THE ASSOCIATION BETWEEN DIALYSIS ADEQUACY, SLEEP QUALITY AND PROTEIN AND FLUID INTAKE AMONG HAEMODIALYSIS PATIENTS IN HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (HPUSM)

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by

TAN XIN YIN

Dissertation submitted in partial fulfilment of the requirements for the degree of Bachelor of Health Science (Honours) (Dietetics)

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CERTIFICATE

This is to certify that the dissertation entitled “The Association between Dialysis Adequacy, Sleep Quality and Protein and Fluid Intake among Haemodialysis Patients in Hospital Pakar Universiti Sains Malaysia (HPUSM) is the bona fide record of research work done by Ms Tan Xin Yin during the period from March 2024 to July 2024 under my supervision. I have read this dissertation and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation to be submitted in partial fulfilment for the degree of Bachelor of Health Science (Honours) (Dietetics).

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated and duly acknowledged. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at Universiti Sains Malaysia or other institutions. I grant Universiti Sains Malaysia the right to use the dissertation for teaching, research and promotional purposes.

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PERKAITAN ANTARA KECUKUPAN DIALISIS, KUALITI TIDUR DAN PENGAMBILAN PROTEIN DAN CECAIR DALAM KALANGAN PESAKIT HEMODIALISIS DI HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (HPUSM)

ABSTRAK

Kajian ini mengkaji hubungan antara kecukupan dialisis, kualiti tidur, protein dan pengambilan cecair dalam kalangan pesakit hemodialisis di Hospital Pakar Universiti Sains Malaysia (HPUSM). Kajian keratan rentas telah dijalankan dalam kalangan 114 pesakit berumur 18 - 60 tahun. Data dikumpul menggunakan soal selidik piawai untuk menilai kualiti tidur (PSQI-M), pengambilan diet (diari diet 3 hari), dan kecukupan dialisis (nilai Kt/V). Daripada 114 subjek, didapati 104 subjek (91.2%) mempunyai terapi hemodialisis yang mencukupi (Kt/V > 1.2); 17 subjek (14.9%) mempunyai kualiti tidur yang baik (skor PSQI < 5); median pengambilan protein ialah 50.39g dan 55.77g dengan julat interkuartil masing-masing 44.73g dan 36.03g untuk lelaki dan wanita. Terdapat perkaitan yang signifikan antara jantina dan pekerjaan (p = < 0.001), antara jantina dan pendapatan isi rumah bulanan (p = < 0.001), antara jantina dan tahap pendidikan (p = 0.02) dengan wanita mempunyai tahap pendidikan yang lebih tinggi daripada lelaki, dan antara jantina dan pengambilan cecair (p = 0.015) dengan lelaki mempunyai pengambilan cecair yang lebih tinggi daripada wanita. Terdapat juga perkaitan yang ketara antara pengambilan protein dan kecukupan dialisis (p = 0.02) dengan pengambilan protein yang lebih tinggi kecukupan dialisis yang lebih tinggi dan pengambilan cecair dan kualiti tidur (p = 0.046) dengan pengambilan cecair yang lebih tinggi kualiti tidur yang lebih buruk. Tiada perkaitan signifikan antara kecukupan dialisis dan kualiti tidur, antara pengambilan

cecair dan kecukupan dialisis dan pengambilan protein dan kualiti tidur. Namun, lebih banyak kajian perlu dijalankan untuk memberikan pemahaman yang jelas tentang faktor yang mempengaruhi kecukupan dialisis dan kualiti tidur untuk meningkatkan status pemakanan dalam kalangan pesakit hemodialisis.

ASSOCIATION BETWEEN DIALYSIS ADEQUACY, SLEEP QUALITY AND PROTEIN AND FLUID INTAKE AMONG HAEMODIALYSIS PATIENTS IN HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (HPUSM)

ABSTRACT

This study investigates the relationship between dialysis adequacy, sleep quality, protein and fluid intake among haemodialysis patients at Hospital Pakar Universiti Sains Malaysia (HPUSM). A cross-sectional study was conducted among 114 patients aged 18-60 years old. Data were collected using standardized questionnaires: the Pittsburgh Sleep Quality Index (PSQI) to assess sleep quality, three days dietary diaries for dietary intake and Kt/V value for dialysis adequacy. Out of 114 subjects, 104 subjects (91.2%) had adequate haemodialysis therapy (Kt/V > 1.2); 17 subjects (14.9%) had good sleep quality (PSQI scores < 5); median of protein intake is 50.39g and 55.77g with interquartile range of 44.73g and 36.03g for men and women respectively. There is significantly association between gender and occupation ($p < 0.001$), between gender and monthly household income ($p < 0.001$), between gender and education level ($p = 0.02$) with women had higher education level than men, and between gender and fluid intake ($p = 0.015$) with men had higher fluid intake than women. There is also significantly association between protein intake and dialysis adequacy ($p = 0.02$) with higher protein intake higher dialysis adequacy and fluid intake and sleep quality ($p = 0.046$) with higher fluid intake poorer sleep quality. However, there was no statistically significant association was found between dialysis adequacy and sleep quality, between fluid intake and dialysis adequacy and protein intake and sleep quality. Nonetheless, it is suggested more studies should be carried out to provide clear understanding on the factors affecting dialysis adequacy and

