THE RELATIONSHIP BETWEEN MICRONUTRIENTS INTAKE (VITAMINS AND MINERALS), BODY MASS INDEX (BMI), AND DEPRESSIVE SYMPTOMS AMONG PRE-DIALYSIS CHRONIC KIDNEY DISEASE (CKD) PATIENTS IN HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (HPUSM).

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UNIVERSITI SAINS MALAYSIA

2026

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By

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Dissertation submitted in partial fulfillment of the requirements for the degree of Bachelor of Health Sciences (Honours) (Dietetics)

June 2026

ACKNOWLEDGMENT

In the name of Allah, the Most Gracious, the Most Merciful.

First and foremost, I would like to express my deepest gratitude to Allah SWT for granting me the strength, patience, and perseverance to successfully complete this final year project.

I would like to extend my sincere appreciation to my supervisor, Dr. Divya Vanoh, for her guidance, continuous support, valuable advice, and encouragement throughout the completion of this study. Her knowledge, patience, and constructive feedback have greatly contributed to the success of this research.

I would also like to express my heartfelt gratitude to all lecturers in the Dietetics Programme, School of Health Sciences, Universiti Sains Malaysia, for sharing their knowledge and providing guidance throughout my academic journey.

My special thanks go to the staff of Hospital Pakar Universiti Sains Malaysia (HPUSM), especially the doctors, nurses, and clinic personnel who assisted me during the data collection process. Their cooperation and support made this study possible.

I would also like to express my sincere appreciation to Amalin, who provided tremendous assistance throughout the data collection process. Her willingness to help, continuous support, and encouragement greatly eased many challenges encountered during this study. I am truly grateful for her contribution and kindness.

My heartfelt thanks also go to my closest friends, Filzah, Ainin Athirah, Nur Adibah and Nur Hanisya, for their unwavering support, encouragement, and motivation throughout the data collection period and the completion of this research. Their friendship, understanding, and constant words of encouragement gave me the strength to persevere during difficult times.

I would also like to thank all the respondents who willingly participated in this

study. Their time, cooperation, and valuable contributions are greatly appreciated.

Finally, I would like to express my deepest gratitude to my beloved parents, and Mohd Hadif for their unconditional love, prayers, understanding, and endless support. Their encouragement has always been my source of strength and inspiration.

Thank you to everyone who has directly or indirectly contributed to the completion of this study. May Allah SWT bless all of you for your kindness, generosity, and support.

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LIST OF ABBREVIATION

USM	Universiti Sains Malaysia
HPUSM	Hospital Pakar Universiti Sains Malaysia
KRK	Klinik Rawatan Keluarga
KPP	Klinik Pakar Perubatan
IQR	Interquartile
SD	Standard Deviation
RM	Ringgit Malaysia
BMI	Body Mass Index

HUBUNGAN ANTARA PENGAMBILAN MIKRONUTRIEN (VITAMIN DAN MINERAL), INDEKS JISIM BADAN (BMI), DAN GEJALA KEMURUNGAN DALAM PESAKIT PENYAKIT BUAH PINGGANG KRONIK (CKD) PRA-DIALISIS DI HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (HPUSM)

ABSTRAK

Penyakit Buah Pinggang Kronik (CKD) merupakan masalah kesihatan global yang semakin meningkat dan sering disertai dengan pelbagai komplikasi fizikal dan psikologi, termasuk kemurungan. Kajian ini bertujuan untuk mengkaji hubungan antara pengambilan mikronutrien, Indeks Jisim Badan (Body Mass Index, BMI), dan gejala kemurungan dalam kalangan pesakit CKD pradialisis di Hospital Pakar Universiti Sains Malaysia (HPUSM). Kajian keratan rentas telah dijalankan terhadap 90 orang pesakit CKD pradialisis yang memenuhi kriteria kemasukan kajian dan direkrut menggunakan kaedah persampelan mudah. Data dikumpulkan melalui temu bual bersemuka menggunakan soal selidik sosiodemografi dan sejarah perubatan, Patient Health Questionnaire-9 (PHQ-9), pengukuran antropometri, serta rekod pemakanan 24 jam. Data dianalisis menggunakan Statistical Package for the Social Sciences (SPSS) versi 30.

Hasil kajian menunjukkan bahawa hampir separuh daripada responden (45.6%) berada dalam kategori kurang berat badan. Majoriti responden mengalami gejala kemurungan pada tahap minimum (38.9%) atau ringan (34.4%). Secara keseluruhannya, pengambilan kebanyakan vitamin dan mineral adalah di bawah tahap Saranan Pengambilan Nutrien

(Recommended Nutrient Intake, RNI) Malaysia, menunjukkan pengambilan mikronutrien yang tidak mencukupi dalam kalangan populasi kajian. Responden yang mengalami gejala kemurungan minimum mempunyai pengambilan beberapa jenis vitamin yang lebih tinggi secara signifikan, termasuk vitamin A, beta-karotena, alfa-tokoferol, riboflavin, niasin, vitamin B6 dan folat ($p < 0.05$), berbanding responden yang mengalami gejala kemurungan ringan. Sebaliknya, pengambilan natrium, kalium, zat besi, kalsium, magnesium dan zink adalah lebih tinggi secara signifikan dalam kalangan responden yang mengalami gejala kemurungan ringan berbanding responden tanpa gejala kemurungan ($p < 0.05$). Walau bagaimanapun, BMI tidak menunjukkan hubungan yang signifikan dengan gejala kemurungan ($p = 0.140$).

