KNOWLEDGE, ATTITUDE AND SELF CARE ON CHRONIC KIDNEY DISEASE PREVENTION, QUALITY OF LIFE AND READINESS OF USING MOBILE HEALTH APPLICATION AMONG DIABETES MELLITUS TYPE 2 PATIENTS AT HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA

SITI SALMAH BINTI MOHAMAD ZAID

UNIVERSITI SAINS MALAYSIA

2025

KNOWLEDGE, ATTITUDE AND SELF CARE ON CHRONIC KIDNEY DISEASE PREVENTION, QUALITY OF LIFE AND READINESS OF USING MHEALTH APPS AMONG DIABETES MELLITUS TYPE 2 PATIENTS

by

SITI SALMAH BINTI MOHAMAD ZAID

Thesis submitted in fulfilment of the requirements
for the degree of
Master of Science

August 2025

ACKNOWLEDGEMENT

First and foremost, I would like to express my deepest gratitude to Allah SWT for granting me the strength, patience, and perseverance to complete this thesis successfully. I thank my main supervisors, Mr. Ali Aminuddin Mohd Rasani and Associate Professor Dr. Dariah binti Mohd Yusoff, for their continuous guidance, invaluable advice, and unwavering support. I would also like to sincerely thank my co-supervisors, Associate Professor Dr. Erica Kueh Yee Cheng and Dr. Wan Faizah Wan Yusoff, for their insightful feedback, kind assistance, and motivation, which have greatly enriched my work. My deepest appreciation goes to my beloved family. To my dear husband, Kamarul Hezley bin Ramli, thank you for your endless love, understanding, and encouragement. Your belief in me gave me the courage to keep going, even during the most challenging times. To my wonderful children, thank you for your patience and sacrifices, and for being my constant source of joy and inspiration. To my parents, thank you for your unconditional love, prayers, and unwavering support throughout my academic journey. Your blessings have been my source of strength.

I would also like to acknowledge all the participants who contributed their time and effort to this research. I sincerely appreciate the management, colleagues and friends of ILKKM Kubang Kerian for their support and understanding throughout my studies. Special thanks to my superior for the encouragement and the flexibility given. Lastly, I am also grateful to the School of Health Sciences, Universiti Sains Malaysia, all the lecturers and staff who have provided me with the knowledge, resources, and a nurturing environment that made this journey possible.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF SYMBOLS

N	Sample size
p	Proportion
Z	Standard normal distribution
E	Precision
%	Percentage
<	Less than
>	More than

LIST OF ABBREVIATIONS

T2DM	Type 2 Diabetes Mellitus
CKD	Chronic Kidney Disease
QoL	Quality of Life
KAS	Knowledge, Attitude & Self-care
CPCA	Consensus PCA
NCD	Non-communicable Disease
WHO	World Health Organization
VAS	Visual Analog Scale
MyDiPP	Malaysia Diabetes Prevention Programme
NHMS	National Health and Morbidity Survey
CPG	Clinical Practice Guidelines
HBM	Health Belief Model
USM	Universiti Sains Malaysia

LIST OF APPENDICES

PENGETAHUAN, SIKAP DAN PENJAGAAN KENDIRI TERHADAP PENCEGAHAN PENYAKIT BUAH PINGGANG KRONIK, KUALITI HIDUP DAN KESEDIAAN MENGGUNAKAN APLIKASI KESIHATAN MUDAH ALIH DALAM KALANGAN PESAKIT DIABETES MELLITUS JENIS 2 DI HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA

ABSTRAK

Diabetes Mellitus Jenis 2 (T2DM) adalah penyakit kronik yang semakin meningkat di seluruh dunia. Salah satu komplikasi yang paling biasa bagi T2DM adalah penyakit buah pinggang kronik (CKD), di mana kira-kira separuh daripada individu yang didiagnosis dengan T2DM akan mendapat CKD. Kajian ini bertujuan untuk menilai tahap pengetahuan, sikap, dan penjagaan diri (KAS) dalam pencegahan CKD, kualiti hidup, kesiapsiagaan penggunaan aplikasi mHealth, dan menentukan kaitan antara KAS, faktor sosio-demografi dengan kualiti hidup serta kesiapsiagaan penggunaan aplikasi mHealth di kalangan pesakit T2DM di Malaysia. Dengan menggunakan kaedah pensampelan bertujuan, kajian ini dijalankan secara rentas-seksyen melibatkan 400 responden yang mendapatkan rawatan di Klinik Pakar Diabetes dan Klinik Rawatan Keluarga, HUSM. Pengetahuan, sikap, dan penjagaan diri diukur menggunakan soal selidik KAS_CKD yang baru dibangunkan, kualiti hidup diperoleh menggunakan versi terkini Soal Selidik Kualiti Hidup Diabetes (DQoL), manakala kesiapsiagaan menggunakan aplikasi mHealth dinilai menggunakan skala kesiapsiagaan mHealth yang telah disahkan. Data yang dikumpulkan dianalisis menggunakan SPSS versi 27 dengan analisis deskriptif dan inferensial. Hasil kajian ini mendapati bahawa kebanyakan pesakit menunjukkan tahap pengetahuan, sikap, dan penjagaan diri yang tinggi dalam pencegahan CKD. Kualiti

