composite reliability using Raykov's Rho confirmed internal consistency. Among participants, 77% had poor knowledge, 58.2% had poor attitudes, and 50.78% had poor practices regarding DKD prevention. Key associated factors of poor knowledge included being single, widowed, or divorced, having lower education, and having diabetic complications, while unemployed participants had lower odds of poor knowledge. Poor attitudes were associated with lower education and unemployment, and poor practices were linked to lower education, ethnicity, and poor attitudes. For DKD factors, participants not working had nearly twice the odds of DKD compared to those working. Microalbuminuria, macroalbuminuria, and persistent albuminuria significantly increased the odds of DKD, as did serum creatinine levels and diabetic foot ulcers. Among KAP domains, only practice was significantly associated with DKD, with poor practice linked to a lower likelihood of DKD.

Conclusion: The validated KAP DKD prevention scale provided a reliable tool for assessing knowledge, attitudes, and practices related to DKD prevention among T2DM patients in Malaysia. The findings highlighted the role of patient-level factors—such as employment status, albuminuria, serum creatinine levels, and diabetic foot ulcers—in predicting DKD. Poor practices were associated with lesser odds of DKD. This complex relationship was explained further, emphasizing the need for patient-focused interventions that enhance education and preventive practices. This study underscored the importance of DKD prevention strategies tailored to the socio-demographic and clinical characteristics of T2DM patients.

CHAPTER 1

INTRODUCTION

1.1 Overview of chronic kidney disease

Chronic kidney disease (CKD) was a growing global public health concern that posed significant healthcare challenges. CKD is characterized by damage to the renal parenchyma, resulting in a progressive decline in renal function that could lead to end-stage renal disease (ESRD). In 2017, it was estimated that 1.2 million deaths were attributable to CKD, with a 42% increase in all-age mortality from 1990 to 2017 (Chronic Kidney Disease Collaboration, 2020). According to the World Health Organization (WHO), CKD has risen to be among the top 10 causes of death globally, with kidney disease mortality increasing by 60% between 1990 and 2019 (World Health Organization - WHO, 2020). The global prevalence of CKD was estimated at 9.1%, affecting approximately 700 million people worldwide (Cockwell & Fisher, 2020).

The aetiology of CKD has shifted from infections like acute glomerulonephritis to non-communicable diseases (NCDs), with diabetes mellitus and hypertension becoming the primary causes. DKD, a form of CKD specific to patients with diabetes, has emerged as the leading cause of CKD in Malaysia. The Director General of Health Malaysia emphasized the role of diabetes mellitus as a critical driver of CKD prevalence in the country (Ministry of Health Malaysia, 2018).

The factors contributing to the diagnosis and progression of CKD were multifactorial. According to the chronic care model (CCM), effective intervention in chronic diseases like CKD requires a multifaceted approach, addressing factors at the

patient, provider, setting, and community levels (Wagner, 1998). This study, however, focused on exploring the patient and provider perspectives through multilevel analysis, where the patient formed the first level and the clinic the second. This framework allowed for a comprehensive understanding of how individual- and clinic-level factors contributed to DKD status in the context of Kelantan.

1.2 Diabetic kidney disease (DKD)

The global increase in diabetes mellitus (DM) prevalence has led to a corresponding rise in both microvascular and macrovascular complications, including CKD. Among these complications, CKD was of particular concern. The term "diabetic kidney disease" (DKD) was first introduced in 1995 by Dr. Andrzej Krolewski to describe kidney disease diagnosed clinically in patients with diabetes (Yamanouchi *et al.*, 2020). This terminology was created to distinguish diabetes-related kidney complications from other forms of CKD. In contrast, the term 'diabetic nephropathy' referred specifically to a pathological diagnosis that required a kidney biopsy, thus differentiating it from DKD (Qi *et al.*, 2017).

In type 2 diabetes mellitus (T2DM), the histopathological presentation varies and may include ageing-related changes, primary or secondary focal segmental glomerulosclerosis, prior acute kidney injury, or other glomerulopathies (Anders *et al.*, 2018). Differentiating diabetic nephropathy from mixed-feature nephropathy, which is common in T2DM, typically requires a kidney biopsy; however, biopsies are rarely performed in clinical practice. Additionally, registries like the Malaysian National Diabetic Registry often classify CKD in T2DM patients broadly as 'nephropathy' without detailed specification (Arunah Chandran & F, 2019; Division, 2020). Despite these pathological distinctions, the clinical course and management of nephropathy in

T2DM follow similar principles. As noted by Umanath & Lewis, (2018), while pathological differences provide academic insights, they do not substantially alter treatment strategies or clinical interventions.