Kesimpulannya, pengambilan mikronutrien yang tidak mencukupi merupakan keadaan yang biasa berlaku dalam kalangan pesakit CKD praradialisis. Dapatan kajian ini menunjukkan bahawa pengambilan mikronutrien tertentu mempunyai hubungan yang signifikan dengan tahap gejala kemurungan, manakala BMI tidak menunjukkan hubungan yang signifikan dengan gejala kemurungan dalam populasi kajian.

THE RELATIONSHIP BETWEEN MICRONUTRIENTS INTAKE (VITAMINS AND MINERALS), BODY MASS INDEX (BMI), AND DEPRESSIVE SYMPTOMS AMONG PRE-DIALYSIS CHRONIC KIDNEY DISEASE (CKD) PATIENTS IN HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (HPUSM).

ABSTRACT

Chronic Kidney Disease (CKD) is a growing global health problem that is often accompanied by various physical and psychological complications, including depression. This study aimed to examine the association between micronutrient intake, Body Mass Index (BMI), and depressive symptoms among pre-dialysis CKD patients at Hospital Pakar Universiti Sains Malaysia (HPUSM). A cross-sectional study was conducted among 90 pre-dialysis CKD patients who met the study inclusion criteria and were recruited using convenience sampling. Data were collected through face-to-face interviews using a sociodemographic and medical history questionnaire, the Patient Health Questionnaire-9 (PHQ-9), anthropometric measurements, and a 24-hour dietary recall. The data were analysed using Statistical Package for Social Sciences (SPSS) version 30. The results showed that nearly half of the respondents (45.6%) were underweight. Most respondents reported either minimal (38.9%) or mild (34.4%) depressive symptoms. Overall, the intake of most vitamins and minerals were below the Malaysian Recommended Nutrient Intake (RNI) levels, indicating suboptimal micronutrient consumption among the study population. Participants with minimal depressive symptoms had significantly higher intake for several vitamins, including vitamin A, beta-carotene, alpha-tocopherol, riboflavin, niacin, vitamin B6, and folate ($p < 0.05$) as compared to those with mild depressive symptoms. On the other hand, sodium, potassium, iron, calcium, magnesium, and zinc were significantly higher among

those with mild depressive symptoms as compared to those who were normal ($p<0.05$). Similarly, BMI was not significantly associated with depressive symptoms ($p = 0.140$). In conclusion, inadequate micronutrient intake was common among pre-dialysis CKD

patients in HPUSM, although neither micronutrient intake nor BMI was significantly related to depressive symptoms. Further studies involving larger sample sizes and longitudinal designs are needed to provide a better understanding of these relationships.

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Chronic kidney disease (CKD) is defined based on the presence of kidney damage or a glomerular filtration rate (GFR) lower than 60 mL/min/1.73m² for 3 months (Kidney Int Supply, 2011). Based on the National Action Plan for Healthy Kidneys (ACT-KID), chronic kidney disease (CKD) can also be defined as a chronic condition influenced by lifestyle and behavior. CKD is marked by long-term, irreversible loss of kidney function. The effect of this malfunction is a change in the body's chemical balance, the disruption of essential bodily processes, and the buildup of waste products in the blood resulting in damage to the body's organs and systems. Chronic kidney disease was divided into five stages based on the level of GFR. According to the National Action Plan for Healthy Kidneys (ACT-KID), in the first stage of CKD, the kidney is damaging. However, it is symptomless due to no decrease in GFR. Stage 2 of CKD shows some reduction in GFR, high blood pressure and possible dysfunction of other organs. Stage 3 of CKD shows a significant decrease in GFR, with increasing levels of urea and creatinine in the blood, and dysfunction in different organs. However, it is typically symptomless. Stage 4 of CKD shows severely reduced kidney function, high levels of urea and creatinine in blood, dysfunction in other organs, and mild symptoms. The last stage of CKD, the kidneys function no longer adequately to sustain life, with a range of symptoms and abnormalities affecting multiple of organs. In the early stage of CKD, patients are often asymptomatic. However, some patients may experience fatigue, muscle cramps, nausea, itchy skin, headaches, and loss of appetite. In the later stages of CKD, patients are more likely to develop complications, which may include cardiovascular disease, bone and muscle problems, sleep apnoea, and anaemia. There is no cure for CKD however, the disease can

be prevented and treated either in slow progression or stopped. Kidney replacement therapy, such as dialysis or transplant, is necessary in end-stage renal disease (ESRD), in which the kidneys are no longer functioning well to sustain life.

