KNOWLEDGE, ATTITUDE AND PRACTICE ON CHRONIC KIDNEY DISEASE PROGRESSION PREVENTION AND READINESS OF MOBILE HEALTH APPLICATION USAGE AMONG EARLY STAGES OF CHRONIC KIDNEY DISEASE PATIENTS AT ISLAND HOSPITAL, PENANG

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By

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LIST OF ABBREVIATIONS

CKD	Chronic Kidney Disease
RMHA	Readiness of Mobile Health Application
IPS	Institut Pengajian Siswazah
USM	Universiti Sains Malaysia
DM	Diabetes Mellitus
CPN	Chronic Pyelonephritis
PKD	Polycystic Kidney Disease
KAP	Knowledge, Attitude and Practice
mHealth apps	Mobile Health Applications

LIST OF APPENDICES

PENGETAHUAN, SIKAP DAN AMALAN PENCEGAHAN PERKEMBANGAN PENYAKIT BUAH PINGGANG KRONIK DAN KESEDIAAN PENGGUNAKAN APLIKASI KESIHATAN MUDAH ALIH DALAM KALANGAN PESAKIT BUAH PINGGANG KRONIK PERINGKAT AWAL DI HOSPITAL ISLAND, PULAU PINANG.

ABSTRAK

Penyakit buah pinggang kronik (CKD) adalah kebimbangan kesihatan yang penting di seluruh dunia. Oleh itu, pengesanan awal dan rawatan masalah buah pinggang boleh mengelakkan buah pinggang daripada merosot dan menyebabkan komplikasi, terutamanya pada Peringkat 1 dan 2. Oleh itu, adalah penting untuk mengakses pengetahuan, sikap dan amalan (KAP) pesakit untuk melambatkan perkembangan penyakit. penyakit dan untuk meningkatkan teknologi aplikasi kesihatan mudah alih, yang telah dikenal pasti sebagai salah satu alat yang produktif untuk membantu penjagaan pesakit. Kajian ini bertujuan untuk mengesahkan soal selidik aplikasi kesihatan mudah alih Versi Bahasa Melayu, menentukan tahap KAP, kesediaan aplikasi kesihatan mudah alih (aplikasi mHealth; Readiness of mHealth Applications RMHA) dan faktor-faktor yang dikaitkan dengannya dalam kalangan pesakit CKD peringkat awal dan yang merupakan pesakit dari nefrologi. klinik di Island Hospital. Kajian ini terdiri daripada 2 fasa. Responden adalah pesakit CKD peringkat awal. Bagi Fasa 1, 200 responden telah mengambil bahagian dalam pengesahan soal selidik untuk versi Bahasa Melayu RMHA. Instrumen yang digunakan untuk RMHA ialah aplikasi mHealth versi Bahasa Melayu yang asalnya dalam versi bahasa inggeris oleh (Putu et al., 2021). Data dianalisis dengan menggunakan SPSS 27 dan Mplus8.0. Purata umur peserta ialah 51.71 (SD=14.05), dan majoriti adalah lelaki (57.5%). Versi Bahasa Melayu RMHA adalah sah dan boleh

dipercayai berdasarkan analisis faktor pengesahan dan kebolehpercayaan ketekalan dalaman (alfa Cronbach berjulat dari 0.866 hingga 0.968). Bagi Fasa 2, 169 responden telah melengkapkan soal selidik untuk mengukur tahap KAP dan kesediaan untuk menggunakan aplikasi mHealth. Kajian keratan rentas telah dijalankan pada Fasa 2 dan pengkaji menggunakan persampelan kemudahan untuk memilih responden yang layak untuk kajian ini. Data dikumpul melalui soal selidik KAP. Data dianalisis dengan menggunakan SPSS 27 dan Mplus8.0. Daripada analisis regresi linear, faktor yang didapati dikaitkan dengan kesediaan mHealth ialah jantina (p=< 0.001), pengetahuan (p=0.027), kesediaan teknologi (p=< 0.001), kesediaan orang (p=< 0.001), kesediaan penglibatan (p=< 0.001), dan kesediaan motivasi (p=< 0.001). Penemuan menunjukkan bahawa pesakit CKD peringkat awal mempunyai pengetahuan dan sikap yang baik tetapi amalan yang lemah terhadap CKD. Bagi warga RMHA, penglibatan dan kesediaan motivasi berkait positif dengan kesediaan mHealth. Instrumen yang digunakan untuk menyaring KAP pada CKD ialah Indeks Saringan CKD oleh Khalil (2014). Purata umur peserta ialah 53.18 (SD=15.39), dan majoriti adalah lelaki (51.4%). Bagi KAP, majoriti responden mempunyai tahap pengetahuan tinggi, n=270 (75.2%), tahap sikap tinggi, n=331 (92.2%) tetapi tahap amalan rendah, n=228 (63.5%). . Kajian itu menyimpulkan bahawa pesakit CKD peringkat awal mempunyai pengetahuan dan sikap yang baik tetapi amalan yang lemah, dengan kesediaan teknologi dan orang yang berkaitan secara positif dengan kesediaan mHealth.

KNOWLEDGE, ATTITUDE AND PRACTICE ON CHRONIC KIDNEY DISEASE PROGRESSION PREVENTION AND READINESS OF MOBILE HEALTH APPLICATION USAGE AMONG EARLY STAGES OF CHRONIC KIDNEY DISEASE PATIENTS AT ISLAND HOSPITAL, PENANG