In primary care settings, DKD was typically diagnosed clinically, with treatment goals focused on reducing proteinuria and preventing the progression to end-stage renal disease (ESRD). The terms CKD and DKD were often used interchangeably in guidelines, including the KDIGO (Kidney Disease: Improving Global Outcomes) diabetes guideline (Kidney Disease: Improving Global Outcomes (KDIGO) Diabetes Work Group, 2022). Consequently, this research used the term DKD to refer to CKD in diabetes patients to maintain consistency with clinical practice and avoid confusion regarding terminology (Umanath & Lewis, 2018; Malaysia, 2020). Given that DKD is a subset of CKD, any risk factor associated with CKD inherently poses a risk for DKD as well. This connection emphasizes that CKD-related risks directly contribute to the likelihood of developing DKD, highlighting the need for comprehensive management of CKD risk factors to mitigate DKD progression (Fenta *et al.*, 2023; Zhao, Li & Su, 2023).

1.3 The knowledge, attitude, and practice (KAP) model

The Knowledge, Attitude, and Practice (KAP) model is a widely recognized quantitative research method that originated in the 1950s in the fields of family planning and population research (Andrade *et al.*, 2020). It conceptualizes behaviour change as a sequential process, beginning with the acquisition of knowledge, followed by the development of attitudes and beliefs, and ultimately leading to the adoption of specific practices or behaviours (Wang *et al.*, 2020). The KAP model employs standardized questionnaires to assess individuals' knowledge, attitudes, and practices

related to specific health issues, making it a valuable tool for public health research and intervention planning. A KAP survey is a structured research approach designed to evaluate what a population knows (knowledge), believes (attitude), and does (practice) regarding a particular topic—in this case, DKD prevention. These components are systematically measured through a questionnaire, which allows for the quantification and analysis of collected data. One of the key advantages of a KAP survey is its ability to gather a large volume of data, which can then be statistically analyzed to generate evidence-based insights that align with the study objectives (Médecins du Monde, 2018).

Several researchers have studied knowledge, attitudes, and practices related to CKD. However, many of these studies employed questionnaires that were not properly validated (Chow *et al.*, 2012; Yusoff, Yusof & Kueh, 2016; Alvis Zibran *et al.*, 2018; Hapsari & Agustiyowati, 2020). Additionally, some studies focused solely on knowledge, without addressing attitude and practice (Chow *et al.*, 2012; Yann Ng, Shiun Lee & Seong Goh, 2016; Gheewala *et al.*, 2018; Younes *et al.*, 2022)Chow *et al*., 2012; Gheewala *et al*., 2018; Younes *et al*., 2022). Among the available tools, the most comprehensive and well-validated questionnaire for assessing all three KAP components was the questionnaire developed by Khalil *et al.*, (2014) named the CKD Screening Index. This questionnaire was translated into Malay by Yusoff, Yusof & Kueh, (2016), who assessed its content and face validity. However, construct validation had not been performed, and this gap was addressed in the present study.

The literature on factors associated with a poor KAP level predominantly focused on sociodemographic variables such as age, gender, marital status, employment, education level, income, and smoking status. Some studies also

examined clinical factors, including diagnosis of diabetes or DKD, duration of diabetes, the presence of comorbidities, and other diabetic complications.

The factors contributing to the DKD were more complex. The CCM highlighted that chronic disease management required the involvement of not only patients (including their KAP) but also healthcare providers, the healthcare system, and the community to ensure proper management and complication prevention. Clinic-level factors, such as resource availability, staff expertise, and the quality of care provided, played a critical role in ensuring proper diagnosis and management of DKD. This study explored the relationship of the KAP, patient-level and clinic-level factors contributing to the DKD among T2DM patients.

1.4 Problem statement

The rising burden of DKD in Malaysia has become a critical public health issue, with 58% of new end-stage renal disease (ESRD) cases attributed to diabetes (Abu Seman & Othman, 2023). Among individuals with Type 2 Diabetes Mellitus (T2DM), 1 in 2 patients is affected by DKD, yet many cases remain undiagnosed or are diagnosed at late stages, limiting opportunities for early intervention (Wan *et al.*, 2024). Delayed diagnosis is often due to poor awareness, inadequate screening, and low prioritization of kidney health in diabetes management, increasing the risk of disease progression to ESRD (Saminathan *et al.*, 2020).

This delay in DKD diagnosis is reflected in the increasing number of patients experiencing reduced kidney function (estimated glomerular filtration rate, eGFR < 80 ml/min/1.73 m^2), a crucial indicator of disease progression (Saminathan *et al.*, 2020). Progression to ESRD necessitates lifelong dialysis, placing an enormous financial burden on Malaysia's healthcare system, with USD 706 million spent on ESRD

treatment—94% of which is allocated to dialysis costs (Ismail *et al.*, 2019). The limited availability of kidney transplants further exacerbates this issue, leaving most ESRD patients dependent on dialysis for survival, significantly affecting their quality of life (Saidi & Hejazii Kenari, 2014; Jeon *et al.*, 2019).