A study conducted by The National Health and Morbidity Survey (NHMS) shows that the prevalence of CKD in Malaysia increasde from 9.07% in 2011 to 15.48% in 2018 (Saminathan et al., 2020). A cross-sectional study was conducted by Saminathan et al. (2020) in Malaysia. The study, conducted between September 2017 and June 2018, reported that the estimated prevalence of CKD was 3.85% in stage 1, 4.82% in stage 2, 6.48% in stage 3, and 0.33% in stages 4 and 5. Moreover, the incidence of end-stage renal disease requiring dialysis in Malaysia has risen significantly, increasing from 96 per million population in 2002 to 216 cases per million in 2016 (Saminathan et al., 2020). Most individuals are often unaware of having impaired kidney function, kidney diseases typically progress silently without obvious symptoms in the early stages. Moreover, Acute Kidney Injury (AKI) experienced by13.3 million people each year may resolve or lead to CKD or kidney failure in the future. In 2017, there were approximately 697.5 million reported cases of CKD across all stages, representing a global prevalence of 9.1%. Compared to 1990, the overall prevalence of CKD worldwide had risen by 29.3%. That same year, CKD was responsible for 1.2 million deaths, with global all-age mortality increasing by 41.5% between 1990 and 2017 (Deng et al., 2025).

A clear understanding of what causes CKD is vital. At present, diabetes mellitus is the primary cause of CKD, with nearly 40% of patients with either type 1 or type 2 diabetes progressing to CKD worldwide (Tang et al., 2022). Hypertension is also an increasing global health issue, driven mainly by rising obesity rates and an aging population. It is well established as both a risk factor and a cause of kidney dysfunction as well as cardiovascular disease (Ren et al., 2021). In diabetic patients, prolonged

hyperglycemia can damage the microvasculature, which consists of arterioles, venules, and capillaries, crucial for regulating blood flow and nutrient exchange between blood and tissues (Cook et al., 2022). These structural changes include the glomerular capillaries as well as the afferent and efferent arterioles (Cook et al., 2022). Over time, this damage may lead to the thickening of the glomerular capillary walls due to protein and antibody deposition, resulting in glomerulosclerosis (Cook et al., 2022). Acute kidney injury (AKI) is also a major cause of CKD. Patients who have previously experienced AKI are at greater risk of recurrent episodes that can lead to the development of CKD (Meersch et al., 2017).

Micronutrient deficiency occurs due to low dietary intake and poor diet quality, particularly when the diet lacks fruits and vegetables. Fruits and vegetables are major sources of essential vitamins and minerals such as vitamin C, folate, potassium, and antioxidants. When these foods are consumed infrequently or not at all, the body fails to meet its micronutrient requirements, increasing the risk of deficiencies over time. Deficiency of micronutrients is associated with more rapid progression of CKD (Annals et al., 2023). Micronutrients, which consist of vitamins and minerals, are essential for maintaining normal human physiology (Annals et al., 2023). High intake of several micronutrients, including vitamins C, E, D, cobalamin, folate, magnesium, and potassium, was associated with a decreased risk. In contrast, sodium was associated with an increased risk of incident CKD (Farhadnejad et al., 2016). Of minerals, higher intakes of potassium and magnesium were significantly associated with lower risk of incident CKD. Patients with the highest intakes of potassium and magnesium had lower odds of incident CKD, compared to those with the lowest intake of potassium and magnesium (Farhadnejad et al., 2016).

Depression can develop when a person is constantly thinking about their illness,

feeling tired of repeated hospital visits, and worrying about their health. Over time, this ongoing stress and fear can affect their emotions and make them feel low, anxious, and mentally exhausted. Depression, or depressive disorder, is a common mental disorder. It involves a depressed mood or loss of pleasure or interest in activities for long periods of time (World Health Organization, 2023). Depression is also commonly observed among adults with end- stage renal disease (ESRD) due to the psychosocial and biologic changes that are associated with dialysis (Shirazian et al., 2017). In addition, it is reported that depression was commonly observed among patients with pre-dialysis CKD (Lee et al., 2013). Patients with CKD who are not undergoing dialysis experience depression at rates up to three times greater than those in the general population (Shirazian et al., 2017). The presence of major depressive episodes in patients with CKD generally results in a higher risk of hospitalization and progression of the disease to end-stage renal disease (ESRD) (Hedayati et al., 2010).

In addition, body mass index (BMI) is one of the anthropometric measurements related to CKD. BMI is defined as a measurement of a person's weight with respect to his or her height. In stage 3–5 CKD, being underweight was associated with a higher risk of death and being overweight or obese class I was associated with a lower risk of death. However, being obese class II or III was not associated with a different risk of death (Ahmadi et al., 2015).

1.2 Problem Statement

According to the Ministry of Health Malaysia, CKD is a common but silent and often under-recognised condition. However, 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 aging population. CKD is one of the strongest risk factors that leads to mortality. If CKD is detected early and managed appropriately, the deterioration in kidney function can be reduced by as much as 50% (Ministry of Health Malaysia, 2018). Even though much research has been performed on the incidence and prevalence of CKD, limited studies have been conducted to measure the knowledge and awareness among the general population and students (Sowtali et al., 2019).