sleep quality to improve nutritional status among haemodialysis patients. Future research should focus on longitudinal studies to establish causal relationships and explore interventions to optimize dietary intake and fluid management in haemodialysis patients.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

End-stage renal disease, also known as kidney failure, is defined as the kidneys' inability to perform excretory function, resulting in the retention of nitrogenous waste products from the blood (Bindroo et al., 2023). Dialysis is the most used renal replacement therapy in patients with chronic kidney disease (Lopez-Vargas et al., 2013). Chronic kidney disease is defined as having a declining or abnormal kidney function with a glomerular filtration rate (GFR) of 60 mL/min/1.73 m2 or albuminuria of 30 mg per 24 hours for at least three months (Chen et al., 2019). Chronic kidney disease (CKD) affects more than 10% of the world's population and is a leading cause of death (Kovesdy, 2022). The global prevalence of CKD is rising, with 13.4% of people suffering from CKD stages 1-5 and 10.6% suffering from CKD stages 3-5. CKD stages 1–5 affect an estimated 843.6 million people (Jager et al., 2019). According to Murugesan (2023), the prevalence of CKD has increased from 9.07% in 2011 to 15.48% in 2018.

Dialysis is the process of removing waste and excess water from the blood when the patient's kidneys fail, also known as kidney failure or the end stage of renal disease (Lee, 2017). It is an artificial replacement for kidney function, particularly in cases of renal failure. Dialysis does not completely restore lost kidney function, but it does manage its activities to some extent through diffusion and ultrafiltration (Murdeshwar & Anjum, 2023). According to the National Kidney Foundation (2015), more than two million people worldwide receive dialysis treatment. According to preliminary data from the

National Renal Registry (NRR), there were 49,447 dialysis patients in Malaysia in 2022, with 43,663 receiving haemodialysis and 5,784 receiving peritoneal dialysis. It is also stated that approximately 100,000 patients are expected to require dialysis by the year 2040 (Ibrahim, 2023).

Dialysis adequacy refers to the ability of haemolysis to remove waste products from patients' blood while maintaining fluid balance (Barzegar et al., 2016). Achieving an optimal balance is critical because insufficient dialysis can result in uraemia and fluid overload, while excessive dialysis can result in malnutrition and muscle wasting (Kiebalo et al., 2020). Kt/V and urea reduction ratio (URR) have traditionally been used to assess dialysis adequacy (Somji et al., 2020).

Haemodialysis patients frequently experience sleep problems. Patients undergoing haemodialysis frequently experience sleep disturbances such as insomnia, frequent awakenings, and excessive daytime sleepiness. These sleep issues are attributed to a variety of factors, including dialysis discomfort, fluid balance changes, and biochemical imbalances (Lin et al., 2022). One of the factors associated with sleep quality is dialysis adequacy (Tosun et al., 2015). According to a study conducted in a hospital in Pakistan, the frequency of poor sleep quality among CKD patients receiving chronic haemodialysis is high (Anwar & Nayer Mahmud, 2018). Poor sleep quality can also have an effect on cognitive function, mood, and quality of life (Lin et al., 2022).

Nutrition is critical to the health of haemodialysis patients. Protein consumption is an important factor in stratifying malnutrition. Increased intraglomerular pressure and glomerular hyperfiltration may result from a high protein intake (Kiebalo et al., 2020). This can harm the glomerular structure, causing or exacerbating chronic kidney disease (CKD) (Ko et al., 2017). Protein intake is critical for maintaining muscle mass and overall

health, whereas insufficient intake results in protein-energy wasting during hemodynamic therapy. Controlling fluid intake is critical for avoiding fluid overload and its complications. Water homeostasis are controlled by the kidneys via sensor (tubuloglomerular feedback) and regulator systems (sodium reabsorption) (Kettritz et al., 2021). Fluid volume regulation affects the amount of sodium in the body primarily through the extracellular space, whereas osmoregulation affects both the intra- and extracellular spaces (Kettritz et al., 2021). High water consumption lowers plasma levels of arginine vasopressin (AVP), which is expected to be beneficial for kidney function preservation. Previous research suggests that drinking water reduces plasma AVP levels, and high levels of AVP have been linked to adverse effects in animal models of kidney disease (Choi et al., 2015). It also suggested that increased total water intake, particularly plain water, may have a protective effect on the kidney (Sontrop et al., 2013).