hidup (QoL) didapati tertinggi dalam domain kepuasan, sederhana dalam domain impak, dan terendah dalam domain kebimbangan. Responden menunjukkan kesiapsiagaan yang sederhana untuk menggunakan aplikasi mHealth. Faktor sosio-demografi seperti umur, jantina, tahap pendidikan, dan pekerjaan memberi pengaruh yang signifikan terhadap QoL. Terdapat hubungan negatif antara pengetahuan dan QoL dalam domain kepuasan, manakala sikap yang lebih positif dikaitkan dengan QoL yang lebih rendah. Ujian regresi linear mudah menunjukkan hubungan yang tidak signifikan antara penjagaan diri dan QoL. Umur didapati memberi impak signifikan terhadap kesiapsiagaan untuk menggunakan aplikasi mHealth, namun tiada kaitan signifikan antara pengetahuan, sikap, atau penjagaan diri dengan kesiapsiagaan penggunaan aplikasi mHealth. Dapatan ini menunjukkan bahawa walaupun pesakit T2DM menunjukkan tahap pengetahuan, sikap, dan penjagaan diri yang tinggi, kualiti hidup mereka berbeza mengikut domain. Kajian ini menekankan kepentingan faktor sosio-demografi dalam mempengaruhi QoL dan perlunya intervensi yang disesuaikan. Walaupun kesiapsiagaan untuk menggunakan aplikasi mHealth adalah sederhana, tiada kaitan signifikan ditemui antara pengetahuan, sikap, atau penjagaan diri dengan kesiapsiagaan mHealth. Kajian lanjutan diperlukan untuk meneroka faktor-faktor lain yang mungkin mempengaruhi kesiapsiagaan untuk penggunaan aplikasi mHealth.

KNOWLEDGE, ATTITUDE AND SELF CARE ON CHRONIC KIDNEY DISEASE PREVENTION, QUALITY OF LIFE AND READINESS OF USING MOBILE HEALTH APPLICATION AMONG DIABETES MELLITUS TYPE 2 PATIENTS AT HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA

ABSTRACT

Type 2 diabetes mellitus (T2DM) is a widespread chronic disease that is on the rise globally. One of the most common complications of T2DM is chronic kidney disease (CKD), with around half of the people diagnosed with T2DM ending up developing CKD. This study aims to assess the level of knowledge, attitude, and self-care (KAS) on CKD prevention, quality of life, readiness of using mHealth apps, and to determine the association between KAS, socio-demographics, quality of life, and readiness of using mHealth apps among T2DM patients in Malaysia. Using a purposive sampling method, this study was carried out through a cross-sectional study among 400 respondents who attended Klinik Pakar Diabetes and Klinik Rawatan Keluarga, HUSM. Knowledge, attitude, and self-care were measured by using a newly developed KAS_CKD questionnaire. QoL was obtained using the Revised Version of Diabetes Quality of Life (DQoL). Meanwhile, readiness using mHealth Apps was assessed using a validated mHealth readiness scale. Collected data was analysed using SPSS version 27 with descriptive and inferential analyses. The findings of this study revealed that most patients demonstrated a high level of knowledge, attitude, and self-care in preventing chronic kidney disease (CKD). Quality of life (QoL) was found to be highest in the satisfaction domain, moderate in the impact domain, and lowest in the worry domain. Respondents showed moderate readiness to use mHealth applications. Socio-demographic factors such as age, gender, education level, and

occupation significantly influenced QoL. A negative association between knowledge and satisfaction QoL was observed, while a more positive attitude was associated with poorer QoL. Simple linear regression showed an insignificant relationship between self-care and QoL. Age was found to significantly impact readiness to use mHealth apps, but no significant association was found between knowledge, attitude, or self-care and mHealth readiness. These findings suggest that while T2DM patients exhibit a high level of knowledge, attitude, and self-care, their quality of life varies across domains. The study highlights the importance of socio-demographic factors in influencing QoL and the need for tailored interventions. Although readiness to use mHealth applications was moderate, no significant association was found between knowledge, attitude, or self-care and mHealth readiness. Further research is needed to explore other factors that may influence readiness for mHealth adoption.

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Type 2 Diabetes Mellitus (T2DM) is a prevalent non-communicable disease (NCD) that is increasing all over the world. It is estimated that 422 million individuals had diabetes worldwide in 2014 (WHO, 2016). The World Health Organization (2016) also reported that the number of diabetes patients increased from 108 million in 1980 to 422 million in 2014, with a more rapid rise in low- and middle-income countries than in high-income countries. Ironically, it was expected that there would be a great increase in the prevalence of people with diabetes between 2021 and 2045, in middle-income countries (21.1%) compared to high-income (12.2%) and low-income (11.9%) countries (Sun, 2022).

Meanwhile, a study by Lin (2020) stated that the incidence of diabetes increased globally from 11.3 million in 1990 to 22.9 million in 2017. A study by Khan (2020) reported that an estimated 462 million individuals were affected by T2DM in 2017, corresponding to 6.28% of the world's population, with more than 1 million deaths, making T2DM the ninth leading cause of mortality. The same study also reported that developed regions, such as Western Europe, showed higher prevalence rates of T2DM that continue to rise (Manne-Goehler,2016).

In the past two decades, the prevalence of type 2 diabetes (T2DM) has been increasing in Southeast Asian countries like Indonesia, Malaysia, Thailand, and Vietnam (Khan, 2020). A study by Guariguata (2014) revealed that over 60% of people with T2DM live in Asia, with China having the highest number of affected adults (98.4 million), followed by India (65.1 million). Tin (2015) supported this finding, emphasizing that countries like China and India have a significant number of diabetes

patients, with prevalence rates as high as 40% in some Pacific Island populations. Guariguata (2014) projected that the number of people with diabetes would reach 592 million by 2035, with 382 million already diagnosed in 2013. The International Diabetes Federation (IDF) also highlighted that 60% of diabetes cases globally are in Asia.

In Malaysia, the prevalence of T2DM is high, with approximately one out of every seven people in the country affected (Akhtar, 2022). The National Diabetes Registry Report 2020 in Malaysia indicated that almost all patients enrolled in the registry had T2DM (99.33%), followed by type 1 diabetes (0.59%) and other types (0.06%).