Despite the increasing prevalence of DKD, efforts to enhance preventive strategies remain insufficient, particularly in bridging gaps in Knowledge, Attitude, and Practice (KAP) among individuals with Type 2 Diabetes Mellitus (T2DM). The lack of a properly validated questionnaire for assessing CKD or DKD raises concerns regarding the accuracy and reliability of item measurements in capturing the intended constructs. Limited awareness of DKD risk factors, negative perceptions toward kidney health, and poor self-management practices further contribute to delayed diagnosis and accelerated disease progression (Chen, Al Mawed & Unruh, 2016).

Recognizing these challenges, the Ministry of Health Malaysia launched the National Action Plan for Healthy Kidneys (ACT-KID) 2018–2025, emphasizing early detection, risk factor modification, and patient-centred interventions to curb CKD progression (Ministry of Health Malaysia, 2018). The plan underscores the importance of enhanced screening programs, patient education, and lifestyle modifications to improve kidney health outcomes. However, its success depends on patient engagement and adherence, necessitating a deeper understanding of the current KAP landscape in DKD prevention.

1.5 Rationale of study

DKD is a leading cause of ESRD, placing a significant burden on healthcare systems and reducing the quality of life for affected individuals. Effective prevention and early intervention require a comprehensive understanding of patients' KAP related

to DKD. However, the absence of a properly validated questionnaire for assessing KAP in DKD prevention has hindered accurate measurement, limiting the reliability of existing data. Validating a KAP questionnaire specific to DKD ensures that the instrument effectively captures the intended constructs, enhancing the accuracy of assessments and enabling the development of targeted educational and intervention strategies.

Establishing a baseline assessment of KAP among individuals with T2DM is crucial in identifying existing knowledge gaps, misconceptions, and behavioural barriers that may contribute to delayed diagnosis and disease progression. A clear understanding of the current KAP landscape provides essential insights for designing patient education programs and public health initiatives aimed at enhancing DKD awareness, promoting kidney health, and encouraging early screening and lifestyle modifications. Without a baseline measure, efforts to improve DKD prevention may lack direction, potentially leading to ineffective strategies that fail to address the most critical gaps.

This study applied the Chronic Care Model (CCM) to explore the relationship between KAP and DKD while accounting for patient-level and clinic-level factors to improve prevention strategies and mitigate the risk of end-stage renal disease (ESRD). At the patient level, the CCM highlights how knowledge, attitudes, and self-management behaviours influence DKD outcomes, identifying gaps that contribute to delayed diagnosis and disease progression. At the clinic level, the model emphasizes the role of healthcare teams, screening accessibility, and structured interventions in facilitating early detection and improving disease management. Understanding how these factors interact is crucial for designing patient-centred interventions that address specific barriers, enhance adherence to preventive measures, and optimize healthcare

system support. By strengthening KAP in DKD prevention through a CCM-based approach, this study aims to provide evidence-based insights that will improve disease management, reduce the incidence of ESRD, and alleviate the burden on Malaysia's healthcare system.

1.6 Research questions

1. Is the Malay-translated KAP DKD prevention scale questionnaire valid and reliable to determine the scale of KAP on DKD among T2DM patients?

2. What is the level of KAP DKD prevention scale among T2DM patients in Kelantan using a validated questionnaire?

3. What are the factors associated with poor KAP DKD prevention among T2DM patients in Kelantan?

4. Is there a relationship between the KAP DKD prevention level, when the patient-level and clinic-level factors are taken into account, with the DKD among T2DM patients?

1.7 Objective

1.7.1 General objective:

To validate the translated version of the KAP DKD prevention scale, and determine the level of the poor KAP DKD prevention, its associated factors and its relationship with the DKD accounted for patient-level and clinic-level factors among T2DM patients in Kelantan.

1.7.2 Specific objective:

1. To determine the validity and reliability of the translated version of the KAP DKD prevention scale among T2DM patients in Kelantan.

2. To determine the level of poor KAP DKD prevention among T2DM patients in Kelantan.

3. To determine factors associated with poor KAP DKD prevention levels among T2DM patients in Kelantan.

4. To examine the relationship between the KAP DKD prevention level accounted for patient-level and clinic-level factors toward DKD among T2DM patients in Kelantan.

1.8 Research hypotheses

1. The translated version of the KAP DKD prevention scale is a valid and reliable tool to determine the level of KAP in DKD prevention.