ABSTRACT

Chronic kidney disease (CKD) is a significant health concern globally. Thus, early detection and treatment of kidney problems can prevent the kidney from deteriorating and causing complications, especially in Stages 1 and 2. Therefore, it is essential to access the patient's knowledge, attitude and practice (KAP) to slow down the progression of the disease and to increase the mobile health application technology, which has been identified as one of the productive tools to aid patient care. This study aims to validate the mobile health application version questionnaire, determine the level of KAP, the readiness of mobile health applications (mHealth apps; Readiness of mHeatlh Applications RMHA) and the factors associated with it among early-stage CKD patients and who were patients from the nephrology clinic at Island Hospital. This study consisted of 2 phases. The respondents were early-stage CKD patients. For Phase 1, 200 respondents participated in the questionnaire validation for the Malay version of RMHA. The instrument used for the RMHA was the mHealth apps Malay version that originally in english version by (Putu et al., 2021). The data was analyzed by using SPSS 27 and Mplus8.0. The mean age of participants was 51.71 (SD=14.05), and the majority were male (57.5%). The Malay version of RMHA was valid and reliable based on confirmatory factor analysis and internal consistency reliability (Cronbach's alpha ranged from 0.866 to 0.968). For Phase 2, 169 respondents completed the questionnaires to measure the KAP level and the readiness to use the

mHealth apps. A cross-sectional study was conducted in Phase 2 and the researcher used convenience sampling to select eligible respondents for this study. The data were collected through KAP questionnaires. The data was analyzed by using SPSS 27 and Mplus8.0. From the linear regression analysis, factors that were found to be associated with mHealth readiness were gender (p=< 0.001), knowledge (p=0.027), technological readiness (p=< 0.001), people readiness (p=< 0.001), engagement readiness (p=< 0.001), and motivational readiness (p=< 0.001). The findings suggested that the early-stage CKD patients had good knowledge and attitude but poor practice on CKD. For the RMHA people, engagement and motivational readiness positively relate to mHealth readiness. The instrument used to screen KAP on CKD was the CKD Screening Index by Khalil (2014). The mean age of participants was 53.18 (SD=15.39), and the majority were male (51.4%). For KAP, the majority of the respondents have a high level of knowledge, n=270 (75.2%), a high level of attitude, n=331 (92.2%) but a low level of practice, n=228 (63.5%). The study concluded that early-stage CKD patients had good knowledge and attitude but poor practice, with technological and people readiness positively related to mHealth readiness.

CHAPTER 1

INTRODUCTION

1.1 Background to the study

1.1.1 Chronic Kidney Disease

Chronic kidney disease (CKD) is a significant health concern globally, and this disease is ranked 19th among the leading causes of morbidity (Jager & Fraser, 2017). About 1 to 2 million people worldwide died due to renal failure, and the percentage spiked up to 32% since 2005 (Wang et al., 2016). CKD is defined as the presence of a kidney problem with a glomerular filtration rate (eGFR) less than 60 ml/min (1.73 mt), continuing for three months or more (Vaidya et al., 2024). CKD is also defined as progressive and irreversible kidney damage with symptoms lasting more than three months that eventually result in the need for replacement therapy such as dialysis or transplantation (Kidney Disease Improving Global Outcomes KDIGO, 2017).

Figure 1.1 shows that CKD can be categorized into five stages, which are stages 1 to 5 (KDIGO, 2022). The stages are based on urinary protein excretion, and the renal function status is based on the estimated glomerular filtration rate (eGFR). The earlier CKD stages (Stages 1 and 2) are usually asymptomatic or mild, and severe symptoms appear in stages 4 to 5. The common symptoms for these last two stages are nausea, vomiting, loss of appetite, fatigue and weakness, sleep disturbance, oliguria, swelling of feet and ankles, or persistent pruritus (Vaidya et al., 2021).

Stage of CKD	eGFR result	What it means
Stage 1	90 or higher	- Mild kidney damage - Kidneys work as well as normal
Stage 2	60-89	- Mild kidney damage - Kidneys still work well
Stage 3a	45-59	- Mild to moderate kidney damage - Kidneys don't work as well as they should
Stage 3b	30-44	- Moderate to severe damage - Kidneys don't work as well as they should
Stage 4	15-29	- Severe kidney damage - Kidneys are close to not working at all
Stage 5	less than 15	- Most severe kidney damage - Kidneys are very close to not working or have stopped working (failed)

Figure 1.1:Stages of CKD

Source: American Kidney Fund (2022)

Based on this figure, Stage 1 refers to kidney damage with a normal GFR (greater than 90 ml/min), and the kidney is still functioning normally, but the urine and the abnormal structural findings are detected. While a mild reduction in GFR (60–89 mL/min) is indicated in Stage 2, there is a mild reduction in kidney function. Stage 3 is divided into two types: Types 3a and 3b. In Stage 3a, a moderate reduction is indicated in the GFR (45 to 59 mL/min) and a mild decrease in the GFR (30 to 44 mL/min) of kidney function in 3b. While in Stage 4, a severe reduction in GFR (15 to 29 mL/min) is indicated with severely reduced kidney function. Finally, Stage 5, where the GFR is less than 15 mL/min with very severe kidney damage or end-stage renal failure (Vaidya et al., 2024). Most patients are categorized under Stage 3 (90%), and there is proper treatment to prevent further deterioration.

Regarding prevalence, CKD was reported at 13·4% and 10·6% of stages 3 to 5 (Vaidya et al., 2024). According to Romagnani et al., (2017), CKD affects 1 in 10 adults globally. Worldwide, more than 10% of the adult population has CKD, which confirms that the prevalence of CKD will keep increasing (Kovesdy CP, 2022). In Asian countries such as Indonesia, Japan, Vietnam, and China, there are more than 10 million cases of CKD per year (Liyanage et al., 2022). According to (Liyanage et al., 2022), there are 434.3 million CKD patients across Asia, and most cases are from China and India (up to 299.9 million).

Whereas in Malaysia, Swaminathan et al., (2020) indicated an increase of 9.07% in CKD patients in Peninsular Malaysia. As for the Pulau Pinang population, it is reported that CKD patients in Pulau Pinang were among the third highest in Malaysia between 2014 and 2018 (Malaysian Society of Nephrology, 2018). The prevalence is reported based on the stages: Stage 1 (4.16%), Stage 2 (2.0%), Stage 3 (2.26%), Stage 4 (0.24%), and Stage 5 (0.36%), as in Table 1.0.

Table 1.1: Number of CKD Patients in Pulau Pinang between 2014 to 2018

State	Sector	2014	2015	2016	2017	2018
Pulau Pinang	Public	764	773	789	752	708
	Private	2391	2484	2682	2714	2765
	NGO	1264	1294	1385	1401	1364
	Total	4419	4551	4856	4867	4837

Source: Malaysia Society Nephrology, (2018)

There are several leading causes of CKD, including diabetes mellitus (DM), hypertension, chronic pyelonephritis (CPN), polycystic kidney disease (PKD), and toxic nephropathy. The leading cause of CKD is DM, a worldwide public health issue (World Health Organization WHO 2021). The presence of CKD combined with DM

increases morbidity and mortality rates and eventually leads to cardiovascular risk (Swamy, Noor, & Mathew, 2023). This is followed by hypertension. Long-term hypertension (more than five years) may increase the risk of renal impairment (Panagiotis et al., 2023). Polycystic kidney disease (PKD) refers to an enlarged kidney with renal cysts, with or without a family history of PKD. Lastly is toxic nephropathy, which is considered one of the leading factors, particularly if the patient has a strong history of nephrotoxic agent usage (e.g., nonsteroidal anti-inflammatory drugs (NSAIDs), traditional medicines, etc (Klomjit & Ungprasert 2021).