Long-term diabetes can lead to several complications due to damage to blood vessels and nerves. It is reported that T2DM is a major cause of blindness, chronic kidney disease (CKD), cardiovascular disease, and lower limb amputation (WHO, 2016; Goyal, 2022). Of all complications, CKD is one of the most common complications in T2DM patients, which develops in nearly half of patients with T2DM (Sun, 2021). Yang (2019) emphasized that T2DM can lead to several complications, including mortality, as people with diabetes can have a 1.89-fold risk of mortality. About 20% of adults with T2DM will develop an eGFR < 60 mL/min/1.73 m2, and between 30–50% will have elevated urinary albumin excretion (Hoogeveen,2022). Koye (2018) also reported that people with T2DM have nearly 2-fold higher odds of having CKD than those without T2DM. Meanwhile, Afkarian (2013) reported that T2DM was associated with a substantially increased risk of mortality in the United States population, and 42.3% of them had CKD as defined by albuminuria, impaired GFR, or both.

CKD in patients with T2DM also accounts for most patients with end-stage renal disease (ESRD) globally and is associated with high morbidity, mortality, and poor quality of life (Ranaswami, 2020). In recent years, there has been a marked increase in the population living with T2DM and CKD (Wheeler,2020). Diabetic kidney disease is a widely recognised and growing concern among clinicians involved in the management of T2DM.

The prevalence of CKD and ESRD is increasing worldwide. This increasing trend is partly attributed to the tremendous increase in the incidence of diabetes mellitus and hypertension, which are the primary causes of ESRD in Malaysia (Wong, Chan & Lim, 2011). CKD is a strong risk factor for mortality and coronary events, but it is preventable and treatable. The deterioration can also be reduced by as much as 50% if the screening and detection are done earlier and managed appropriately (CPG Management of CKD, 2018).

The number of Malaysians with CKD is projected to significantly increase in the future, mainly due to the increasing prevalence of diabetes, hypertension, and the ageing population. However, most T2DM patients are not aware that they are at risk for CKD. According to the Malaysian National Health and Morbidity Survey (2024), of 9.07% of adults with CKD, only 4% of respondents were aware of the diagnosis. Similarly, in India, a study reported that patients reported as having poor knowledge levels (63.6%) and poor attitude levels (51.6%) towards the risk for CKD (Sahu, 2022). There was a significant association between education and knowledge ($p = 0.025$) toward the risk of CKD, with participants who were in school and were college graduates having better knowledge than illiterate participants (Sahu, 2022). In contrast, a population in Bangladesh had an average level of knowledge and attitude

towards CKD and was willing to seek healthcare services from various possible sources (Mondal, 2021).

A study conducted by Agustivowati (2020) found that a majority of patients in Indonesia also had a lack of knowledge about CKD. In contrast, a study by Afzal (2021) in Pakistan demonstrated a high level of knowledge and positive attitudes (71.5% and 72.8%, respectively) among participants. The sources of knowledge about CKD varied across studies. Nakagawa (2022) reported that television was the most common source of information on CKD in Japan, while Ng (2016) found that knowledge about CKD was linked to obtaining information from newspapers, the internet, medical personnel, and health campaigns. However, opportunities to learn about CKD online were limited, as people often searched for information only when they were interested in CKD (Nakagawa, 2022).

The findings from a Jordanian study by Khalil (2014) revealed that although participants knew CKD, they were unaware of the importance of early detection of health problems. Similarly, a study conducted in Malaysia by Dariah (2016) showed that most participants had poor knowledge of CKD and could not recognize its signs and symptoms. On the other hand, Ahmed (2018) reported that more than 50% of participants believed hypertension and obesity were the main risk factors for CKD. Another study by Chiun (2016) highlighted that knowledge levels about CKD and its complications among high-risk patients remained low.

Attitude refers to an individual's reaction or response to a specific objective or situation (Gaiseanu, 2020). Afzal (2021) found that attitudes regarding prevention, outcomes, and burden of CKD were high among T2DM patients in Pakistan (73%), but the impact and management of CKD were perceived to be low. Mondal (2021) reported that most participants (60.7%) had an average level of attitude, with many

expressing interests in learning more about kidney problems, being worried about the disease, and the chances of survival if diagnosed with CKD.

Self-care involves behaviors and abilities to care for oneself, promoting optimal health and well-being through awareness, self-control, and self-reliance (Martinez, 2021). It includes self-management of the illness. Patients with chronic diseases spend significant time managing their conditions and practicing self-care. Education, counseling, and workshops enhance patients' knowledge, self-efficacy, and self-management behavior (Moktan, 2019). A study by Ahn et al. (2022) emphasizes that improved self-care behavior is pivotal in CKD patients' health management and treatment adherence. Healthcare providers play a crucial role in educating, motivating, and training patients to engage in self-management behavior to delay the progression of CKD (Moktan, 2019). However, the rate of self-care among CKD patients has been reported to be low due to a lack of recognition regarding the benefits of such behavior (Tsai, 2021).

While some populations exhibit poor knowledge and attitudes, others show higher awareness and positive attitudes. The sources of knowledge also differ, with television, newspapers, the internet, medical personnel, and health campaigns playing a role. Self-care among CKD patients is crucial but often inadequate, highlighting the need for education and support from healthcare providers to promote effective self-management behaviors.

T2DM patients in the long term and without effective self-care management, are at risk for CKD. Furthermore, when the disease condition is no longer under control, the patient’s quality of life can be affected. Education, marital status, occupation, family history of diabetes, complications, and social support were associated with diabetes quality of life (DQoL) (Alaofe, 2022; Syed, 2022). Healthy

eating, problem-solving, coping strategies, and risk reduction were significant predictors of DQoL (Alaofe, 2022).

Mobile health (mHealth) apps help T2DM patients to optimise health systems, improve care and health, and reduce health disparities. These apps are applicable for T2DM patients to book appointments and receive health information (AshaRani,2021). With the advancement of information and medical technology, patients can easily have access to latest information about their diseases (Wang, 2022). According to Vo, Auroy & Sarradon-Eck (2019), mHealth apps are available on a mobile device, which can be used by both patients and their health care providers. On the other hand, patients believe that their well-being can be improved by using apps that give them information and help them deal with their health problems (Bults, 2022; Jafari, 2015). Meanwhile, healthcare providers agreed that mHealth apps could improve patient care by sharing medical records across different service providers (Yoon,2022).