2. There are statistically significant associations between factors with poor KAP DKD prevention levels among T2DM patients in Kelantan.

3. There are statistically significant associations between the KAP DKD prevention level accounted for patient-level and clinic-level factors toward the DKD among T2DM patients in Kelantan.

CHAPTER 2

LITERATURE REVIEW

The literature search for DKD was conducted using CKD as a proxy due to the limited availability of studies specifically addressing DKD. The search focused on identifying relevant questionnaires and scales measuring knowledge, attitude, and practice related to CKD, as well as factors associated with these measures. Additionally, patient-level and clinic-level factors associated with CKD were explored. The search was performed across multiple academic databases, including PubMed, ScienceDirect, EBSCOhost, and SpringerLink. Various search strategies were employed, combining keywords with logical operators (AND, OR, NOT) to refine results. The review included literature published between 2013 and 2024.

2.1 CKD and DKD burden

In Malaysia, CKD was defined by the Clinical Practice Guidelines (CPG) for the Management of CKD 2nd Edition as the presence of kidney damage or abnormalities in kidney structure or function persisting for more than three months, with significant health implications (Ministry of Health, Malaysia, 2018). CKD was diagnosed based on either a sustained reduction in glomerular filtration rate (eGFR) or the persistence of one or more markers of kidney damage for over three months. These markers of kidney damage are outlined in Table 2.1:

Table 2.1: Markers of kidney damage as adapted from CPG for Management of CKD 2nd edition (Ministry of Health, Malaysia, Malaysian Society of, Nephrology, Academy of Medicine, 2018)

Markers of kidney damage (one or more)
• Albuminuria (AER ≥ 30 mg/24 hours; ACR ≥ 30mg/g [≥3 mg/mmol])
• Urine sediment abnormalities
• Electrolyte and other abnormalities due to tubular disorders
• Abnormalities detected by histology
• Structural abnormalities detected by imaging
• History of kidney transplantation

DKD, a complication of diabetes mellitus, is a leading cause of CKD and ESRD worldwide. The global burden of DKD has grown significantly alongside the rising prevalence of T2DM, a major contributor to CKD-related morbidity and mortality. In 2019, around 134.58 million people globally were living with DKD, with 2.62 million new cases that year alone (Deng *et al.*, 2021). Over the past three decades, DKD incidence has increased by 156%, with the age-standardized death rate rising by 172% (Deng *et al.*, 2021). Factors such as hypertension, obesity, and poor glycaemic control drive the disease, particularly in low- and middle-income countries where healthcare access is limited. DKD's impact is reflected in disability-adjusted life years (DALYs), with over 13 million DALYs lost globally in 2019 (Deng *et al.*, 2021).

In Malaysia, DKD poses a significant public health challenge, driven by one of the highest diabetes rates in Southeast Asia. A recent study reported that approximately 56.7% of T2DM patients in Malaysia have DKD, a much higher prevalence than previously recorded, likely due to improved screening (Wan *et al.*, 2024). DKD accounts for over 50% of new dialysis cases in Malaysia from 2011 to 2021, indicating the severe strain it places on renal health services (Ministry of Health Malaysia, 2018).

The economic burden of DKD in Malaysia is considerable, as the high demand for costly dialysis services places significant strain on the public healthcare system. In Malaysia, the total annual public sector expenditure on end-stage renal disease (ESRD) grew by 94% over seven years, from MYR 572 million in 2010 to MYR 1.12 billion in 2016. In 2010, ESRD costs accounted for 2.95% of the public health sector's total expenditure, rising to 4.2% in 2016. Notably, only 6% of this expenditure was allocated to renal transplantation, with the remaining 94% directed toward dialysis, underscoring the substantial financial demands posed by dialysis-dependent patients (Ismail *et al.*, 2019).

The economic burden is considerable, as high demand for costly dialysis services strains Malaysia's public healthcare system, further intensified by limited healthcare resources in low- and middle-income regions. Malaysia's public healthcare sector relies heavily on a tax-based system, which places the system at risk if the costs of dialysis continue to escalate. This dependency means that, without intervention to curb the progression of DKD to ESRD, the rising expenses associated with dialysis could increasingly drain public funds, endangering the sustainability of the healthcare system and limiting resources for other critical health needs. (Ismail *et al.*, 2019; PricewaterhouseCoopers, 2024).

Preventing DKD and halting its progression to ESRD is essential to reducing the health and economic burdens associated with diabetes-related kidney disease. Given the high diabetes prevalence in Malaysia, identifying risk factors was urgently needed to formulate effective strategies. Early intervention, improved access and quality of preventive care are critical to slowing DKD progression, lessening reliance on costly dialysis, and easing the strain on healthcare resources.