1.2 Problem Statement

End-stage renal disease (ESRD), also known as kidney failure, is a debilitating condition that affects millions of people worldwide and requires life-sustaining haemodialysis treatment. While haemodialysis effectively removes waste products and excess fluids from the bloodstream, haemodialysis patients' outcomes and quality of life are subject to complex interdependencies (Bindroo et al., 2023). Among these are dialysis adequacy, sleep quality, and dietary practises, particularly protein and fluid intake. However, a thorough understanding of the relationships and underlying mechanisms between these variables is still lacking, leaving a significant gap in the care of haemodialysis patients.

Dialysis adequacy, as measured by parameters like Kt/V and URR, is critical for solute clearance and fluid management (Somji et al., 2020). Inadequate dialysis can cause uraemia and fluid overload, while excessive dialysis can cause malnutrition and muscle wasting. According to a Tanzanian study, only 34.3% of patients (based on urea reduction ratio (URR)) and 40.6% (based on Kt/V) received adequate hemodynamic therapy (Somji et al., 2020). Concurrently, haemodialysis patients experience sleep disturbances such as insomnia, fragmented sleep, and daytime drowsiness, which impairs cognitive function and emotional well-being. These sleep problems are linked to dialysis's physical and biochemical stress, altered fluid balance, and related dietary changes. According to a study conducted in Jakarta, Indonesia, sleeping problems such as insomnia are the most common sleep disorder among patients receiving haemodialysis treatment, with a prevalence ranging from 69 to 80% (Lufiyani et al., 2019).

Furthermore, proper nutrition, particularly protein intake, is critical for preventing malnutrition and muscle wasting in haemodialysis patients. Simultaneously, fluid control

is required to avoid fluid overload and its negative consequences. Dietary restriction and fluid allowance regimens are routinely prescribed; however, patient adherence to these regimens is frequently inadequate (Kettritz et al., 2021). According to the National Kidney Foundation (2023), a higher protein intake is required to help maintain blood protein levels and improve health if the patient begins dialysis. Protein intake of 0.6 to 0.8 g/kg/day with >50% HBV proteins is recommended for non-dialysis CKD patients. Dietary protein intake of 1.0-1.2 g/kg/day is recommended for patients on peritoneal dialysis and hemodynamic dialysis (Zha & Qian, 2017). According to the National Kidney Foundation (2018), dialysis patients should limit their fluid intake to 32 ounces or 1000 millilitres (ml) per day to help their dialysis treatment remove extra water from the body.

As a result, we would like to investigate whether haemodialysis patients make dietary changes based on recommendations, sleep quality, and dialysis adequacy in this study. We also look at the relationship between dialysis adequacy, sleep quality, and protein and fluid consumption. Furthermore, the findings of this study can be useful in providing valuable insights as well as highlighting strategies that should be taken to develop and design informed interventions, in addition to addressing family support and community-based health management programmes for the Kelantan population of community-dwelling haemodialysis patients.

1.3 Research Question

The following questions are sought to be answered at the end of the study:-

i. Is the dialysis treatment adequate among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

ii. How was the sleeping quality among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

iii. How much protein and fluid is consumed daily among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

iv. Is there a significant association between dialysis adequacy and sleep quality among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

v. Is there a significant association between dialysis adequacy with protein and fluid intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

vi. Is there a significant association between sleep quality with protein and fluid intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

1.4 Research Objective

1.4.1 General Objective

To investigate the association between dialysis adequacy, sleep quality and protein and fluid intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

1.4.2 Specific Objective

i. To determine dialysis adequacy among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

ii. To assess the sleep quality status among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

iii. To assess the mean protein and fluid intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

iv. To determine the association between dialysis adequacy and sleep quality among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

v. To determine the association between dialysis adequacy with protein and fluid intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

vi. To determine the association between sleep quality with protein and fluid intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

1.5 Research Hypothesis

1.5.1 Hypothesis

Null Hypothesis (H_0)

1. There is no association between dialysis adequacy and sleep quality among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).
2. There is no association between dialysis adequacy and protein and fluid intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).
3. There is no association between sleep quality and protein and fluid intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

Alternative Hypothesis (H_A)