WHO (2017) reported that early detection and treatment of kidney problems can prevent the kidney from deteriorating and causing complications. This is particularly important for those at Stage 1 to Stage 2 of CKD as in the advanced stages (Stages 4 to 5), the patients may encounter more serious symptoms such as fatigue, poor appetite, nausea, vomiting, metallic taste, unintentional weight loss, pruritus, changes in mental status, dyspnea, or peripheral edema (Chen, Knicely, & Graams 2019).

As mentioned earlier, there are five stages of CKD, which are based on the result of eGFR and the function of kidneys to filter waste products and extra fluid from the body. In the early stages (Stages 1-2), the kidney can still function well and filter waste out of blood. The patient may or may not have any symptoms. However, in advanced stages (Stages 4-5), the kidney must work harder to continue its function and may stop working altogether. According to (Chen, Knicely, & Graams 2019), CKD patients in the early stages are at high risk of CKD progression. This includes those who are elderly, suffer from obesity, hypertension, diabetes, hypertriglyceridemia, hypercholesterolemia, low levels of HDLc, hyperuricemia, anemia, history of CKD, history of stroke, family history of CKD, and potential nephrotoxins (e.g., nonsteroidal

anti-inflammatory drugs [NSAIDs], medication use, antibiotic therapies such as gentamicin, history of nephrolithiasis, autoimmune disease, chronic infections, (Chen, Knicley and & 2019). Thus, taking steps to slow down the disease's progress is essential.

The ideal management strategies for CKD stages 1 and 2 include reducing the risk of heart-related issues through medications like statins and controlling blood pressure, managing albuminuria with drugs like ACE inhibitors or ARBs, staying away from substances that can harm the kidneys like NSAIDs, and making necessary changes to medication doses such as certain antibiotics and oral diabetes drugs. These are essential strategies for improving health outcomes. Besides that, treatment of hypertension is among the most vital factors in slowing the progression of kidney failure (Pugh et al., 2019). Patients also require close monitoring for the complications of CKD, such as hyperkalemia, metabolic acidosis, hyperphosphatemia, vitamin D deficiency, secondary hyperparathyroidism, and anemia (Chen, Knicely, & Graams, 2019). The main goal at each stage of CKD is to delay the progression of kidney failure and keep the kidney functioning as long as possible (Ward et al., 2015).

Elendu et al., (2023) stated that the current management strategies to slow the progression of CKD include reasonable control of blood pressure, glycemic control for diabetic patients and reducing proteinuria, staying physically active, dietary changes and smoking cessation. The key recommendation for managing early CKD by KDIGO (2022) is to monitor kidney function progression regularly and other risk factors for CKD progression, education and 5ounselling to CKD patients to promote self-management and compliance to treatment, referral to a nephrologist when appropriate based on patient's CKD stage progression, use non-steroidal anti-

inflammatory drugs carefully in CKD patients avoid nephrotoxic agents whenever possible.

However, only 5% of the patients with early CKD are aware of their disease, the treatment options, and risk assessment tools that incorporate GFR, which help the patient manage their early CKD stages and thus slow the progression (Chen et al., 2019). Therefore, this study will focus on early-stage CKD patients.

1.1.2 Knowledge, Attitude, and Practice (KAP)

Understanding KAP is crucial in managing CKD (Ghannadi et al., 2016). Studies have highlighted that a lack of sufficient knowledge about CKD can negatively impact management, particularly in those with early-stage CKD. For example, a study by Dariah et al., (2016) on patients with other medical diseases showed that the respondents had poor knowledge of CKD. The result showed that of the 103 respondents, 70% had less understanding of CKD compared to only 30% who had broad knowledge of CKD. Aboibaidi S et al., (2021) also presented that the patients in their study had a poor understanding of CKD, as 66.9% of the patients wrongly believed that herbal supplements could treat CKD effectively, while only 50.1% of the patients used medications to slow down the CKD progression in the study. This indicates the patient's poor knowledge regarding CKD treatment. Another study also observed that 76.6% of patients believed in the effectiveness of herbal supplements, and only 23.4% knew that medications could slow down CKD (Gheewala et al., 2018). Therefore, it is essential to ensure patients have sufficient education and knowledge on CKD to improve their health-seeking behavior and slow down the progression of CKD.

However, most of the patients in this study had a positive attitude towards the risk of CKD (Dariah et al., 2016). Calisanie et al., (2020) suggested that one must create good knowledge and adopt a positive attitude and practice to improve patients' attitudes towards CKD. Most respondents (52.6%) in their study cultivated a positive attitude towards CKD, which was caused by good knowledge (Calisanie et al., 2020). However, attitudes and practices are critical in preventing and managing CKD. Despite efforts to increase awareness and promote self-care behaviors, there are significant challenges related to patients' attitudes and practices, which can hinder the effectiveness of CKD prevention programs.

Many CKD patients fail to recognize the seriousness of their condition, particularly in the early stages, where symptoms may be less apparent. This lack of urgency or understanding can lead to poor engagement with treatment protocols and preventive measures. According to Dariah et al., (2016), some patients do not fully grasp the risks associated with CKD, which affects their motivation to adhere to recommended practices. This problem may stem from insufficient knowledge or cultural misconceptions about the disease. Cultural beliefs and the acceptance of alternative therapies, such as herbal supplements, pose another significant barrier to CKD prevention. Patients often believe that herbal or traditional remedies are safer and more effective than medically recommended treatments. Gheewala et al., (2018) found that a substantial portion of CKD patients (76.6%) believed In the effectiveness of herbal supplements, even though these were not proven to slow CKD progression. This preference for alternative therapies often leads to inconsistent adherence to prescribed medications, delaying effective management and increasing the risk of disease progression.