2.2 Review of questionnaires measuring knowledge, attitude, and practice related to CKD and DKD prevention

Questionnaires are commonly utilised as quantitative tools to assess knowledge, attitude, and practice (KAP). Due to the limited availability of questionnaires specifically addressing DKD, this study used CKD as a proxy in the search strategy to identify tools measuring KAP related to DKD prevention. Although several questionnaires were identified in the literature, most focused on only one or two KAP components and lacked comprehensive validation.

Chow *et al*. (2012) developed a questionnaire to assess CKD knowledge among primary care patients. This questionnaire included three domains: attitude toward organ donation, knowledge of CKD, and demographic data. However, their study only discussed the knowledge domain, which consisted of seven multiple-choice items. Moreover, no analysis of construct validity was performed, as only content validity was assessed through focus group discussions and expert reviews involving primary care doctors and nephrologists (Chow *et al.*, 2012).

Hapsari & Agustiyowati (2020) used a questionnaire to measure knowledge and attitude toward CKD among dialysis patients. Although they reported high Cronbach's alpha values for both knowledge (0.82) and attitude (0.81), they did not specify the source of the questionnaire. Additionally, no details were provided regarding content, face, or construct validity.

Stanifer *et al*. (2015) developed and validated a KAP questionnaire to assess CKD among Swahili-speaking populations. They employed a mixed-method approach, using qualitative methods to establish construct validity tailored specifically to the cross-cultural context of sub-Saharan Africa. However, this population-specific

focus limited the generalizability of the questionnaire to other regions. Furthermore, the validation process did not include indicators of convergent and divergent validity (Stanifer *et al.*, 2015).

In another cross-sectional study, Wolide *et al.*, (2020a) developed a questionnaire to assess KAP on CKD among healthcare providers in Jimma, Ethiopia. The questionnaire consisted of 25 items across all KAP domains and reported a Cronbach's alpha of above 0.62, though the exact value was not disclosed. Despite performing content validation and pilot testing, the authors did not assess construct validity (Wolide *et al.*, 2020a).

A major limitation of the above questionnaires was that they either lacked comprehensive validation or focused solely on knowledge, omitting attitude and practice. The best-validated questionnaire that covered all three KAP components was developed by Khalil *et al.* (2014), known as the CKD Screening Index. This questionnaire was designed to measure KAP toward the prevention and early detection of CKD.

A panel comprising two nephrology nurses (with over 20 years of experience), a physician from the nephrology department, and CKD patients on haemodialysis evaluated the content validity of the CKD Screening Index. A pilot study was conducted with 50 randomly selected patients from primary healthcare centres to assess the questionnaire's feasibility and pre-test its validity. Exploratory factor analysis (EFA) and reliability testing revealed three constructs:

- Knowledge construct: The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.88, with all 24 items retaining a Guttman split-half reliability of 0.70.

- Attitude construct: The KMO value was 0.81, and the attitude domain was divided into two subscales: "Actions/Application" (factor I) and "Seeking Help/Assistance" (factor II). For factor I, five items had loadings ranging from 0.5 to 0.81, while for factor II, four items had loadings from 0.4 to 0.79.
- Practice construct: The KMO value was 0.76, and the practice domain was also split into two subscales: "Lifestyle" (factor I) and "Seeking Help/Assistance" (factor II). Factor I included six items with loadings between 0.55 and 0.69, while factor II contained three items with loadings between 0.44 and 0.81 (Khalil *et al.*, 2014).

The CKD Screening Index has been widely used in subsequent studies. For example, Sa'adeh *et al.*, (2018) utilized it to assess KAP in Palestine, and Alghamdi *et al.*, (2023) applied it to patients at risk of CKD in Saudi Arabia. Tegegne *et al.*, (2020) used the knowledge domain of the index to evaluate CKD prevention awareness among hypertensive patients in Ethiopia. Additionally, Sahu *et al.* (2022) conducted a KAP study in India among CKD caregivers, while Badran *et al.*, (2023)examined the relationship between the KAP on DKD prevention using the CKD Screening Index and the Michigan Diabetic Knowledge Test (MDKT) in Palestine. A study in Fiji was conducted to assess DKD prevention by adapting to both the CKD screening index and another questionnaire by Stanifer *et al.* (2015).

In Malaysia, a Malay-translated version of the CKD Screening Index was made (Yusoff, Yusof & Kueh, 2016). Their study reported content and face validation, but construct validity was not repeated following the translation. Despite the recommendation to confirm exploratory factor analysis (EFA) results by Khalil *et al.* (2014), confirmatory factor analysis (CFA) or two-parameter logistic item response

theory (2PL-IRT) was not conducted in this study or other related studies. Furthermore, few studies specifically target either T2DM patients, DKD patients, or both, underscoring the need to establish a questionnaire tailored to measure KAP within these populations.