There are several risks associated with CKD. One of the risks is high sodium. In a study conducted in Poland that evaluated the dietary intake of non-dialysis female CKD patients by means of a three-day food record, the intake was lower than in the present study for all micronutrients except for vitamin A, vitamin E, and pyridoxine (Machado et al., 2018). In three large American cohort studies (MDRD, CRIC, and NHANES III), high phosphorus intake was observed, as in the present study, in which an amount of 1184 mg was recorded, almost 60% above the recommended amount (Machado et al., 2018). However, in the present study, the sodium intake was lower than in those studies, and the potassium intake was slightly higher (Machado et al., 2018).

In addition to micronutrients, BMI is also a crucial parameter. Patients with stage 3–5 CKD have a differential association between obesity classes I–III and mortality as compared to the general population, indicating an obesity paradox in the CKD population (Ahmadi et al., 2015).

Other researchers have also found that a higher BMI is associated with better survival in non-dialysis-dependent CKD patients (Lin et al., 2018). Moreover, depressive

symptoms could also lead to having CKD. One study shows that participants with non-dialysis CKD reported end-stage renal disease and deaths. High depressive symptoms increased the risk of progression to end- stage renal disease or death and the risk of first hospitalization (Zhang et al.,2024).

1.3 Research Question

I. What is the mean micronutrient (vitamin and mineral) intake among Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

II. What is the proportion of Body Mass Index (BMI) among Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

III. What is the level of depressive symptoms among Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

IV. Is there a differences in mean micronutrient intake across levels of depressive symptoms among Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

V. Is there an association between Body Mass Index (BMI) and depressive symptoms among Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

1.4 Research Objective

1.4.1 General Objectives

To determine the relationship between micronutrients (vitamins and minerals), Body Mass Index (BMI), and depressive symptoms among Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

1.4.2 Specific Objectives

I. To determine the mean micronutrient intake among Pre-Dialysis Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).
II. To determine the mean Body Mass Index (BMI) among Pre-Dialysis Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).
III. To assess the level of depressive symptoms among Pre-Dialysis Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).
IV. To compare the mean micronutrient intake across different levels of depressive symptoms among Pre-Dialysis Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).
V. To determine the association between Body Mass Index (BMI) and depressive symptoms among Pre-Dialysis Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

1.5 Research Hypothesis

1.5.1 Null hypothesis (Ho)

I. There is no significant difference in mean micronutrient intake across different levels of depressive symptoms among Pre-Dialysis Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

II. There is no association between Body Mass Index (BMI) and depressive symptoms among Pre-Dialysis Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

1.5.2 Alternative hypothesis (HA)

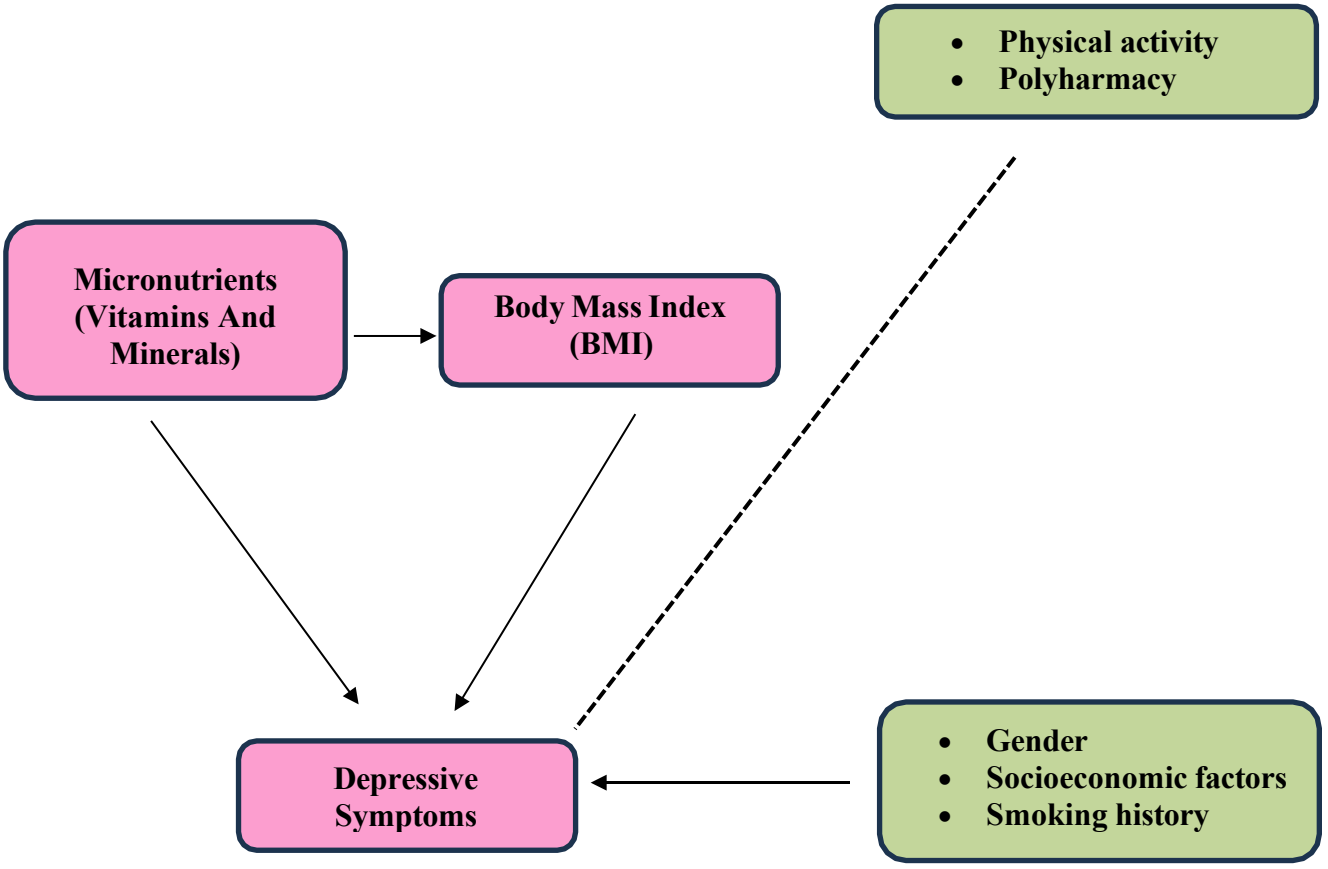
i. There is a significant difference in mean micronutrient intake across at least one level of depressive symptoms among Pre-Dialysis Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