1. There is an association between dialysis adequacy and sleep quality among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).
2. There is an association between dialysis adequacy and protein and fluid intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).
3. There is an association between sleep quality and protein and fluid intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

1.6 Justification of Study

The research findings will provide information about haemodialysis patients' dietary changes, sleep quality, and dialysis adequacy among haemodialysis patients at Hospital Pakar Universiti Sains Malaysia (HPUSM). A number of studies are currently being conducted to investigate the dietary changes (protein and fluid intake) of dialysis patients in Malaysia, and haemodialysis patients must increase their protein intake while limiting their fluid intake. The current research on dietary changes focuses solely on the importance or quantity of increasing protein intake and decreasing fluid intake (Khor et al., 2020; Wong et al., 2017). As a result, the findings of this study may shed light on whether haemodialysis patients monitor and adjust their dietary protein and fluid intake, as well as investigate the relationship between dietary intakes and dialysis adequacy and sleep quality. Furthermore, the patients' sleep quality evaluated to see if it is related to dietary changes (protein and fluid intake), as no study has been conducted that identifies the relationship between dietary changes (protein and fluid intake) and the sleep quality of haemodialysis patients. Patients on haemodialysis who consume a high protein diet and a low fluid intake may experience sleep disturbances as a result of their dietary changes. Furthermore, this study may assess the adequacy of dialysis among haemodialysis patients to determine whether the patients are receiving the appropriate amount of dialysis treatment. As a result, the goal of this research project is to fill a knowledge gap by unravelling the intricate relationships between dialysis adequacy, sleep quality, protein, and fluid intake in haemodialysis patients. Understanding these relationships, as well as the potential moderating or mediating factors at work, is critical to improving the overall care and well-being of this vulnerable patient population. The project's findings will not only help improve patient care, but they may also lead to more

informed clinical guidelines and interventions for more successful and patient-centred haemodialysis therapy.