2.3 The importance of proper validation in KAP questionnaires

Validity and reliability are fundamental qualities that ensure the effectiveness of a questionnaire in empirical research. Validity refers to the extent to which a questionnaire accurately measures what it is intended to measure, while reliability refers to the consistency of the measurement across different instances (Awang, 2014). A valid and reliable questionnaire is essential for generating accurate and meaningful data.

Validating a questionnaire is critical for ensuring the quality of responses and the overall integrity of the research results. A systematic approach must be employed in the design, development, and validation phases to ensure the tool's effectiveness (Yusoff, Arifin & Hadie, 2021; Ranganathan, Caduff & Frampton, 2024). This process involves establishing various types of validity, such as face validity (whether the tool appears to measure what it is intended to), content validity (whether the questionnaire covers the full range of the concept being measured), and construct validity (whether the tool accurately measures the theoretical construct) (Awang, 2014).

The lack of comprehensive validation in many of the existing KAP questionnaires posed significant risks. Without proper validation, such as construct validity, content validity, and reliability testing, the data collected from these instruments may have been inaccurate or misleading. This could have resulted in flawed insights into knowledge, attitudes, and practices, leading to poorly informed

public health interventions (Dowrick *et al.*, 2015). For instance, an improperly validated questionnaire might have underreported or overestimated the knowledge or behaviours of at-risk populations, which could have skewed the development of educational programs or healthcare policies (Hawkins *et al.*, 2020).

Construct validation is a crucial step in ensuring that the KAP DKD Prevention Scale accurately measures what it is intended to—knowledge, attitude, and practice regarding DKD prevention among T2DM patients. Without construct validation, the reliability and accuracy of the scale could be compromised, leading to potential misinterpretation of the data collected (Ranganathan, Caduff & Frampton, 2024)

Therefore, ensuring that KAP questionnaires undergo rigorous validation was crucial to gathering reliable data that could guide effective, evidence-based decision-making in CKD prevention and management.

2.4 KAP on CKD prevention level and score

Assessing knowledge, attitudes, and behaviours was a crucial first step in determining an individual's capacity to adopt healthy behaviours that could ultimately prevent DKD. The assessment of KAP on DKD prevention was an essential element when formulating strategies or developing health intervention materials aimed at preventing DKD. Individuals who were provided with accurate information and knowledge about DKD and its risk factors were more likely to engage in health-promoting behaviours and make lifestyle changes that helped them maintain optimal blood sugar and blood pressure levels, thereby reducing the risk of developing DKD (Roomizadeh *et al.*, 2014). Moreover, patients with a positive attitude toward DKD, particularly those at risk, were more inclined to enhance their self-care management, such as adhering to routine follow-up appointments, which was key to preventing

DKD (Lin *et al.*, 2013). Practising healthy behaviours, like optimizing blood sugar and blood pressure through medication adherence and adopting a healthy lifestyle, was shown to significantly lower the odds of developing DKD (Jitraknatee, Ruengorn & Nochaiwong, 2020).

Chow *et al*. (2012) conducted a cross-sectional study involving 1,520 patients from three primary care centres in Singapore. They reported 44.9% of their patients scored less than 4 for CKD knowledge with a maximum score of 7. A higher proportion was observed in a study among outpatients at Muar Hospital, Johor, Malaysia. They found that 73.7% of patients scored less than 4 out of 7 items on the questionnaire (Yann Ng, Shiun Lee & Seong Goh, 2016). In a more recent study conducted by Isa *et al.*, (2023), they conducted a study at Kepala Batas health clinic among primary care patients, 81.0% of participants scored less than 4 out of 7 items. Although the studies above use the same questionnaire that they claimed was validated, the validation only constitutes content and face validation without further analysis to determine the construct, convergent and divergent validity, resulting in doubts about the result validity. Furthermore, the questionnaire only assessed knowledge but not attitude and practice.

Hapsari & Agustiyowati, (2020) reported in their study involving pre-dialysis patients from 3 referral hospitals, that the mean knowledge score of 10.55 out of a total score of 20, translating to 52.8%. In terms of attitude, exhibited a mean score of 46.80 ± 3.49, which was considered low as the authors used a cut-off point of 47 to have a supportive attitude. Their study, however, did not include the practice domain and the validity of the questionnaire used remained unclear. A study by Stanifer *et al.* (2016), included adults from communities constituting both urban and rural populations. Participants had a mean knowledge score of only 3.28 out of 10, equivalent to 33.0%.