Adopting and maintaining lifestyle modifications, such as dietary changes and regular exercise, is crucial for preventing CKD progression. However, many patients struggle with adhering to these changes due to ingrained habits, lack of support, or insufficient understanding of the long-term benefits. As Tsai et al., (2021) pointed out, knowledge and attitude are linked to better self-management, yet may revert to unhealthy practices that exacerbate their condition without continuous reinforcement. For example, patients may fail to adhere to dietary restrictions or neglect to engage in recommended physical activities, undermining the preventive efforts.

Another significant problem is the delay in seeking medical advice or follow-up care. Patients with a passive attitude toward their health may not pursue regular check-ups or monitoring until the disease has progressed to a more severe stage. This delayed health-seeking behavior can be attributed to either a lack of awareness or a sense of complacency due to early-stage CKD symptoms being mild or absent, emphasizing that this lack of timely intervention exacerbates the risk of complications and worsens health outcomes. Many patients face challenges in actively engaging with CKD prevention programs due to various barriers, including time constraints, limited motivation, and a lack of perceived relevance. Calisanie et al., (2020) suggest that while some patients may have a positive attitude toward CKD management, others lack the drive to participate in educational or lifestyle modification programs. For example, patients who are working full-time may find it challenging to attend educational sessions or make the necessary lifestyle adjustments. This disengagement limits the effectiveness of CKD prevention initiatives.

Lastly, an insufficient support network, including family involvement or encouragement from healthcare providers, can also diminish patients' ability to stay on track with their CKD prevention strategies (Kalantar-Zadeh et al., 2021). In conclusion, addressing the challenges related to attitudes and practices in CKD prevention requires a multi-faceted approach. Educational programs must focus on dispelling cultural myths, improving disease awareness, and emphasizing the importance of consistent adherence to treatment and lifestyle changes (Mboweni et al., 2023). Additionally, continuous support and engagement strategies, such as follow-up care and the use of mobile health applications, should be implemented to help patients maintain their commitment to effective CKD prevention practices (Shi et al., 2024).

Effective management of CKD, especially in its early stages, relies on sound knowledge, positive attitudes, and appropriateness. As Tsai et al., (2021) pointed out, having high levels of expertise and a positive attitude is essential for prolonging renal health and slowing CKD progression.

In this study setting, most patients demonstrated a high level of knowledge about CKD and the treatment options. For example, most are aware of medications' slowing CKD progression. However, this study reveals a mixed attitude among patients toward CKD management. While some patients exhibit a positive attitude and a willingness to engage in self-care, others may not fully grasp the seriousness of the disease or the importance of adhering to treatment protocols. In this study setting, there is a minority amount of patients favoring additional or alternative therapies, such as herbal supplements, which are often perceived as more natural or less invasive. This attitude may stem from misinformation and cultural preferences, undermining adherence to medically recommended treatments and monitoring practices.

This study setting highlights inconsistent adherence to prescribed treatments and lifestyle modifications. Patients with insufficient knowledge or negative attitudes may struggle with following medical advice, such as taking medications regularly or making necessary dietary changes. This inconsistency can contribute to the progression of CKD and the development of complications. This study setting also shows a tendency towards delayed health-seeking behavior. Patients may not seek timely medical advice or follow-up care due to a lack of awareness about the importance of regular monitoring and proactive management. This delay can exacerbate CKD progression and negatively impact patient outcomes.

However, there are several limitations to the current interventions aimed at improving KAP among patients with CKD. Firstly, there is a lack of continuous support or regular monitoring. For example, some patients may not have strong family or moral support and constant monitoring. Secondly, limited patient engagement exists (Molnar et al., 2017). Many patients may have limited motivation due to time constraints or a lack of perceived relevance, which can reduce their participation and commitment to the intervention (Cassidy et al., 2018). For example, some patients have time constraints due to working. Thus, addressing these limitations required a robust approach to ensure that KAP improvement strategies are effective and sustainable.

1.1.3 Mobile Health Applications

Mobile health application technology has been identified as one of the most straightforward tools to aid patient care (WHO, 2016). However, the usage of mHealth apps in Asian countries is still minimal (WHO, 2019). mHealth apps refer to healthcare and public health initiatives supported by mobile devices like smartphones, patient monitoring tools, and various wireless devices (Putu et al., 2021). The mHealth apps used by the participants are adopted from the existing apps. Examples of the mHealth apps used by the participants were Care for Kidney and myCKDCPG. Care for Kidney mHealth app is a free health application funded by the National Kidney Foundation (NKF) Malaysia. It is designed to promote kidney health and provide education on CKD. myCKDCPG mHealth app is an integrated digital tool for a comprehensive, one-stop platform that offers holistic approaches to your CKD management needs. Both consist of tools that assess the patient's CKD progression risk and provide concise information on CKD management. According to Vaghefi et al., (2019), It can also aid patients in controlling their HbA1c readings to prevent further deterioration of kidney function (Siddique et al., 2019).

There are several benefits to using mHealth apps. Firstly, mHealth apps are vital, as patients can uphold their level of knowledge more than those who do not use mobile health applications (Tsai et al., 2021). Secondly, mHealth apps can enhance the management of CKD by improving patient education, encouraging behaviors like medication adherence and dietary changes, and enhancing communication between patients and healthcare providers (Ong et al., 2016). Thirdly, the mHealth apps not only provide health information but can also aid in tracking diet and nutrition, provide

drug information, estimate kidney functions, and provide information on disease signs and symptoms that can help manage the development of CKD (Siddique et al., 2019).

mHealth apps can provide helpful access for the patient, as Yee et al., (2019) suggested. Using mHealth apps has positively helped patients gain self-care and self-efficacy. However, Krosel et al., (2016) claimed that those applications still required a vast improvement in the sense that they must include additional benefits for the user, such as personalized education and enhanced self-management. This is important as it can affect the patient's readiness to use mHealth apps, and further studies need to be carried out.