ii. There is an association between Body Mass Index (BMI) and depressive symptoms among Pre-Dialysis Chronic Kidney Disease (CKD) patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

1.6 Justification of study

Chronic kidney disease (CKD) is a global public health issue with significant morbidity and mortality (Zhang et al., 2024). Depressive symptoms are highly prevalent among CKD patients, and this can worsen disease progression, reduce treatment adherence, and negatively impact quality of life. Nutritional status, particularly micronutrient intake and body composition, plays a crucial role in mental health. Deficiencies in essential vitamins and minerals have been linked to impaired neurotransmitter function and increased risk of depressive symptoms. At the same time, abnormal body mass index (BMI), whether underweight or overweight, may further complicate the health status of CKD patients and is associated with increased morbidity and mortality. Nevertheless, limited research has been done in Malaysia to investigate the relationship between BMI, depression symptoms, and micronutrient among CKD patients. Instead of examining how these elements relate to one another, the majority of current research tends to study each individual factors separately. Thus, by assessing how anthropometric and dietary factors affect the psychological well-being of CKD patients at Hospital Pakar Universiti Sains Malaysia (HPUSM), this study fills a knowledge gap.

1.7 Conceptual Framework



Chronic kidney disease (CKD) occurs when the kidneys have become damaged over time (for at least 3 months) and are unable to perform all their essential functions (National Kidney Foundation, 2023). Micronutrient deficiency can contribute to depressive symptoms in people with non-dialysis CKD by affecting both brain function and overall physical health. Low levels of vitamin D and B-group vitamins can interfere with neurotransmitters such as serotonin and dopamine and increase inflammation, which may lead to low mood and emotional distress. In addition, mineral problems such as iron deficiency, low zinc or magnesium, and disturbed calcium–phosphorus balance can cause fatigue and chronic inflammation, further increasing the risk of depression in CKD patients.

Vitamin B12 deficiency causes neurological dysfunction, mood disorders, cognitive decline, and psychotic symptoms, especially in the elderly (Baik, 2024). Zinc deficiency affects neurotransmitters, neurogenesis, and antioxidant function, contributing to depression, anxiety, and cognitive impairment (Baik, 2024). Vitamin D deficiency is linked to depression, anxiety, and cognitive decline. Vitamin D enhances serotonin synthesis, has anti- inflammatory and neuroprotective effects, and regulates the hypothalamic-pituitary-adrenal axis and circadian rhythms (Baik, 2024). Moreover, iron deficiency is common in CKD due to impaired erythropoiesis and chronic inflammation and has been shown to associate with higher rates of depression in non-dialysis CKD in stages 2–4 patients. In one study, iron deficiency anemia correlated with both depressive and anxiety symptoms in CKD (Genc et al., 2023). Also, iron-deficiency anemia has been shown to increase the risk of psychiatric disorders, including depression, underscoring a mechanistic role of iron in neurotransmitter metabolism, myelination, and mood regulation (Lee et al., 2020). Another important aspect is phosphate imbalance, in which increased serum phosphate

levels have been linked to oxidative stress, inflammation, and mood disorders such as depression and cognitive decline (Rroji et al., 2022).

Electrolyte imbalances, particularly sodium and potassium, are also relevant in chronic kidney disease. While their direct relationship with depression in CKD has not been fully explored, disturbances in these electrolytes can affect brain function by influencing nerve signaling, blood flow, and overall neuronal activity, which may indirectly contribute to mood changes or depressive symptoms (Korgaonkar et al., 2010).