In terms of attitude and practice, they did not report an overall score for each domain, but they reported the score based on items. Only 49.3% of participants believed that kidney disease was a significant issue in their region, yet 90.0% expressed a willingness to learn more about the disease. Interestingly in terms of practice, although 97.8% indicated they would seek care from biomedical clinics, 33.8% were still inclined to use traditional medicine as a form of CKD treatment. The lack of an overall score and the validation that was specific to the population in Tanzania made it complicated to use as a tool for public health intervention which requires a simpler measurement and ease of comparison.

CKD screening index was a KAP questionnaire developed by Khalil *et al* constituted knowledge attitude and practise domain. The questionnaire was developed to evaluate the knowledge, attitudes and practice of CKD prevention and early detection. The questionnaire was widely used worldwide to determine the KAP on CKD. A study in Jordan using the CKD screening index was conducted among 740 outpatients from hospitals across various regions. They found that the mean knowledge score was 19.27(2.60) translating to 80.2% in percentage. As for attitude, the mean score was 59.00 (6.10) and for practice, the mean score was 31.00 (5.10) (Khalil & Abdalrahim, 2014). Sa'adeh *et al.*, (2018) conducted a cross-sectional study involving 420 hypertensive patients in Palestine, utilizing the same questionnaire. Their study reported a median knowledge score of 20 out of 30 equivalents, a median attitude score of 69 (with a range of 18 to 90), and a median practice score of 39 (with a range of 12 to 48). A study conducted by Sahu *et al*. (2022) in India examined 250 participants who were caregivers or family members of CKD patients. The findings revealed that 64% of participants had inadequate knowledge, 52% held a negative attitude, and 47% had a negative perception of CKD prevention. In another study in Indonesia among

hypertensive patient in Dustira Hospital, they assessed their patient using the CKD screening index, they reported a mean knowledge score of 15.08(4.00) translating to 68.55%, a mean attitude of 36.50(4.25), and a mean practise of 23.11(3.30) (Calisanie, Isyaturodhiyah & Lindayani, 2020). In another study by Alghamdi *et al*. in Saudi Arabia, they reported their KAP score according to the variable that they studied. The knowledge score ranges from 11.56(4.5) to 14.59(6.0), for attitude the score ranges from 46.04(5.9) to 48.55 (6.1) and lastly for practise 34.74(5.9) to 37.15(5.6). They subcategorize the score based on variables to allow comparison of mean scores using one-way ANOVA (Alghamdi *et al.*, 2023).

The only local study to date that used the CKD screening index was in a study conducted by Yusoff, Yusof, and Kueh (2016) conducted a cross-sectional study among 103 inpatients at a tertiary hospital in Kubang Kerian, Malaysia. The study targeted individuals with diseases considered to carry a high risk for CKD, including diabetes mellitus. Using a Malay-translated version of the CKD Screening Index, they found that participants had a poor knowledge was 69.9%, a poor attitude was 31.1%, and a poor practice score of 11.7%. This study also categorized the KAP score into good and poor. By categorizing scores into "good" and "poor," the results become more straightforward to interpret and convey. This approach simplifies identifying the proportion of the population that achieves the targeted level of knowledge, attitudes, or practice (Okello *et al.*, 2020). Classifying KAP scores can aid in pinpointing groups that need targeted interventions. For instance, Bloom's cutoff point was commonly applied to identify populations that may benefit from additional education or behavioural change initiatives (Bloom, 1968; Alzahrani *et al.*, 2022). This method was especially valuable in public health campaigns, where efficient resource allocation is essential (Adli *et al.*, 2022; Stapleton-Corcoran, 2023). However, Yusoff, Yusof, and

Kueh (2016) used a 70% cutoff point, though its origin was unclear. Therefore, this study has opted to adhere to their method of reporting KAP scores and has further strengthened this approach by applying Bloom's taxonomy for its categorization.

2.5 Factor associated with KAP

Researchers employ various methods for reporting KAP, with some presenting direct scores like mean or median, while others categorize scores into scales such as “good” and “poor.” These diverse approaches also led to variations in analytical methods for determining associated factors, reflecting different research preferences for interpreting KAP and facilitating easier comparisons across studies.

2.5.1 Factors associated with knowledge

2.5.1.1 Age

Several studies highlighted the significant role of age in influencing CKD knowledge. Sa’adeh *et al.*, (2018) reported that younger age was significantly associated with higher knowledge scores (Adj. β: -0.18; 95% CI: -3.49, -1.00). Similarly, Yann Ng, Shiun Lee & Seong Goh, (2016) found that younger individuals demonstrated greater CKD knowledge in their study of outpatients at Muar Hospital in Malaysia. These findings suggest that younger populations may have greater access to or engagement with CKD-related information, possibly due to increased exposure to health education.