The tools used to measure the validity and reliability of the RMHA were developed by (Putu et al., 2021). The tool appeared to be a well-structured instrument designed to assess readiness across several essential domains. However, despite the reported good reliability (as indicated by Cronbach's alpha values greater than 0.7), there were still potential problems that could have arisen related to the validity and reliability of the tool. A possible issue related to the validity and reliability of the tool was response bias. This could have been subject to various forms of response bias, such as social desirability bias (where respondents answered in a way they believed was socially acceptable) or acquiescence bias (where respondents tended to agree with statements regardless of their feelings). If respondents were not answering honestly or if they tended to agree with statements due to bias, the validity of the tool could have been compromised.

Additionally, even though the RMHA questionnaire had been validated, it was essential to assess whether it comprehensively covered all aspects of readiness. There could have been relevant factors influencing readiness that were not captured by the four domains (technological, people, motivational, and engagement readiness). Suppose the questionnaire did not include all critical aspects of preparedness. In that case, the tool might have missed essential elements that could have influenced the overall readiness to use mHealth apps, leading to incomplete or biased results. Thus, it was vital to acknowledge these limitations and suggest ways to address them, such as through further validation studies.

1.1.4 Association between KAP and RMHA

Regarding the association between KAP and RMHA, only a few studies have explored innovative technologies, such as smartphones and mHealth apps, as supplementary tools to enhance treatment adherence in patients with CKD Cedillo-Couvert et al., (2018) stated that low adherence to CKD treatment has been associated with a greater probability of disease progression and higher mortality. A key challenge in implementing this technology is the lack of awareness among users about the potential advantages of gaining CKD knowledge on the applications. In the present study, the researcher must show the usage of the mHealth apps to determine KAP in CKD. The main goal of introducing mHealth for health self-management is to improve or increase treatment adherence.

Thus, integrating mHealth app technology into the routine of CKD patients holds great promise, as it can enhance their knowledge and empower them in managing their treatment. However, in the Deniz-Garcia et al., (2023) study, patients only showed moderate command of mHealth apps. Thus, healthcare providers should encourage

using such applications and offer the necessary information to support this technology. This includes sharing test results, dietary guidelines, and medication prescriptions (Cedillo-Couvert et al., 2018). Introducing mobile technology into patients' routines with CKD is highly promising, as it can enhance their knowledge and empower them to manage their treatment wisely (Cedillo-Couvert et al., 2018).

1.2 Problem Statements

CKD is a worldwide health problem. Its prevalence is increasing each year, and the treatment is putting an enormous burden on healthcare systems (Wollide et al., 2020; Gebrie et al., 2019). According to the Malaysia Society of Nephrology (2018), Pulau Pinang has the third highest number of CKD patients in Malaysia, with the highest prevalence within stages 1 and 2. This finding shows that those who are at risk for advanced CKD need to be taken care of by ensuring they have adequate knowledge, attitude, and practice to prevent the disease from getting worse to severe stages (stages 4–5).

The study by Vainauskiene et al., (2021) suggested that increased knowledge about and positive attitudes toward the disease and effective self-management practices are linked to a better understanding of how to prevent, diagnose, and control risk factors. By assessing attitude and practice, this study aimed to understand how knowledge alone may not be sufficient to drive meaningful behavioral change. Therefore, this study will identify and evaluate early-stage CKD patients based on their KAP to drive meaningful behavioral change.

Accordingly, it is vital to identify their knowledge and early identification in the early stages of CKD patients to manage their disease confidently and eventually reduce unforeseeable outcomes (Younes S et al., 2022). However, some factors also affect the patients' KAP levels, such as a lack of physician awareness (Dariah et al., 2016). Stanifer et al., (2016) highlighted that attitudes were also frequently marked by concern about kidney disease's economic and social effects. According to Sharma et al.,(2023), a notable correlation was observed between knowledge and attitude scores, knowledge and practice scores, and practice and attitude scores. This suggested that as a patient's knowledge about CKD Increases, their attitude toward the disease also becomes more positive, leading to healthier practices to reduce the progression of CKD. It also indicates that by enhancing a patient's knowledge through education and repeated counseling, their attitude and practices related to their progression of CKD can be prolonged.

However, minimal national studies have focused on KAP towards CKD progression prevention. Therefore, these risk factors need to be explored further to understand how to overcome them and, later on, help to structure appropriate strategies to improve knowledge, attitudes, and practices in the early stages of CKD patients.

The purpose of mHealth apps is to aid the early stages of CKD patients in monitoring the disease process and provide related information related to CKD (Schrauben et al., 2021). Its usage shows a positive attitude by monitoring the patient's progress, which will increase the patient's health status (Jembai et al., 2022). However, limited studies and challenges are being examined in this matter. According to Yusif et al., (2017), many plausible adverse effects can influence the patients' readiness to use the mHealth apps. (Wang et al., 2021) emphasized that a significant gap hinders

the patients' attitude towards using mHealth apps, which limits their readiness to switch from physical mode to mHealth apps. A study by Jeffrey et al., (2019) found that non-app users found no significant reasons to use the application. Krosel et al., (2015) reported that the usability and accessibility of mHealth apps are stagnant to moderate.

Moreover, most respondents said that the mHealth apps need more upgrading, such as essential functions, especially in diabetes management, to enhance the patient's readiness for them (Krosel M et al., 2015). Future applications should be more user-oriented and improve application usability based on accepted clinical guidelines (Krosel M et al., 2015).

However, studying the readiness to use mHealth apps is crucial, even though previous research has identified significant barriers that hinder patients from adopting these technologies. Firstly, the mHealth apps have potential benefits in improving health outcomes Okolo et al., (2024) as these apps could significantly enhance disease management, leading to better control of CKD progression and improved quality of life—secondly, the empowerment and engagement of patients toward the mHealth apps (Hamberger et al., 2022). When patients feel confident and ready to use mHealth apps, they are more likely to engage actively in their health management, leading to better adherence to treatment plans and more proactive disease management. As healthcare continues to digitize, integrating mHealth apps into the healthcare system can address existing challenges, such as incomplete or non-standardized medical data and communication gaps, particularly in the interactions between patients and healthcare providers (Hamberger et al., 2022). By studying readiness now, the research can inform future strategies that overcome current barriers and anticipate and mitigate

future challenges as technology evolves. The mHealth apps used by the participants are adopted from the existing apps.

Future applications should be more user-oriented and improve application usability based on accepted clinical guidelines (Krosel et al., 2015). Addressing these challenges is vital for enhancing the efficacy of mHealth apps in managing CKD. In light of all the mentioned issues, the researcher is inspired to conduct this study to evaluate the early stages of CKD patients' knowledge, attitude, and practice toward CKD and their readiness to use the mHealth apps to manage the disease.