1.2 Problem Statement/Originality of research

Early screening and prevention of CKD among those with T2DM is important to delay the progression of the disease. It is known that CKD is one of the most common complications of T2DM and is the 9th leading cause of death worldwide, resulting in a huge economic burden on health systems (Afzal, 2021). According to Afzal (2021), a crucial challenge of CKD patients in developing countries is the late presentation of the disease, with most patients detected when they are in an advanced stage. In many developing countries, including Malaysia, CKD is often diagnosed at a late stage, largely due to poor knowledge, limited awareness, and inadequate self-care among T2DM patients (Afzal, 2021; Mondal, 2021).

T2DM significantly influences patients' quality of life (QoL), particularly among those with poor health literacy, older age, lower socioeconomic status, and poor treatment adherence (Trikkalinou, 2017; Khodour, 2020; Bujang, 2021). Despite CKD being a common complication in T2DM patients worldwide, there is a scarcity of studies focusing on knowledge, attitude, and self-care (KAS) related to improving QoL. Recognising this gap, the researcher is motivated to conduct a study incorporating the element of QoL to address this important issue.

Internet and mobile services have been increasing with the increasing number of people with T2DM worldwide. Therefore, mHealth apps are very much needed in the current situation. This is supported by Samadbeik (2018), who found that T2DM patients were ready to have experience and skill in working with the internet to communicate with the doctor, and mobile-related skills were at high levels. Meanwhile, Bults (2022) reported that most of the patients using mHealth apps strongly agreed that the use of apps would be an easy task for them, while half of the non-users thought that apps would be clear and easily comprehensible to them (Bults,2022). Mobile health (mHealth) was defined as a public health practice supported by mobile devices such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices (WHO, 2018).

According to Seman (2017), the adoption of mobile applications for smartphones and tablet computers is growing. It is actively applied in Malaysia's healthcare, but limited studies were found looking at mHealth apps that focus on the Malaysian context.

Mobile health applications have emerged as promising tools to support self-management among individuals with type T2DM patients (Bene, 2019). The

applications offer opportunities for improving patient awareness, monitoring, and lifestyle modification. In Malaysia, research on mHealth use is still developing, with studies examining various aspects such as awareness, attitudes, functionality, and effectiveness. For example, studies have reported good awareness and attitudes toward mHealth among medical students, largely due to urbanization and improved socioeconomic conditions (Jembai, 2022). Other local research has explored mobile phone apps for the prevention of T2DM in women with gestational diabetes mellitus, which may inform the design of future randomized controlled trials (Benton, 2022). In addition, comparisons of diabetes management apps on iOS and Android have highlighted their content, functionality, and design features (Izahar, 2017), while the Malaysia Diabetes Prevention Programme (MyDiPP) app was found to be useful among participants at high risk of diabetes (Fauzi, 2021). Despite these efforts, the overall body of research on mHealth apps remains limited globally and even more so in Malaysia. This gap highlights the importance of examining the readiness of T2DM patients to use mHealth applications for self-care management.

1.3 Research Questions

1. What is the level of KAS on CKD prevention among T2DM patients?
2. What is the QoL of the T2DM patients?
3. What is the level of readiness for using the mHealth application among T2DM patients?
4. Is there any association between KAS, sociodemographic factors, and QoL among T2DM patients?

5. Is there any association between KAS, socio-demographic factors, and readiness of using mHealth apps among T2DM patients?

1.4 Research Hypothesis

1. There is no significant association between KAS, socio-demographic factors, and QoL among T2DM patients.
2. There is a significant association between KAS, socio-demographic factors, and readiness to use mHealth apps among T2DM patients.

1.5 Research Aims and Objectives

To determine knowledge, attitude, and self-care on the prevention of chronic kidney disease (CKD), quality of life (QoL), and readiness of using mHealth apps among diabetes mellitus type 2 (T2DM) patients.

1.5.1 Specific Objectives

1. To determine the level of KAS on the prevention of CKD among T2DM patients.
2. To assess the QoL of T2DM patients.
3. To assess the readiness of using mHealth apps among T2DM patients.
4. To determine the association between KAS, socio-demographic factors, and QoL among T2DM patients.
5. To determine the association between KAS, socio-demographic factors, and readiness of using mHealth apps among T2DM patients.

1.6 Operational Definition

Table 1.1 Operational definition

Terms	Conceptual definition	Operational definition
Knowledge	Knowledge is information, understanding and skills that gain through education or experience (Oxford Dictionary, 2023)	In this study, knowledge is the patient's understanding of T2DM and the prevention of CKD.
Attitude	Attitude refers to a personal reaction when attention is focused on a certain objective, either a mental or external object/situation perceived during the exploration of the surrounding reality (Gaiseanu, 2020)	In this study, attitude is the patient's reaction when focusing on preventing CKD after diagnosed with T2DM.
Self-care	Self-care is a behavior or the ability to care for oneself through awareness, self-control, and self-reliance in order to achieve, maintain, or promote optimal health and well-being (Martinez, 2021)	In this study, self-care is the patient's behavior to care for oneself thrrough awareness, self-control, and self-reliance to prevent CKD.
Quality of Life	Quality of Life is an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns (WHO 2018).	In this study, quality of life of T2DM patient's perception was assessed through Diabetes Quality of life (DQoL) Malay-version by Bujang et al. (2018)
Mhealth apps	Applications with functions related to human health, providing users with health-related information or instructions, tracking and sharing users' health statistics (Chib, 2018).	In this study, readiness using mHealth apps was assessed using Readiness Using mHealth Applications questionnaire developed by Putu Wuri Handayani, Rima Indriani, and Ave Adriana Pinem (2021).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the current literature related to knowledge, attitude, and self-care (KAS), quality of life among Diabetes Mellitus Type 2 (T2DM) patients on prevention of chronic kidney disease (CKD), and the use of mobile Health applications (mHealth apps). This chapter is important to build a current knowledge base and to determine the research design and tools required to achieve the objectives. The selected theory as the conceptual framework of this study is also included.