However, Gheewala *et al.* (2018) found that while younger participants tended to have slightly higher knowledge scores, the difference was not statistically significant after adjusting for confounders. These findings suggest that factors such as educational background, health literacy, and exposure to healthcare services may play

a more substantial role in shaping CKD knowledge than age alone. The inconsistency in findings highlights the need for further research to explore the interaction between age and other sociodemographic factors in influencing CKD awareness campaigns or digital resources.

2.5.1.2 Sex

Sex differences in CKD and DKD knowledge levels have been highlighted in several studies, underscoring the need for tailored educational approaches. Mondal *et al.*, (2021) found that male T2DM participants had significantly higher DKD knowledge scores compared to females (p-value < 0.001), suggesting that gender-specific strategies might be beneficial in educational interventions. Similarly, Khalil & Abdalrahim, (2014) reported that males scored higher on CKD knowledge assessments.

However, these results are not consistent across all studies and may vary based on cultural and contextual factors. For instance, Akokuwebe & Idemudia, (2022) found that more than half of the adult women in their study demonstrated good knowledge of CKD risk factors, contrasting with studies that often favoured male participants. This discrepancy suggests that women's knowledge levels can be comparable to or even surpass those of men, depending on the context. These inconsistencies underscore the need for further research to understand the underlying factors contributing to sex differences in CKD and DKD knowledge.

2.5.1.3 Education

Educational attainment consistently emerged as a critical determinant of CKD knowledge across multiple studies. Tegegne *et al.*, (2020) found that secondary education (Adj. OR: 2.90; 95% CI: 2.23, 13.02) and higher education (Adj. OR: 5.40;

95% CI: 2.23, 13.02) were associated with better CKD knowledge. Isa *et al.*, (2023) similarly identified lower education levels as a significant risk factor for poor knowledge, with primary education (Adj. OR: 39.75; 95% CI: 3.78, 417.62) and secondary education (Adj. OR: 4.69; 95% CI: 1.38, 15.91) being associated with significantly poorer knowledge compared to tertiary education. Asmelash *et al.*, (2020) reported similar findings, with primary education (Adj. OR: 18.34; 95% CI: 2.11, 16.70) and secondary education (Adj. OR: 8.6; 95% CI: 2.11, 34.99) significantly predicting higher CKD knowledge scores. Mondal, Sarker & Chandra Banik, (2021) and Zibran & Mohammadnezhad, (2019) supported this association in a study among T2DM patients, reporting that DKD knowledge scores differed significantly by education level, higher education status were associated significantly with higher knowledge (p-value < 0.001).

Despite strong evidence linking education to CKD knowledge, some studies have reported no significant association. For example, Khalil & Abdalrahim (2014) found that while higher education was correlated with CKD awareness, the difference was not statistically significant after adjusting for confounding factors such as healthcare access and prior CKD exposure. These findings highlight the complexity of CKD knowledge acquisition, suggesting that educational interventions must account for multiple influencing factors beyond formal schooling.

2.5.1.4 Employment and working status

Employment type also influenced CKD knowledge in several studies. Tegegne *et al*. (2020) identified private-sector employment as a significant factor associated with higher CKD knowledge (Adj. OR: 4.30; 95% CI: 1.81, 10.07). This finding aligns with observations by Yann Ng, Shiun Lee, and Seong Goh (2016), who reported that

professional status was positively associated with knowledge scores among Malaysian outpatients. Similarly, Mondal *et al*. (2021) reported that DKD knowledge scores varied significantly by occupation (p-value < 0.001) among T2DM patients in Bangladesh.

However, the relationship between employment type and CKD knowledge is not consistently observed across studies. A recent study by Alobaidi (2021) assessing public knowledge of CKD in Saudi Arabia found that employment status was not significantly associated with CKD knowledge. This finding contrasts with earlier research and suggests further research was needed to confirm the association between employment status and CKD knowledge.

2.5.1.5 Income

Mondal *et al.* (2021) found significant differences in DKD knowledge scores based on monthly family income ($p<0.001$). Higher monthly income was consistently associated with better CKD knowledge across studies. Yann Ng, Shiun Lee, and Seong Goh (2016) reported that higher income levels positively influenced knowledge scores among Malaysian outpatients. Similarly, Asmelash *et al.* (2020) highlighted the role of socioeconomic status, where higher-income individuals demonstrated greater awareness of CKD. These findings reinforce the link between financial capacity and access to educational resources or healthcare services.

However, the relationship between income and CKD knowledge is not universally consistent. Sa'adeh *et al.* (2018), in a study conducted in Palestine, found no significant association between income levels and CKD knowledge among hypertensive patients. This discrepancy indicates that other confounders may modulate the impact of income on health literacy. In summary, while higher income levels are