1.3 Significance of the Study

The global burden of CKD is increasing (Foreman et al., 2018). If CKD remains uncontrolled, the progression is to end-stage renal failure (ESRF), where renal replacement therapy will be needed (Li et al., 2020). However, CKD progression can be delayed if the level of KAP is one of the vital keys to managing CKD (Ghannadi et al., 2016).

Several studies have been done on the risk of CKD globally and in Malaysia, but minimal studies have been done in Pulau Pinang. According to the Malaysia Society of Nephrology (2018), Pulau Pinang has the third highest number of CKD patients in Malaysia, with the highest prevalence within stages 1 and 2. The research studies on the readiness to use the mHealth apps among early-stage CKD patients in Pulau Pinang are still relatively low.

This study studied the patients's KAP level on CKD prevention and RMHA among early-stage CKD patients at Island Hospital. The findings of this study will help reduce the prevalence of CKD and its complications, which is in line with the increase in awareness and readiness to use mHealth apps to help guide patients in managing the disease more effectively.

Moreover, since this study seeks to determine the socio-demographic KAP on CKD prevention and readiness for using mHealth apps among early-stage CKD patients, this would also be useful for nurses, doctors, policymakers, or any related health personnel to guide them in improving their health condition.

1.4 General and Specific Objectives

1.4.1 General Objectives

This study aims to determine the knowledge, attitude and practice (KAP) and readiness of mobile health applications (mHealth apps) and their associated factors among early-stage CKD patients.

1.4.2 Specific Objectives

Phase 1

1. To determine the validity and reliability of the Malay version of the RHMA questionnaire among early-stage CKD patients.

Phase 2

2. To determine the readiness of early-stage CKD patients to use the mHealth apps.
3. To determine the level of KAP on CKD prevention among early-stage CKD patients.
4. To determine the association between socio-demographic characteristics, KAP, and readiness to use the mHealth apps among early-stage CKD patients.

1.5 Research Questions

Phase 1

1. Is the readiness to use the Malay version of the mHealth apps questionnaire valid and reliable?

Phase 2

2. What are the readiness levels for using mHealth apps among early-stage CKD patients?

3. What are the levels of KAP in CKD prevention among early-stage CKD patients?

4. Is there any association between socio-demographic characteristics, KAP on CKD prevention and the readiness to use mHealth apps among early-staged CKD patients?

1.6 Hypothesis

1.6.1 Null Hypothesis (H_0)

1. The readiness to use the Malay version of the mHealth apps questionnaire is not valid and reliable.

2. There is no significant association between socio-demographics characteristics, KAP on CKD prevention and medical variables with readiness to use mHealth apps among early-stage CKD patients.

1.6.2 Alternative Hypothesis (H_a).

1. The Malay version of the Readiness of using mHealth apps Questionnaire is valid and reliable.

2. There is a significant association between socio-demographic characteristics, KAP on CKD prevention and medical variables with readiness to use mHealth apps among early-stage CKD patients.

1.7 Operational Definitions

Table 1.2: Conceptual Definition and Operational Definition for KAP, CKD, Early-stages CKD and mHealth app

Term	Conceptual Definition	Operational Definition
Knowledge	Knowledge is information and understanding the person's issue (Collins Dictionary, 2024).	In this study, the patient's level of knowledge will be measured using the CKD Screening Index version by (Dariah et al., 2016). The knowledge of CKD will be assessed *(Knowledge continue)in depth regarding the patient's understanding of the complications of CKD and the care of CKD to prevent further deterioration of CKD.

Table 1.2 Continued

Attitude	Attitude is how a person behaves about something (Cambridge Dictionary, 2024).	In this study, the patient's level of attitude will be measured using the CKD Screening Index Malay version by (Dariah et al., 2016). The attitude of CKD will be assessed based on the patient's viewpoint on CKD, which will affect their chronic outcomes.
Practice	Refers to a task that a person typically carries out to maintain *(Practice continues) daily life (Cambridge Dictionary, 2024).	In this study, the patient's level of practice will be *(Practice continues) measured using the CKD Screening Index version by Dariah et al., 2016). The practice of CKD will be assessed based on the overall management of CKD.

Table 1.2 Continued

CKD	CKD is continuous and irreversible with a Glomerular Filtration Rate (eGFR) of less than 60mL/min/1.73 progressively over 3 months (Arora et al., 2017).	Based on the inclusion criteria, this study will assess the CKD patients' knowledge, attitude and practice level.
Early- Stages CKD	Early stages of CKD are defined as asymptomatic, typically at stages 1 and 2, and symptoms will only manifest in stages 4 or 5 *(Early- Stages of CKD) (Vaidya et al., 2024). In the early stages (1-3), the kidneys are still able to filter waste out of blood (American Kidney Fund, 2022)	In this study, the CKD patient's early stages will be the participants in determining their early stages, their KAP on CKD prevention and their readiness to use mHealth apps.
mHealth apps	mHealth apps refer to healthcare and public health initiatives that are supported by mobile devices like smartphones, patient monitoring tools, and various wireless devices (Putu et al., 2021)	In this study, the patient's readiness to use mHealth apps will be assessed using the scale developed by (Putu et al., 2021)**.**

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses topics related to the progression prevention of early-stage CKD. It includes the early-stage CKD patients' knowledge, attitude, and practice on CKD progression prevention and their readiness to use the mHealth apps. This chapter also explained the theory that will be used to describe the focus of this study.

2.2 Review of literature

The research used keywords and index terms in the included databases. Altogether, 112 related articles were included in this literature review. Articles used within the last 10 years and in English were considered for this review. The researcher searched various medical databases for articles, including Medline, PubMed, and Google Scholar. The keywords used for article searching are 'early-stage 'CKD,' 'knowledge,' 'attitude,' 'practice,' 'attitude,' 'readiness,' and 'mobile' ' and health applications.'Below is the figure on the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) guidelines (Page et al., 2021).