2.2 Review of Literature

The literature searches focus on original research articles of KAS to prevent CKD, QoL and the readiness of using mHealth apps among T2DM patients. The researcher used several databases and online libraries in the literature search for related studies to T2DM and CKD, including ScienceDirect, JSTOR, Scopus, Taylor & Francis, Wiley Online Library, ProQuest and PubMed.

The search retrieved 153 articles, but only 107 met the following inclusion criteria to be selected for close reading:

a) Research on the prevention of CKD among T2DM patients
b) Research includes KAS among T2DM patients on how to prevent CKD.
c) Research includes QoL among T2DM patients.
d) Research includes applications of mHealth apps among T2DM patients.
e) Quantitative or qualitative studies.

The articles selected in this review included quantitative and qualitative studies with different study designs, such as cross-sectional studies and randomized controlled studies. The primary key words used in literature search includes ‘quality of life’, ‘type 2 diabetes mellitus’, ‘knowledge’, ‘attitude’ ‘self-care’, ‘behaviour’, ‘mHealth apps’, ‘prevalence’, ‘mHealth Malaysia’, ‘chronic kidney disease’, “T2DM patients’, ‘prevention of CKD’ and ‘worldwide’. The researcher also used secondary keywords such as ‘life satisfaction’, ‘self-management’, 'effectiveness’, ‘usage’, and ‘perception’ that are related to the quality of life of T2DM and CKD patients.

2.3 Knowledge, Attitude, and Self-Care Management (KAS) on CKD prevention among T2DM Patients

The National Health and Morbidity Survey (NHMS) 2011 reported diabetes prevalence figures of 15.2% and 20.8% for adults above the age of 18 and 30 years in Malaysia. There are approximately one out of every seven people living in Malaysia who are suffering from diabetes, with people aged 60 and above being at higher risk of having T2DM (Akhtar,2022). Meanwhile, according to the National Diabetes Registry Report (NDR) 2020, nearly all the patients enrolled in the NDR were diagnosed with T2DM (99.33%), followed by T1DM (0.59%) and others (0.06%). There were 42.9% men and 57.1% women, with the majority of the Malay population (59.15%), followed by Chinese (19.62%), Indian (13.7%), and others (8.05%). The mean age range is between 57 and 64 years. Diabetes patients enrolled in NDR 2020 reported that 3.90% of diabetes patients in Malaysia were from Kelantan, with a mean age of 64 (63.6 – 63.8) years.

As mentioned earlier, there are many complications of T2DM for patients, and CKD is one of the major complications of T2DM (Albujays, 2018). According to Clinical Practice Guidelines (CPG) Management of CKD (2018), CKD has emerged as a global public health problem because of the increasing number of patients with CKD, the risk of progression to end-stage renal disease (ESRD), and high morbidity and mortality. Furthermore, a study by the Global Burden of Disease (GBD) Chronic Kidney Disease Collaboration (2017) stated that 1·2 million people died from CKD globally, with the global all-age mortality rate from CKD increasing 41·5% between 1990 and 2017.

According to Hooi et al. (2020), the prevalence of chronic kidney disease (CKD) among Malaysian adults was 15.48%, with only 5% of individuals aware of their diagnosis. The rising trend of T2DM worldwide, especially in Malaysia, represents a pressing health challenge, and this is believed to be related to the patient's knowledge, attitude, and self-care, which determine how the patient manages their disease and controls their quality of life.

2.3.1 Knowledge of CKD prevention

More studies have reported that many T2DM patients lack knowledge of the risk of having CKD (Table 2.1). For example, in a study by Hawal (2013), it was reported that the majority of the T2DM patients in an urban area of South India had poor knowledge regarding different aspects of diabetes. A similar finding was found in Minhat & Hamedon (2014), whereby 234 participants had a poor level of understanding related to diabetes among the rural adult community in Malaysia. Similarly, knowledge of diabetes as a risk factor for kidney disease was reported to be lower in a study by Faramarzi (2022).

Chowdury (2019) also found that less than half of the respondents had no knowledge of CKD as a complication of diabetes. A study by Abdulla (2019) showed a very poor result on knowledge of renal disease as a complication of diabetes (2%). At the same time, Ather (2016) stated that only 25.3 % of participants were aware of diabetic complications. A study by Kumela (2019) showed that less than half of the participants had knowledge of CKD. Only 12.7% of respondents in Iran knew that diabetes is one of the risk factors of CKD (Roomizadeh, 2014). Meanwhile, 52.7 % of participants knew that diabetes can cause CKD (Albujays,2018). 25.0 % of participants were aware of the effect of diabetes on their kidneys (Albujays, 2018). 45 % of respondents in Saudi Arabia knew that kidney disease is associated with complications of T2DM (Sharaf, 2021).

On the contrary, some studies showed good knowledge of CKD prevention among T2DM patients. For example, the majority of T2DM patients had good knowledge about diabetes self-care in Mekonnen and Hussien (2021). A study by Zibran (2019) reported that there was a significant association between level of education and knowledge ($p < 0.001$), employment status and knowledge ($p = 0.05$), and average monthly income and knowledge ($p = 0.03$). A study by Hussain (2019) reported that more than three-fourths of T2DM patients' respondents in India were able to identify risk factors of CKD, but only 33.43% of participants identified diabetes as one of the risk factors for the development of CKD. A study by Fahad (2022) showed that 63.7% of respondents knew that diabetes is a major cause of CKD, but less than half of the respondents knew the symptoms and complications of CKD (Table 2.3).