On the other hand, BMI, whether underweight due to malnutrition or overweight or obese due to excess adiposity, may influence mental health. Active agents of antipsychotics act on neural pathways by modulating their activity. Therefore, weight gain

may be due to the blockade of specific receptors, which has an impact on regulatory mechanisms of appetite and body weight (Rindler et al., 2023). Both antidepressants and antipsychotic medications can cause increased BMI levels and may further lead to a greater cardiovascular risk, indicating an exponential rise in BMI scores and metabolic risk (Rindler et al., 2023). This conceptual framework underscores the importance of examining modifiable nutritional and anthropometric factors in relation to depressive symptoms in CKD. By focusing on micronutrient deficiencies and BMI, the study aims to highlight potentially preventable or manageable contributors to poor mental health outcomes in non-dialysis CKD patients at HPUSM.

CHAPTER 2

LITERATURE REVIEW

2.1 Prevalence of Chronic Kidney Disease (CKD) in Malaysia

Chronic kidney disease (CKD) represents an increasing public health concern in Malaysia and globally, characterised by a rising prevalence within communities and significant implications for pre-dialysis management and preventative strategies. Recent national surveys of Malaysia indicate that CKD prevalence has increased from 9.07% in 2011 to 15.48% in 2018. When examined according to disease staging, 3.85% of adults were found to have stage 1 CKD, 4.82% were in stage 2, and 6.48% were in stage 3, while more advanced forms of CKD were less prevalent, with 0.25% in stage 4 and 0.08% in stage 5 (Saminathan et al., 2020). The principal associated risk factors were hypertension, diabetes mellitus, increasing body mass index, and increasing age. According to these data, Malaysia is one of the nations with the highest prevalence of CKD in the pre-dialysis stage. They also emphasise the importance of early screening, risk factor management, and treatment pathways in preventing the illness from progressing to a more severe state.

In a global context, systematic reviews and meta-analyses show CKD is common globally, though variation exists across regions and study methods. A major meta-analysis of 100 general-population studies estimated the global adult prevalence for all CKD stages at approximately 13.4% and for stages 3–5 at approximately 10.6% (Hill et al., 2016). According to the more recent Global Burden of Disease Study 2021, there were approximately 673.7 million cases of chronic kidney disease (CKD) globally in 2021, with an age-standardized prevalence rate of around 8,006 per 100,000 people (Guo et al., 2025). Global statistics demonstrate that CKD is not only prevalent but also growing in terms of the total number of individuals affected.

Moreover, screening for CKD is a cost-effective approach, particularly among

individuals with diabetes mellitus (DM) and hypertension, as well as within the general population. Recognizing this, the Malaysian government has introduced the National Action Plan for Healthy Kidneys (ACT-KID 2018- 2025) to strengthen prevention, early detection, and management of CKD, aiming to reduce its growing burden on both individuals and the healthcare system.

In conclusion, the studies above indicate that pre-dialysis chronic kidney disease (CKD) is common throughout the world, particularly in Malaysia. To slow the development of end- stage renal disease, these results make a compelling case for preventative measures, increased awareness, and mechanisms to identify CKD early and control modifiable risk factors.

2.2 Risk Factors of Chronic Kidney Disease (CKD)

Chronic kidney disease arises from a mixture of well-established medical conditions, demographic traits, and environmental exposures that together determine individual and population risk. According to findings, diabetes mellitus and hypertension are the two leading causes of chronic kidney disease (CKD), accounting for 50.62% and 23.26% of cases worldwide, respectively (Wang et al., 2019).

Diabetes is a major microvascular complication of both type 1 and type 2 diabetes. It is characterised by injury to both glomerular and tubular compartments, leading to kidney dysfunction over time. It is one of the most common causes of chronic kidney disease (CKD) and end-stage renal disease (ESRD). Persistent high blood glucose levels can damage the small blood vessels in the kidneys, impairing their ability to filter waste and fluids from the blood effectively (Hoogeveen, 2022). Moreover, blood sugar levels rise when diabetes is poorly managed. This is known to this as hyperglycemia. Numerous body components, including the kidneys, heart, blood vessels, eyes, feet, and nerves, can be harmed by hyperglycemia, which is high blood sugar (National Kidney Foundation, 2023).

Secondary hypertension is often caused by chronic kidney disease (CKD) (Campese et al., 2006). The increase in systemic blood pressure (BP) accelerates the rate at which the glomerular filtration rate (GFR) decreases for any cause of chronic kidney disease (CKD), including hypertension (Ku et al., 2019). High consumption of sugary drinks or sodas has been demonstrated to be associated with the incidence of albuminuria, CKD, and faster GFR decline in the community (Rysz et al., 2017).

Chronic kidney disease (CKD) develops and progresses under the influence of multiple risk factors, and identifying these is critical in non-dialysis patients across all CKD stages. Non- modifiable risk factors are those that cannot be changed but still play a

significant role in the likelihood of developing CKD. One of the strongest predictors is age, as kidney function naturally declines with time, and the risk of CKD becomes much higher after the age of 60. A family history of kidney disease or kidney failure also increases risk, showing that genetic background and shared household factors may contribute to the disease. Additionally, lifestyle choices such as smoking or tobacco use further worsen kidney damage by harming blood vessels and speeding up disease progression (National Kidney Foundation, 2023).