1.7 Conceptual Framework

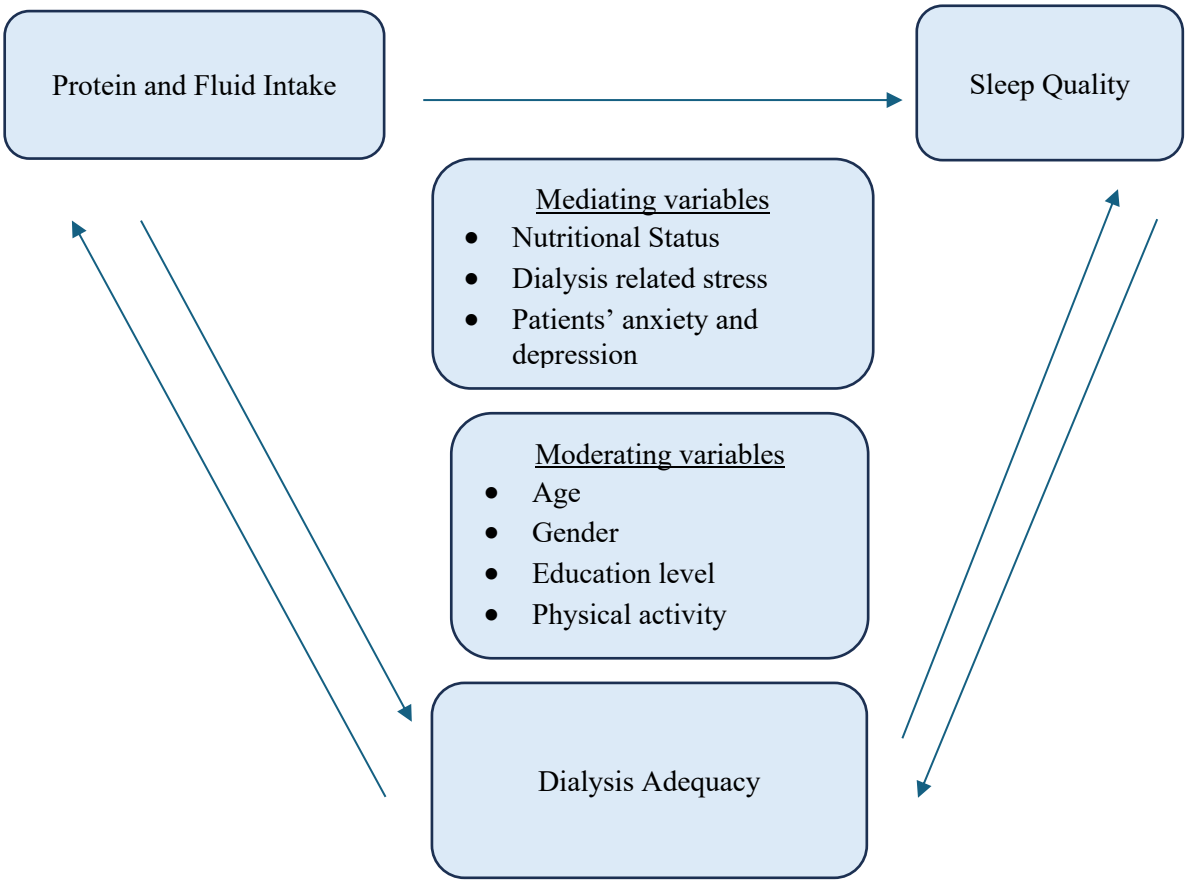

Figure 1: Conceptual framework of cause and effect related to protein and fluid intake, dialysis adequacy and sleep quality

End-stage renal disease (ESRD), also known as kidney failure, is one of the most common diseases, affecting more than 10% of the global population, or more than 800 million people (Jager et al., 2019). Many studies have shown that increasing dietary protein intake while decreasing fluid intake can improve haemodialysis patients' blood protein levels and make them feel better. According to Zha and Qian (2017), the amount of dietary protein consumed may have an effect on the adequacy of dialysis in haemodialysis patients because a high protein intake may cause difficulty getting rid of protein waste products from the body, and the patient requires a higher level of dialysis adequacy to solve this problem. On the other hand, consuming less protein than

recommended may result in protein energy malnutrition (PEM). According to the National Kidney Foundation (2018), haemodialysis patients should limit their fluid intake to reduce the risk of low blood pressure, cramping, and heart stress during dialysis treatment. Thus, in this study, we would like to assess the two-way relationship between protein and fluid intake and dialysis adequacy.

Furthermore, studies show an association between sleep quality and dialysis adequacy. Terzi et al. (2019) discovered that dialysis patients had sleep disturbances such as short, deep sleep periods and shorter total sleep times. Thus, providing efficient dialysis not only improves the individual's quality of life but also contributes to the resolution of sleep problems. According to Ralli et al. (2022), patients with higher quality of sleep and life, both overall and in individual dimensions, had higher dialysis adequacy. Dietary intake also has an impact on patients' sleep quality. According to one study, a high protein intake may take longer to digest and result in poor sleeping quality (Salas, 2021). Low fluid intake, like low fluid intake, will cause patients to feel thirsty or have a dry mouth while sleeping, disrupting their sleep (Ungless, 2023).

In addition, there are mediating and moderating variables that may influence the study's outcome. The relationship between protein intake and patient outcomes, such as sleep quality and dialysis adequacy, is mediated by nutritional status. It includes indicators such as serum albumin levels and body mass index. Malnutrition, for example, is common in haemodialysis patients and leads to a decrease in dialysis adequacy (Afaghi et al., 2021). Dialysis-related stress may have an impact on patients' sleep quality and diet intake because they are stressed about the financial burden and physical pain associated with dialysis treatment (Mistik et al., 2016). According to Mistik et al. (2016), some haemodialysis patients experienced depression and anxiety as a result of their illness,

which may have an impact on their dietary intake and sleep quality. Age, gender, and comorbidities may moderate the relationships between dialysis adequacy, sleep quality, and protein and fluid intake (Shahdadi et al., 2015). These variables can have an impact on how different people react to dialysis, sleep quality, and dietary practises. According to the study, men, younger patients, those with a higher level of education, and those who exercised had better sleep quality and dialysis adequacy (Ralli et al., 2022).

CHAPTER 2

LITERATURE REVIEW

2.1 Prevalence of end stage kidney disease (ESKD) and hemodialysis treatment in Malaysia

Chronic kidney disease (CKD) and end-stage kidney disease (ESKD) are becoming increasingly common in Malaysia, posing a significant public health concern. According to the New Straits Times (2022), chronic kidney disease (CKD) has affected one out of every seven Malaysians, with approximately 4.7 million Malaysians in various stages of chronic kidney disease, and over 40,000 kidney patients in Malaysia, with over 8,000 new patients diagnosed annually since 2018. The prevalence of chronic kidney disease has risen from 9.07% in 2011 to 15.48% in 2018 (Murugesan,2023). According to the Malaysian Ministry of Health (2018), 142 government hospitals and 14 health clinics provide haemodialysis services across the country. The prevalence of end-stage renal disease (ESRD) or kidney failure patients in Malaysia has been steadily increasing over time, according to Malaysia Kini (2023), with 43,804 people receiving dialysis treatment as of 31 December 2018, according to a 2020 report by the Malaysian Dialysis and Transplant Registry (MDTR). Negeri Sembilan had the highest rate of dialysis treatment (402 per million population), followed by Melaka (393 per million population), Perak (361 per million population), Terengganu (355 per million population), and Pulau Pinang (345 per million population). Sabah continues to have the lowest acceptance rate (140 people per million), followed by Perlis (174 people per million), Kelantan (197 people per million), Selangor (231 people per million), and Sarawak (242 people per million). In general, Peninsular Malaysia's west coast states had higher AR than

Peninsular Malaysia's east coast states, which were followed by East Malaysian states (Loke Meng et al., 2023).