Table 2.1 Studies on the knowledge of CKD prevention among T2DM patients

Authors, Year, Country	Sample and age range	Design /tools used	Findings
Hussain, Habib & Najmi 2019 India	323 men and women with T2DM aged 18 years and above	A cross-sectional study on patients attending the outpatient department of endocrinology. Use a questionnaire adopted from Chow et al. (2012)	Only one-third of participants identified diabetes as one of the risk factors of CKD
Fahad et al. 2022 Saudi Arabia	400 men and women with T2DM, age 18 years and above	Cross-sectional study on diabetic patients in the Hail region.	More than half of the participants knew diabetes is a major cause of CKD.
Faramarzi et al. 2022 Iran	240 men and women aged between 30 and 60 years	Cross-sectional study on T2DM patients in the Diabetes Clinic.	Only 12.7 % of respondents knew diabetes was a risk factor for CKD.
Chowdury et al. 2019 Bagladesh	308 men and women with T2DM, age 18 years and above	Cross-sectional study on diabetes patients at the outpatient clinic of Chittagong Diabetic & General Hospital.	41.2 % of respondents did not know CKD as a complication of diabetes.
Abdulla 2015 Sudan	100 men and women with T2DM, age 18 years and above.	A cross-sectional study on diabetes patients of Al Shuhada diabetic center.	Only 2% of respondents knew that renal disease is a complication of diabetes.
Ather 2016 Pakistan	150 men and women with T2DM aged over 20 years	Cross-sectional descriptive study on T2DM patients in the outpatient department of Hospital Karachi.	25.3% of participants were aware of diabetic complications.
Kumela Goro et al. 2019 Ethiopia	208 adults with T2DM, aged 18 years or older	Cross-sectional study among diabetic and hypertensive patients on regular follow up in Jimma University Medical Centre.	36.5 % of participants had average knowledge of CKD.

Table 2 continued

Authors, Year, Country	Sample and age range	Design /tools used	Findings
Roomizadeh et al. 2014 Iran	748 men and women with T2DM, age 18 years and above.	Cross-sectional study on subjects who participated in the kidney disease awareness campaign using the National Kidney Disease Education Program (NKDEP) questionnaire	Only 12.7% of respondents in Iran knew that diabetes is one of the risk factors of CKD
Sharaf et al. 2021 Saudi Arabia	384 adults with T2DM aged between 18 and 80 years old	Cross-sectional study on outpatient clinics in Saudi Arabia.	45% of respondents knew CKD is one of the complications of T2DM.

CKD=chronic kidney disease, T2DM=Type 2 diabetes mellitus

2.3.2 Attitude on CKD prevention

Unlike knowledge, only 27 articles look at this issue out of 107 selected articles. In contrast to knowledge, most studies reported that many T2DM patients had a good attitude toward the prevention of CKD. For example, Mekonnen and Hussein (2021) reported that more than half of the respondents (59.6%) had a good attitude toward diabetes self-care practices. The majority of 338 T2DM patients in North Ethiopia had a good attitude towards the practice of self-care, and it was associated with high economic status (Niguse, 2019).

According to Fahad (2020), the majority of the participants in the study had a good attitude. Whereas a study by Ahmed (2015) showed a low attitude, with only a few respondents monitoring their blood glucose level regularly. Similar results were indicated in a study by Ghannadi (2016) that showed an unfavourable attitude among respondents. However, a study by Mondal (2021) reported that most of the respondents liked the idea of learning about kidney problems and worried about their future, as

well as the chances of survival if they were diagnosed as having CKD. Two-thirds of respondents in Ethiopia had a good attitude toward preventing CKD, as most of them agreed that complications of T2DM can be prevented by having good glycaemic control (Belsti, 2020). A study by Pramanik (2018) showed that most respondents had good attitudes towards complications of T2DM.

Moreover, less than half of the participants showed good attitudes in preventing CKD (Kumela, 2019). Meanwhile, less than half of the participants in Saudi Arabia showed awareness of CKD when they got a kidney function check-up, with 26.9% of participants not aware of the association between T2DM and CKD (Albujays, 2018). CKD awareness among diabetic patients in Northeast Ethiopia was low (Fiseha,2020). Some of the factors that affected the patients' attitude towards prevention of CKD are educational level and monthly income (Alghamdi, 2023). While in Ather (2016), only 25.3% of respondents were aware of diabetic complications (Table 2.2).

Table 2.2 Studies on the attitude of CKD prevention

Authors, Year, Country	Sample and age range	Design used	Findings
Mondal et al. 2021 Bangladesh	224 men and women with T2DM, age below 70 years	Cross-sectional study on T2DM patients attending outdoor diabetic care.	87.5 % of respondents like to learn about kidney problems.
Kumela Goro et al. 2019 Ethiopia	208 adults with T2DM, aged 18 years or older	Cross-sectional study among diabetic and hypertensive patients on regular follow-up in Jimma University Medical Centre.	41.3 % of participants had a positive attitude towards early detection and prevention of CKD
Albujays et al. 2018 Saudi Arabia	372 adults with T2DM, aged 18 years or older	Cross-sectional study on diabetic patients in Al-Ahsa Governorate.	46.0 % of participants showed a good attitude by having a kidney function check-up.

Table 2.2 continued

Authors, Year, Country	Sample and age range	Design used	Findings
Belsti, Y., Akalu, Y., & Animut, Y. 2020 Ethiopia	404 men and women with T2DM, age 18 years and above.	Cross-sectional study on T2DM patients in the diabetic center, Addis Zemen District Hospital.	65.2% had a good attitude level in preventing complications of T2DM.
Pramanik 2018 India	160 men and women with T2DM, age 40 years and above.	A comparative survey was designed on T2DM patients in the diabetic clinic of the Medical College and Hospital, Kolkata.	Most of the respondents had a favourable attitude, and 42% of males and 39% of females had an unfavourable attitude.
Ather et al. 2016 Pakistan	150 men and women with T2DM, age more than 20 years	Cross-sectional descriptive study on T2DM patients at the PNS Shifa Hospital Karachi outpatient department.	Only 25.3 % were aware of diabetic complications.