The risk of drug-induced nephrotoxicity is increased by several factors, including the inherent nephrotoxicity of medications, underlying patient characteristics that increase their risk of kidney injury, and the metabolism and excretion pathways of the various compounds supplied by the kidneys (Perazella, 2018). It leads to chronic kidney disease (CKD) in both individuals and communities when consumption is excessive or uncontrolled. In specific subgroups, CKD is also brought on by structural problems of the urinary system and infectious and inflammatory diseases such as glomerulonephritis and chronic hepatitis (Perazella, 2018).

A poor-quality diet that is high in added sugar is increasingly recognised as an important risk factor for chronic kidney disease (CKD). A study conducted by Kretowicz et al., (2011), shows that excessive fructose intake increases uric acid and oxidative stress, which can damage kidney tubules and elevate glomerular pressure. Moreover, regular consumption of sugar-sweetened beverages, such as sodas, sweetened fruit drinks, and energy drinks, along with desserts like cakes, candies, and pastries made with sucrose or high-fructose corn syrup, can gradually lead to obesity, high blood pressure, and insulin resistance. These conditions place extra stress on the kidneys and contribute to long-term kidney injury. (Kretowicz et al., 2011). A large United Kingdom cohort study shows that drinking more than one serving of sugar- sweetened beverages per day is associated with

about a nineteen percent higher risk of developing CKD (Ga Young Heo et al., 2024). Therefore, reducing consumption of sugary drinks and processed sweets is a practical strategy to lower the risk of CKD.

The increased burden of pre-dialysis chronic kidney disease (CKD) in Malaysia has been related mainly to the rising prevalence of diabetes, hypertension, and obesity. This highlights the importance of identifying primary care needs and addressing risk factors. Overall, CKD in its early stages is often the result of a combination of unavoidable risks, such as age and genetics, along with modifiable health conditions and lifestyle factors that can be improved. This shows why prevention and early management are so important, especially for people living with diabetes, hypertension, obesity, or a strong family history of kidney disease (Saminathan et al., 2020).

2.3 Micronutrients Intake among Chronic Kidney Disease (CKD)

Micronutrients play a crucial role in the development and progression of chronic kidney disease (CKD), with evidence indicating both protective and risk-enhancing effects depending on their intake levels. Studies have demonstrated that imbalanced consumption of certain micronutrients influences the risk of developing advanced stages of CKD. For example, low dietary phosphorus, which is <400 mg/day and vitamin B2 (<0.7 mg/day) intake, alongside high intake of vitamin B6 (≥1.6 mg/day) and vitamin C (≥100 mg/day), significantly increase the risk of CKD stage 3B or worse (Lee et al., 2021). Additionally, insufficient folate intake (<100 μg/day) has been linked to a higher risk of renal decline. Conversely, other micronutrients, such as folate, cobalamin (vitamin B12), vitamin D, vitamin E, magnesium, and potassium, have shown protective associations, where higher intake correlates with reduced incidence of CKD (Farhadnejad et al., 2016). Notably, excessive sodium intake raises CKD risk, emphasizing the need for balanced mineral consumption.

A high dietary sodium intake is a precise and modifiable risk factor for chronic kidney disease. Excess sodium raises blood volume and blood pressure, which, over time, damages the small vessels in the kidney and accelerates loss of kidney function (Levin et al., 2024). In people with existing kidney disease, too much sodium worsens fluid retention and proteinuria and can reduce the effectiveness of blood pressure medicines, driving faster progression to advanced disease (Borrelli et al., 2020). Randomized trials and pooled analyses show that lowering sodium reduces blood pressure and is associated with fewer adverse renal events, supporting sodium reduction as a practical clinical strategy (Shi et al., 2022). As kidney function declines, potassium may accumulate in the blood, leading to hyperkalaemia. High potassium levels can cause muscle weakness and dangerous heart rhythm problems, so dietary potassium often needs to be monitored or

restricted in moderate to advanced CKD. (Simon et al., 2023). Phosphate excretion is also reduced in CKD, causing hyperphosphataemia. Elevated phosphate can trigger secondary hyperparathyroidism, bone disease, vascular calcification, and increased cardiovascular risk. Therefore, controlling phosphate intake through diet and, if needed, phosphate binders is important in CKD management (Goyal & Jialal, 2023). Therefore, reducing processed and restaurant foods, cured meats, instant noodles, and salty snacks, which are familiar sources of excess sodium, can help reduce the risk of CKD.

Micronutrient deficiencies are frequently observed in CKD patients due to impaired kidney function, altered metabolism, and dietary restrictions, making supplementation a critical part of management (Juszczak et al., 2023). For example, vitamin D supplementation is often necessary as dysfunctional kidneys cannot convert it to its active form, which is vital for calcium and phosphorus metabolism (Levo, 2022). Iron and B vitamins help manage anemia, commonly associated with CKD. Overall, these findings underscore the importance of tailored nutritional guidelines that target micronutrient intake to prevent the onset of CKD and slow its progression, thereby designing interventions that balance necessity and the avoidance of excess to optimize renal health outcomes.