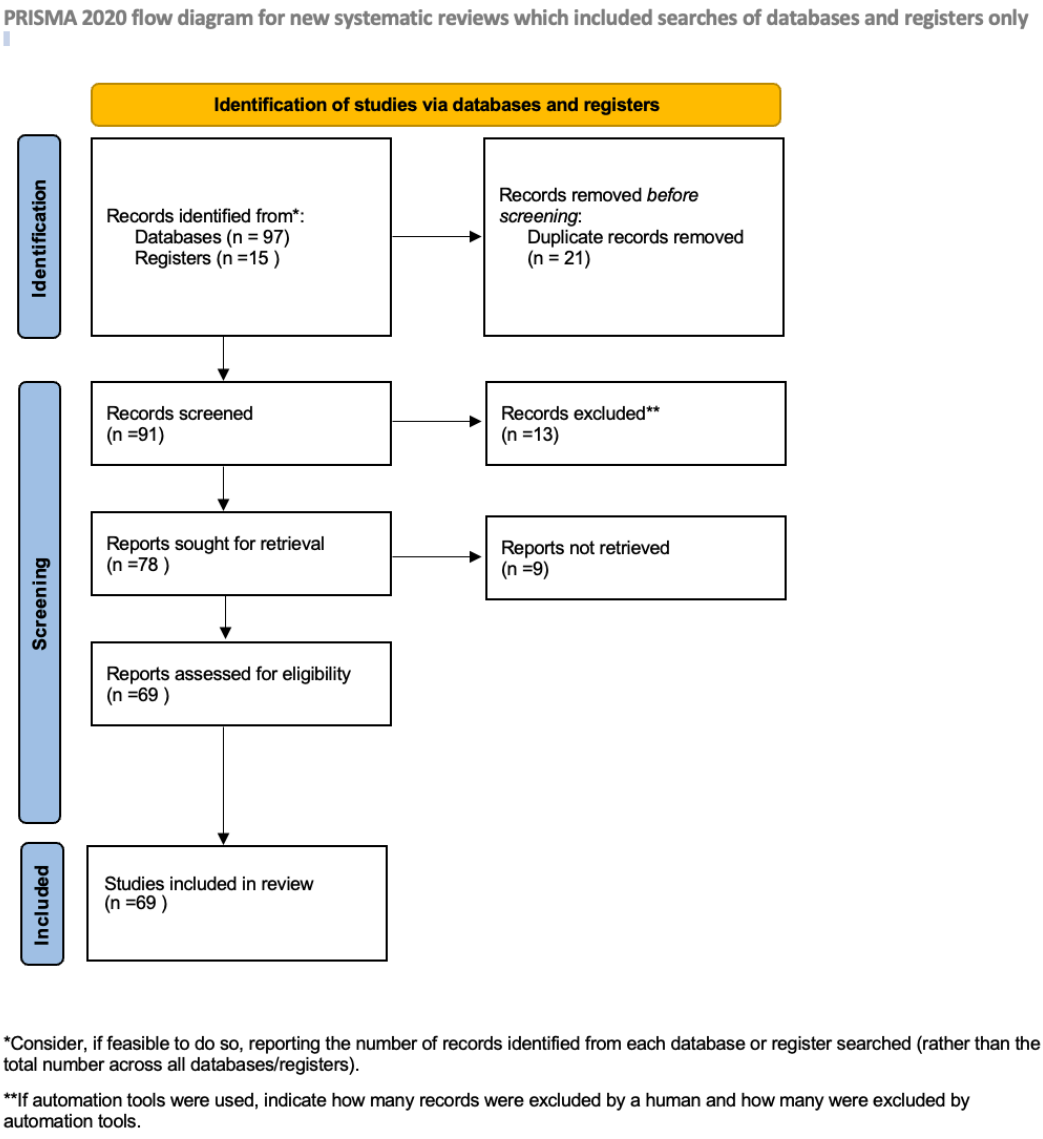

Figure 2.1: PRISMA flow diagram for systematic review. Source: (Page et al., 2021)

2.2.1 Knowledge Towards CKD Progression Prevention

Understanding knowledge in CKD management is crucial. Two studies Heydari et al., (2014) ; Szymona et al., (2016) emphasized the importance of knowledge in CKD management. Heydari et al., (2014) defined knowledge as understanding the disease, its causes, prevention, and treatment. Szymona et al., (2016) highlighted that knowledge influences disease management and treatment outcomes. Knowledge is

crucial because it affects how well patients can manage their condition, potentially impacting disease progression and treatment effectiveness.

There are several influencing factors influencing knowledge (Gheewela et al., 2018) . The factors associated with higher expertise include higher education, better economic status, regular physical activity, family history of kidney failure, and personal history of diabetes mellitus (DM). These factors suggest that socioeconomic and lifestyle variables significantly determine patients' knowledge about CKD. This highlights the need for targeted educational interventions based on these factors.

However, there were several gaps in knowledge and awareness. (Kazley et al., 2014) found that African-American patients had poor knowledge and understanding of CKD, with only 9% of CKD patients being aware of their condition. The group's significant lack of experience is concerning as it hampers effective self-care and disease management. This indicates a need for improved educational outreach and culturally tailored interventions. (Johnston et al., 2016) also found that among 85 respondents with diabetes mellitus, hypertension, and CKD, the average level of knowledge was poor, based on data collected through interviews. The inadequate knowledge level observed could result in suboptimal management and progression of CKD, reinforcing the need for enhanced educational strategies.

There were several similarities and differences in the importance of knowledge. Both Heydari et al., (2014) ; Szymona et al., (2015) emphasize that knowledge is crucial for effective CKD management, aligning with the findings of (Gheewela et al., 2018) regarding the positive impact of higher knowledge levels. All studies underscore the need for better education and awareness as critical components in improving patient outcomes in CKD. However, Gheewela et al., (2018) provide specific factors

associated with higher knowledge, which contrasts with (Kazley et al., (2014) and Johnston et al., (2016) findings of poor knowledge and awareness among specific populations. This highlights a disparity between those with access to resources and education. Kazley et al., (2014) focus on African-American patients, revealing disparities in knowledge within specific racial groups, while Johnston et al., (2016) address a broader group with diabetes and hypertension, showing a general trend of poor knowledge.