CKD=chronic kidney disease, T2DM=Type 2 diabetes mellitus

2.3.3 Self-care for CKD prevention

Self-care is a behavior or the ability to care for oneself through awareness, self-control, and self-reliance in order to achieve, maintain, or promote optimal health and well-being (Martinez, 2021). Table 2.3 shows that only five articles have looked at this issue so far. Behavior towards self-care of diabetes is low among T2DM patients in South India (Hawal, 2013). Self-care on DM to prevent CKD in terms of knowledge and practice among T2DM patients in Iraq was also poor (Mikhael,2018). Meanwhile, three-quarters of the participants in the study had poor self-care due to low income and educational background (Niguse, 2019). In a study by Shirazian (2015), self-care among T2DM patients was affected by family dynamics, which can be a burden or a support for them. A study by Faramarzi (2022) reported that respondents knew about the benefits of performing kidney care behaviours, but still did not perform well in kidney care.

Meanwhile, most participants had good self-care practices (Mekonnen & Hussien, 2021). In terms of factors associated with self-care, a study by Huang (2014) in China reported that elderly and high educational level T2DM patients showed better self-care management. More than half of the respondents in Ethiopia had good self-care, as reported by 69.7% of respondents who never forget to take their medications (Belsti, 2020). A study by Hawal (2013) showed that most T2DM patients in an urban area in South India practiced self-care in diabetes, as they had confidence in their ability to control the disease and recognized the importance of medications. They found that a positive attitude towards diabetes self-care was high in patients with good socio-economic status (Mekonnen & Hussein, 2021).

Table 2.3 Studies on self-care in CKD prevention

Authors, Year, Country	Sample and age range	Design used	Findings
Hawal et al. 2013 India	992 men and women with T2DM, age 16 years and above.	Cross-sectional study on T2DM patients in Urban Health Centre, Belgaum, South India.	Behavior towards self-care of diabetes is low among T2DM patients.
Mikhael et al. 2018 Iraq	Adults diagnosed with T2DM for at least one year, aged 18 years and above	Qualitative method approach on T2DM patients in the National Diabetes Center, Baghdad, Iraq.	Self-care on DM to prevent CKD in terms of knowledge and practice among T2DM patients in Iraq was poor.
NIguse et al. 2019 Ethiopia	338 men and women with T2DM, age 18 years and above	Cross-sectional study on T2DM patients in a diabetic clinic of Ayder Comprehensive Specialized Hospital.	Three-quarters of the participants had poor self-care
Faramarzi et al. 2022 Iran	240 men and women with T2DM, age between 30 to 60 years	Cross-sectional study on T2DM patients in the Diabetes Clinic.	Respondents were aware of the benefits of performing kidney care, even though they did not perform well in kidney care.

Table 2.3 continued

Authors, Year, Country	Sample and age range	Design used	Findings
Belsti, Y., Akalu, Y., & Animut, Y. 2020 Ethiopia	404 men and women with T2DM, age 18 years and above	Cross-sectional study on T2DM patients in the diabetic center, Addis Zemen District Hospital.	69.7% of respondents never forget to take their medication, and most modify their diet according to their doctors.

CKD=chronic kidney disease, T2DM=Type 2 diabetes mellitus

2.4 Quality of life of T2DM patients

Of 107 articles, 25 are related to QoL among T2DM patients. According to Manjunath (2014), women in South India have a higher risk of poor QoL. A study by Zare (2020) reported that QoL scores among T2DM patients in South Iran were relatively low. T2DM patients with complications of CKD, neuropathy and retinopathy showed low quality of life (Timar,2016).

However, a study by Daya (2016) reported that employment status may not have a significant impact on QoL. A study by Khdour (2020) showed that patients with higher treatment satisfaction had a better QoL. Age, education, income and marital status had a significant association with QoL among T2DM patients (Babazadeh,2017; Alsuwayt, 2014; Wang, 2017). A study by Kueh (2015) reported that QoL in satisfaction was high, whereas QoL in impact was low. Meanwhile, one-fifth of participants in Saudi Arabia reported having good QoL (Alshayban, 2020).

2.5 Readiness for using mHealth apps among T2DM patients

The usage of mHealth apps among T2DM patients was reported as poor in the literature, and there were limited studies reported, with only 25 articles found in the literature. MHealth apps are a potential tool to support management among T2DM patients as the apps help maintain lifestyle changes and provide useful information (Peterson, 2017). A study by Fu (2017) also reported that mHealth apps can assist in

diabetes self-management. A systematic review by Dale (2016) found that mHealth apps are an important contributor to behavior change interventions and disease management. The mHealth apps are an aid to lead a stable routine, give information in gaining control over blood glucose level, but some of the participants in this study mentioned that mHealth apps could be a burden because they require too much time and do not help in changing lifestyle (Torbjørnsen,2019).

Meanwhile, a study by Eberle (2021) showed that mHealth apps assist in the improvement of glycemic control with the potential to improve HbA1c (haemoglobin A1c) and the quality of patients' lives. However, participants in a study by Goswami (2023) recommended that mHealth apps include more knowledge and information for improvement. Therefore, education, management, and control of diabetes are of vital importance in mHealth apps (Drincic, 2016). However, there are no studies in the literature on the relationship between KAS and readiness to use mHealth apps among T2DM patients. Therefore, analyzing studies on this issue inspired the researcher to explore the association between them.

2.6 Theoretical and conceptual framework of the study

2.6.1 Theoretical framework

This study utilized the Health Belief Model (HBM) to help the researcher understand her study. The HBM was founded by social psychologists Hockbaum, Rosenstock, and Kegels in the 1950s (Green, 2020). They developed the model to provide an explanation for the lack of engagement and participation by individuals in disease prevention and detection initiatives. The model includes four aspects of assessment: perceived susceptibility to ill health, perceived severity of ill health, perceived benefits of behavior change, and perceived barriers to taking action. Later,

health belief theorists added the concept of self-efficacy as a factor in health behavior decision-making (Green, 2020). The model suggests that people's preventive health behaviors are shaped by their perception of disease threat, as well as the benefits and barriers of taking action. This model is therefore relevant in examining how T2DM patients adopt self-care practices to prevent chronic kidney disease (CKD), maintain quality of life (QoL), and demonstrate readiness to use mobile health (mHealth) applications.