2.2 Dialysis Adequacy

Dialysis sufficiency is a critical aspect of end-stage renal disease management (Barzegar et al., 2016). Numerous studies have been conducted to investigate various markers and methods for determining the efficacy of dialysis. It emphasises the significance of achieving optimal uremic toxin clearance and maintaining adequate fluid balance (Jones & Bargman, 2018). Kt/V, urea reduction ratio (URR), and equilibrated Kt/V are common parameters studied as measures of uremic toxin clearance during dialysis. The "K" in the formula stands for urea dialyser clearance, "t" stands for dialysis time, and "V" stands for urea distribution volume, which is approximately equal to the patient's total body water. The impact of dialysis adequacy on patient outcomes, such as mortality rates and quality of life, is also being investigated (Perez-Garcia et al., 2019). Understanding and improving dialysis adequacy remain critical in improving the overall care of people on renal replacement therapy. According to a study conducted by AlSahow et al. (2020) in Gulf Cooperation Council countries, relatively large proportions of haemodialysis patients have low Kt/V. Increasing the blood flow rate to 350 mL/min and the treatment time to 4 hours three times a week will reduce the prevalence of low Kt/V and may improve survival in haemodialysis patients (AlSahow et al., 2020). Dialysis adequacy is a major concern in the management of end-stage renal disease (ESRD), with numerous studies focusing on evaluating and optimising dialysis treatments' effectiveness (Barzegar et al., 2016). Study emphasised the importance of achieving and maintaining optimal dialysis adequacy in order to avoid complications associated with insufficient clearance, such as cardiovascular issues and fluid overload (Jones & Bargman, 2018).

Variations in patient characteristics, treatment modalities, and dialyzer specifications have all been identified as barriers to achieving adequate dialysis on a consistent basis (Daugirdas, 2015). Optimising dialysis prescription, individualising treatment plans, and incorporating technological advancements are all strategies for improving dialysis adequacy (Clark et al., 2013). According to US guidelines, a Kt/V (without rebound) for thrice-week dialysis should be 1.2 at a minimum, with a target value of 1.4 (15% above the minimum values). However, there is some evidence that higher doses may be required for women, malnourished patients, and patients with clinical problems in order to maximise the positive effects on the diseases (Kim et al., 2021). The recommended minimum Kt/V value varies depending on how many sessions are given per week and is lower for patients with significant residual renal function (Steyaert et al., 2019).

2.3 Association between dialysis adequacy and protein and fluid intake

Over 2 million people worldwide suffer from end-stage kidney disease (ESKD), and the kidneys are critical for nutritional homeostasis. To avoid elevated electrolyte levels and cardiovascular complications, people undergoing haemodialysis are advised to modify their dietary intake, including reduced protein intake and increased fluid intake (Luis et al., 2016). According to KDOQI (2020), it recommends that maintenance haemodialysis patients consume 1.0-1.2 g/kg of protein per day. Haemodialysis patients require more protein due to amino acid and albumin losses, altered albumin turnover, metabolic acidosis, increased amino acid degradation, inflammation, and infection (Zha & Qian, 2017). Consistency with these recommendations, however, is difficult due to their negative impact on quality of life and the lack of dietary education and support strategies (Luis et al., 2016). According to Vanholder et al. (2015), higher protein intake among dialysis patients may be associated with lower morbidity and mortality rates.