In summary, knowledge is critical for managing CKD. Significant gaps exist, particularly among certain demographic groups. These gaps in knowledge can lead to poor disease management and progression. There is a need for enhanced educational strategies tailored to specific populations, including culturally relevant approaches and targeted interventions based on socioeconomic factors. Future research should focus on developing and evaluating such interventions to improve knowledge and patient care. Thus, there is a need for enhanced educational strategies tailored to specific populations, including culturally relevant approaches and targeted interventions based on socioeconomic factors. Future research should focus on developing and evaluating such interventions to improve knowledge and patient care.

2.2.2 Attitude Towards CKD Progression Prevention

Rahaman et al., (2017) defined attitude as the patient's viewpoint or approach to disease management, which can be positive or negative. This study establishes a foundational understanding of how a patient's attitude shapes their approach to managing CKD. A positive attitude could encourage proactive health behaviors, while a negative one could impede the patient's willingness to follow medical advice or engage in self-care. Wang et al., (2016) emphasize that a patient's attitude not only

influences their current disease status but also affects long-term outcomes. This indicates that the attitudes held by patients have a ripple effect, influencing not just short-term treatment success but also the progression of CKD. This underscores the importance of maintaining a positive mindset to effectively manage the chronic nature of CKD. Framingham, (2018) reinforced that a positive attitude improves a patient's health while a negative attitude worsens it. However, the binary view of attitude's impact on health aligns with Wang's findings, emphasizing that fostering positive attitudes can be a crucial part of disease management interventions.

Latif, (2019) suggested that interventions that consider cultural sensitivities can improve patients' attitudes and, consequently, their health outcomes. This introduced a critical dimension: the role of culture in shaping attitudes. By tailoring education and support to specific cultural backgrounds, interventions may be more effective in fostering positive attitudes toward CKD management. Stanifer et al., (2016) found that CKD patients were willing to learn about their condition but faced persistent health and social concerns. This study adds complexity to the discussion by showing that while patients may have a positive attitude toward learning, external factors such as financial strain and social stigma can still negatively affect their overall attitude toward managing their disease.

Both (Framingham, 2016 ; Wang, 2016) agree that a positive attitude is crucial for better health outcomes. This sentiment is supported by Rahaman et al., (2017), who link attitude to effective disease management. Across the studies, there was consensus that attitude plays a pivotal role in managing CKD and the eventual health outcomes, reinforcing the need to address patient attitudes in treatment plans. Stanifer et al., (2016) highlight patients' willingness to learn, which mirrors the emphasis on positive

attitudes in the other studies. Despite challenges, patients are generally open to improving their knowledge and management strategies.

While studies focus on internal factors (e.g., the patient's mindset) and their direct link to health outcomes, Stanifer et al., (2016) highlight external factors, such as economic and social concerns, that can affect attitudes. This introduces a nuanced understanding that attitude alone may not be enough to address economic and social barriers and is also necessary for effective CKD management. Palsson et al., (2019) emphasize the role of culturally tailored interventions in shaping patient attitudes, a factor not extensively covered by the other studies. This suggested that interventions must go beyond generic health education and be adapted to fit the cultural contexts of diverse patient populations.

The studies underscore the critical role of patient attitude in managing CKD, with positive attitudes linked to better outcomes. While a positive attitude is beneficial, it may not be sufficient if external factors such as financial burdens or cultural misunderstandings are not addressed. This highlighted the need for holistic, patient-centered interventions that foster positive attitudes and address these external challenges.

While a positive attitude is widely recognized as crucial for better health outcomes in CKD management, significant external factors—such as economic strain, social stigma, and cultural differences—can hinder patient attitudes and behaviors. Therefore, it is essential to consider these external influences when designing interventions to improve patient attitudes in managing CKD. Future research should focus on developing culturally tailored interventions that address CKD patients' economic and social challenges. These interventions should aim at positive attitudes

and provide practical support to mitigate the barriers patients face in their disease management.

2.2.3 Practice Towards CKD Progression Prevention

Khalil et al., (2014) define practice as the patient's clinical condition and overall disease management, including preventive practices. In Jordan, despite patients having a high level of knowledge, the study found that their preventive practices were often inappropriate or lacking. This discrepancy between knowledge and practice suggests that knowing about CKD does not necessarily translate into appropriate action. The lack of proper preventive measures can seriously affect health outcomes and quality of life, underlining a critical gap in disease management.

Zibran et al., (2018) found that patients do not always possess the three key elements—knowledge, attitude, and practice—together. Some patients might have strong knowledge but a poor attitude or weak practices, while others might lack knowledge but still have good attitudes and practices. This variability highlights the complexity of disease management. It shows that knowing knowledge does not guarantee positive attitudes or correct practices, and vice versa. It suggests that each element (knowledge, attitude, practice) must be addressed separately, as improving one does not automatically lead to improvements in the others.

(Khalil et al., 2014; Zibran et al., 2018) highlighted the gap between knowledge and practice. Khalil et al., (2014) found that patients with high knowledge still engaged in poor preventive practices, while Zibran et al., (2018) found that patients might have one or two elements (knowledge, attitude, practice) but not all three. Both studies suggest that a failure to adopt appropriate preventive practices can negatively impact

patient health and quality of life, regardless of their knowledge level. Khalil et al., (2014) focus on the gap between knowledge and practice, particularly preventive practices in CKD management. In contrast, Zibran et al., (2018) provide a broader view, highlighting the variability in how knowledge, attitude, and practice interact. They point out that patients may have different strengths and weaknesses across these three areas Khalil et al., (2014) suggest that improving practice is the key to better outcomes for patients who already possess knowledge. However, Zibran et al., (2018) imply that a more holistic approach is necessary, as patients might require different types of support depending on which area (knowledge, attitude, or practice) they lack.

The findings from (Khalil et al., 2014; Zibran et al., 2018) highlighted an essential disconnect between knowledge, attitude, and practice in CKD management. Both studies agree that knowledge alone is insufficient to ensure proper disease management. In Jordan, as seen in Khalil et al., (2014), even with high levels of knowledge, patients often fail to implement appropriate preventive practices, which is troubling because it endangers their health and quality of life. Zibran et al., (2018) take this observation further, suggesting that the relationship between knowledge, attitude, and practice is more complex than initially thought. Their study indicates that a good attitude does not necessarily result in good practices, and poor knowledge does not always mean lousy practice or attitude. This variability complicates efforts to improve CKD management, as interventions are tailored to address the specific element (knowledge, attitude, or practice) that patients lack.