The first construct, perceived susceptibility, refers to an individual's belief about their risk of developing CKD. Among T2DM patients, greater awareness of susceptibility is associated with better adherence to lifestyle modifications and routine health checks (Abushaikha et al., 2021). Perceived severity refers to how serious a person believes CKD and its complications are higher severity perception often motivates greater self-care and health-seeking behaviors (Tseng et al., 2017). These two constructs form the perceived threat of illness, shaping knowledge and attitudes toward CKD prevention in this study.

Perceived benefits and perceived barriers further influence behavior. Benefits may include improved health outcomes and better QoL through proper self-care and use of mHealth tools, while barriers may involve financial constraints, limited digital literacy, or fear of side effects (Sharma et al., 2020). For example, patients may recognize the usefulness of an mHealth app for glucose monitoring, but hesitate to use it due to a lack of confidence with technology. Self-efficacy, or the belief in one's ability to perform health behaviors, is a crucial determinant of adherence to diet, exercise, and medication regimens in diabetes management (Mohammadi et al., 2018).

For cues to action, such as physicians' advice, health education campaigns, or push notifications from mHealth applications serve as triggers that activate health

behaviors (Champion & Skinner, 2008). In this study, cues to action are particularly relevant in relation to readiness to adopt mHealth, as external reminders can motivate patients to engage more actively in their self-care.

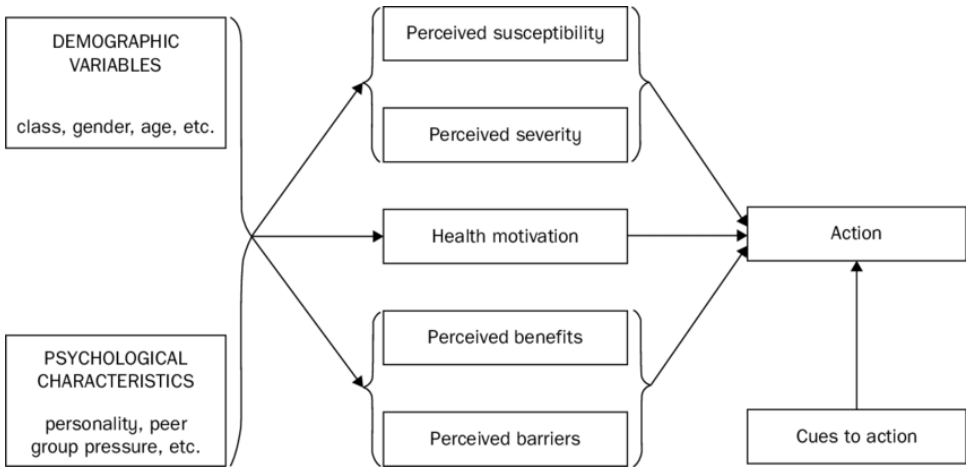

Figure 2.1 The health belief model

2.6.2 Conceptual framework

By understanding this theory, the researcher has come up with a conceptual framework for the study.

All the constructs can be expanded to apply to this proposed study as follows:

a. Perceived susceptibility to a particular health problem: The patients are at risk of having CKD.
b. Perceived severity of the condition: The patients' QoL can be affected if they do not emphasize their KAS towards CKD prevention.
c. Belief in the effectiveness of the new behavior: They believe that practising good KAS and using mHealth apps will prevent CKD.

d. Perceived benefits of preventive action: They believe that by taking preventive measures, they will have better QoL.

e. Barriers to taking action: The patients are not familiar with mHealth apps.

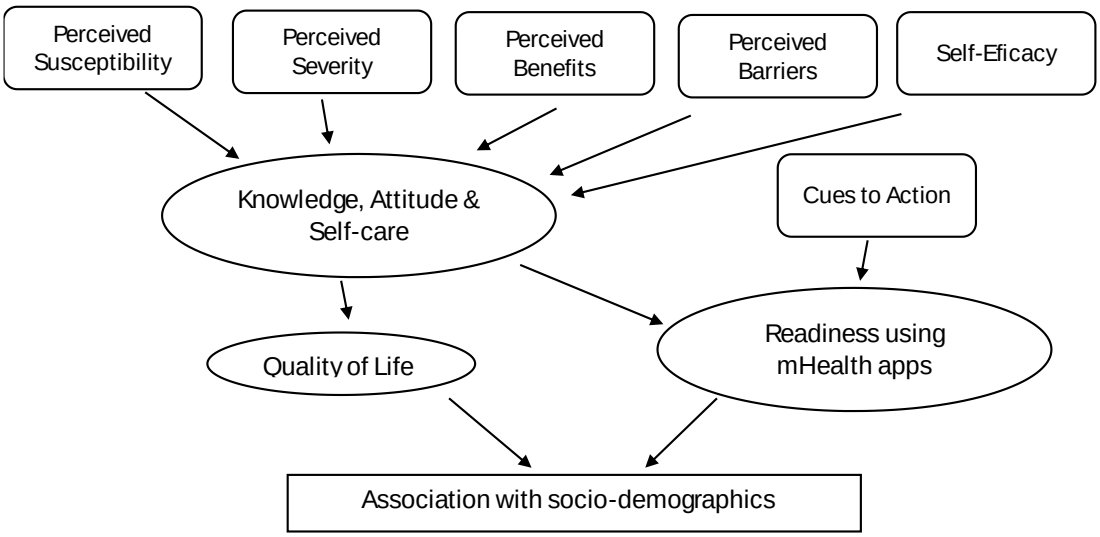

Figure 2.2 Hypothesized interactions between study variables

Through this model, individuals with Type 2 Diabetes Mellitus (T2DM) may perceive in the fact that their knowledge, attitude, and self-care (KAS), as well as their utilization of mobile health (mHealth) applications, can help in averting the development of chronic kidney disease (CKD) and positively influence their overall quality of life.