Protein consumption has been linked to better nutritional status and a lower risk of complications. Low protein intake, on the other hand, can result in protein-energy wasting, increased infection rates, and a compromised immune system, all of which may contribute to increased morbidity and mortality among dialysis patients due to deferring dialysis initiation and slowing the progression of CKD, while the risk of protein-energy wasting and cachexia remains minimal (Rhee et al., 2017). Adequate protein intake is critical for dialysis patients to maintain optimal nutritional status. Chen et al. (2016) observed a link between protein intake and dialysis adequacy, particularly in terms of albumin levels and urea kinetic modelling. Higher protein intake was explained as being linked to higher serum albumin levels, indicating improved nutrition, which is considered a marker of better outcomes in dialysis patients. Adequate nutrition can improve urea removal during dialysis, influencing dialysis adequacy measures. The findings emphasise the significance of tracking and optimising protein intake in order to improve patient outcomes (Chen et al., 2016). Tailored dietary interventions that strike a balance between protein requirements and other dietary restrictions are critical for improving dialysis adequacy and patient well-being (Sabatino et al., 2017). When designing dietary plans to ensure adequate protein intake while also managing other nutritional restrictions imposed by the dialysis regimen, clinicians must consider individual patient factors and nutritional needs (KalantarZadeh et al., 2015). In summary, available research suggests that adequate protein intake is critical for maintaining nutritional status, lowering morbidity and mortality rates, and positively impacting dialysis adequacy in patients with end-stage renal disease who are on dialysis. Individualised approaches that take into account multiple factors, however, are required to optimise protein intake in these patients without jeopardising other aspects of their treatment (Sabatino et al., 2017).

The relationship between fluid intake and dialysis adequacy is an important aspect of managing dialysis patients. Fluid control and patient outcomes in dialysis are frequently discussed in studies. Excessive fluid intake during dialysis can lead to complications such as hypertension, heart failure, and pulmonary oedema (Beerendrakumar et al., 2018). Insufficient fluid intake, on the other hand, can lead to dehydration, high blood pressure, dry skin, challenges in removing waste products during dialysis treatment, and affecting the overall treatment effectiveness. According to research, adhering to a strict fluid intake regimen and achieving dialysis adequacy have a significant impact on patient outcomes. According to some studies, strict adherence to fluid restriction, along with personalized dialysis prescriptions, is associated with better outcomes such as reduced cardiovascular events, improved blood pressure control, and lower mortality rates in dialysis patients (Palmer et al., 2015). Dialysis adequacy measures, including Kt/V (a marker for the amount of urea clearance during dialysis) and ultrafiltration rates, are frequently used to evaluate the efficacy of dialysis treatment (Somji et al., 2020). Improved fluid management and maintaining appropriate ultrafiltration rates (removing fluid during dialysis) have been linked to better overall outcomes and fewer complications in dialysis patients (Clark et al., 2016). Furthermore, personalised care plans that take into account individual patient characteristics and needs, such as dietary restrictions and lifestyle changes, play an important role in achieving optimal fluid control and dialysis adequacy, influencing patient outcomes (Clark et al., 2018). Overall, while the relationship between fluid intake, dialysis adequacy, and patient outcomes is complex, maintaining a balance through personalised care plans is critical in improving dialysis patients' quality of life and reducing complications. Maintaining optimal fluid balance during dialysis presents several challenges that have a significant impact on treatment efficacy. Patient adherence is one of these challenges, as patients

frequently find it difficult to adhere to strict fluid restrictions (Canaud et al., 2019). Fluid intake, including liquids and foods high in water content, can vary, making it difficult to achieve optimal fluid balance (Ko et al., 2013). The tolerance of some of the patients to fluid removal varies. Ultrafiltration may cause discomfort or adverse effects in haemodialysis patients, limiting the amount of fluid that can be safely removed during dialysis sessions (Chou & Kalantar-Zadeh, 2017). Patients with coexisting conditions such as heart failure or other conditions that interfere with fluid regulation, making it more difficult to achieve and maintain the desired fluid balance (Ok et al., 2016). Furthermore, high ultrafiltration rates during treatments can cause hypotension, cramping, or dizziness, potentially limiting the amount of fluid that can be safely removed without causing distress to the patient (Weiner et al., 2014). These obstacles have a significant impact on treatment effectiveness. Complications can arise if optimal fluid balance is not maintained. Inadequate fluid removal can lead to hypertension, whereas excessive fluid removal can lead to hypotension and cardiovascular stress (Ok et al., 2016). Poor fluid control is linked to an increased risk of death in dialysis patients. Fluid imbalance has a negative impact on a patient's overall well-being, causing symptoms such as shortness of breath, swelling, and discomfort (Beerendrakumar et al., 2018). Addressing these issues requires a tailored approach. Tailoring treatment plans to individual patients' needs, constant monitoring, improved patient education, and possibly technological advancements in dialysis equipment all play important roles in improving fluid management during dialysis and, as a result, treatment effectiveness (Moissl et al., 2013).