2.4 Body Mass Index (BMI) among Chronic Kidney Disease (CKD)

The association between Body Mass Index (BMI) and Chronic Kidney Disease (CKD) has gained significant attention in medical research due to the rising prevalence of obesity and CKD globally. BMI, as a widely used indicator of body fatness, is calculated by dividing a person's weight in kilograms by the square of their height in meters (Misra & Dhurandhar, 2019). Obesity increases the risk of developing major risk factors for chronic kidney disease (CKD), like diabetes and hypertension, and it has a direct impact on the development of CKD (Kovesdy et al., 2017). It is crucial to understand the relationship in order to implement early intervention and management methods that reduce the CKD burden. Generally, this association demonstrates a U-shaped pattern, where individuals with a BMI within the normal range have the lowest risk of developing CKD (Lu et al., 2014).

A large prospective cohort study conducted in England involving more than 1.4 million adults found a strong positive association between higher BMI and the risk of advanced CKD. Compared to individuals within the normal BMI range (20–<25 kg/m²), the risk of developing CKD stages 4–5 increased by 34% among those who were overweight (25–<30 kg/m²), almost doubled among those with moderate obesity (30–<35 kg/m²) and tripled among individuals with severe obesity (≥35 kg/m²) (Herrington et al., 2017). The findings remained even after controlling other risk factors like diabetes, hypertension, and cardiovascular disease, indicating that kidney damage is directly caused by excess body fat through mechanisms like glomerular hyperfiltration, chronic inflammation, and metabolic overload. It iss interesting to note that individuals with extremely low BMIs (less than 20 kg/m²) also showed a slightly higher risk of chronic kidney disease (CKD), which the authors linked to frailty and malnutrition that could impair renal resilience.

The association of BMI to the development of CKD is further supported by data from an Asian population. Overweight and obese patients frequently had hypertension and diabetes. In contrast, underweight patients (<18.5 kg/m2) were more likely to have comorbid conditions like cancer and general frailty, according to multicenter cohort research conducted in Taiwan among 4,022 people with chronic kidney disease (Chang et al., 2018). The study observed that the underweight group showed the highest proportion of eGFR decline (25%). However, after controlling for confounders, the statistical significance diminished. This indicates that BMI interacts closely with other metabolic and clinical variables in influencing kidney function rather than acting as an isolated factor. Therefore, while obesity remains a key risk factor for CKD onset, low BMI may also represent a state of vulnerability due to poor nutritional and physiological status.

Obesity is a key feature of metabolic syndrome, which is characterized by a group of cardiovascular risk factors, including central obesity, dyslipidemia, hypertension, and hyperglycemia (Yim & Yoo, 2021). Excessive lipid accumulation in non-adipose tissues leads to the formation of toxic lipid metabolites, including diacylglycerols and ceramides. These bioactive compounds disrupt normal cellular processes by inducing mitochondrial dysfunction, endoplasmic reticulum stress, and apoptotic cell death, which collectively contribute to renal injury and functional decline (Hall et al., 2014). It is also linked with comorbidities like hypertension, type 2 diabetes, and metabolic syndrome, which independently increase CKD risk and exacerbate renal impairment. Bariatric surgery has been shown to reduce proteinuria and reverse hyperfiltration in obese people with conserved kidney function (Ardiles, 2023).

In summary, a high BMI is closely associated with a greater risk of developing CKD through multiple mechanisms, including hemodynamic strain, metabolic

disturbances, and inflammatory responses. Prompt intervention in obesity is crucial to slowing down the progression of CKD.

2.5 Depressive symptoms among Chronic Kidney Disease (CKD)

The association between depressive symptoms and Chronic Kidney Disease (CKD) is increasingly recognized in clinical research. According to Zhu et al., (2023), patients with non- dialysis-dependent CKD stages 3–5 who experience incident depressive symptoms have worse clinical outcomes. Their large population-based cohort study showed that depression in these patients is linked to higher rates of hospitalization, CKD progression, major adverse cardiovascular events, and all-cause mortality. The association with CKD progression became more pronounced one year after depression diagnosis, which suggests a prolonged impact of depressive symptoms on kidney disease (Zhu et al., 2023).

The prevalence of depression among non-dialysis CKD patients is notably high. The prevalence of depression in CKD patients is three to four times higher compared with the general population and two to three times higher compared to other chronic diseases, including diabetes, coronary artery disease, and chronic obstructive pulmonary disease (Simões e Silva et al., 2019). A cross-sectional study by Almutary (2022) reported that about 18.2% of non- dialysis CKD patients had major depressive episodes, with depression being common, especially in advanced CKD stages and those with multiple comorbidities. Another study in Chinese CKD patients without dialysis found a depression prevalence of 22.2%, with no significant differences across various CKD stages (Duan et al., 2021).

The Patient Health Questionnaire-9 (PHQ-9) is a validated screening tool for depression applicable in various clinical context, including chronic illness management like CKD. Using this tool in CKD populations is particularly important, as depressive and anxiety disorders are highly prevalent and adversely affect treatment adherence, quality of life, and clinical outcomes. The quick administration (usually under 5 minutes), ease of scoring, and availability in multiple languages enhance their clinical utility. Moreover,