2.4 Association between sleep quality and dialysis adequacy

Study had highlighted the link between sleep disturbances and dialysis adequacy in dialysis patients. Poor sleep quality, which is common among dialysis patients, has been linked to insufficient dialysis clearance and efficiency (Tosun et al., 2015). Disrupted sleep patterns, such as sleep apnoea or insomnia, can have a negative impact on overall health, potentially affecting dialysis treatment adequacy. Sleep is critical for haemodialysis patients because it has a significant impact on their overall health and well-being. Poor sleep can exacerbate existing conditions in haemodialysis patients who already have health issues (Vatandoost et al., 2018). Thus, the significance of quality sleep lies in its impact on a variety of factors. Sleep quality is essential for the body's recovery and healing. It aids in blood pressure regulation, immune function, and overall cardiovascular health. Patients on haemodialysis frequently have high blood pressure and cardiovascular issues, so disrupted sleep can exacerbate these conditions (Gorji et al., 2019). Sleep is closely related to mental health. Poor sleep can lead to increased stress, anxiety, and depression, all of which are common in haemodialysis patients (Masoumi et al., 2013). Adequate sleep has been shown to improve mood and cognitive function. Sleep disruptions can have a significant impact on a person's quality of life. Fatigue, lack of energy, and daytime sleepiness as a result of poor sleep quality can make it difficult for haemodialysis patients to participate in daily activities and enjoy life (Eloot et al., 2021). Adequate sleep can improve the effectiveness of the treatment. It promotes better toxin removal during dialysis and aids the body's recovery from treatment sessions (Eslami et al., 2014). Poor sleep quality has been linked to an increased risk of death in haemodialysis patients. Sleep disturbances have been linked to an increased risk of cardiovascular events and mortality in this population, according to research (Norozi Firoz et al., 2017). It is critical to improve sleep quality in haemodialysis patients. Sleep

hygiene practices such as maintaining a consistent sleep schedule, creating a comfortable sleep environment, avoiding stimulants before bedtime, and potentially considering medications or therapies to address specific sleep disorders are frequently recommended by healthcare providers (Trbojevic-Stankovic et al., 2014). Overall, improving sleep quality for haemodialysis patients is important not only for their immediate well-being but also for their long-term health outcomes. Sleep disturbances are common among haemodialysis patients in Malaysia, as they are in many other parts of the world. Sleep disorders are common in the haemodialysis patient population in Malaysia, according to research (Ng et al., 2020). According to the study, many factors, including the burden of their condition, discomfort during treatment, lifestyle changes, and comorbidities, contribute to sleep disturbances in haemodialysis patients. Specific information on the prevalence of sleep disturbances among haemodialysis patients in Malaysia may be found in various research studies or hospital reports. However, similar to the global trends, it is likely that a significant proportion of haemodialysis patients in Malaysia have disrupted sleep patterns (Ho et al., 2022).

2.5 Association between sleep quality and protein and fluid intake

Sleep disorders, such as sleep apnoea and disrupted sleep patterns, are frequently associated with dietary changes in dialysis patients (Chaput, 2014). Furthermore, dietary changes, particularly in relation to evening meals or fluid intake, may influence sleep quality (Monfared et al., 2019). Dietary changes, particularly those affecting protein intake and fluid control, can have a significant impact on both sleep quality and dialysis adequacy. Managing nocturnal urine output, for example, can help manage evening fluid intake and potentially improve sleep quality (Mehra et al., 2022). Maintaining a balance between nutritional status and the burden of waste products on dialysis efficiency is critical (Zhang et al., 2014). Dialysis patients' nutritional status, which is influenced by dietary changes, can have an impact on their sleep quality. Nutrient deficiencies or imbalances, which are common in kidney disease patients, may contribute to sleep disturbances (Motamedifard et al., 2023).

Alterations in dietary recommendations aimed at improving nutritional status, on the other hand, may have an indirect impact on sleep quality in these patients (Firoz et al., 2015). Various dialysis-related factors, such as the timing and frequency of dialysis treatments, dialysate composition, and the removal of waste products and excess fluids, can all have an impact on sleep patterns and dietary choices (Mehra et al., 2022). Dialysis parameter and schedule optimisation may have an indirect impact on both sleep quality and dietary habits in these patients (Wang et al., 2013). Understanding the relationship between sleep quality, dialysis adequacy, and dietary changes is critical for providing comprehensive care to dialysis patients (Parvan et al., 2013). More research is needed to understand the specific mechanisms underlying these associations and to develop targeted interventions to improve sleep, diet, and dialysis outcomes in this population. The effects of haemodialysis on sleep quality and dietary changes are numerous. Due to early

morning or late evening sessions, haemodialysis treatment schedules frequently disrupt the natural sleep-wake cycle (Ismail et al., 2020). Patients may have difficulty falling or staying asleep, resulting in sleep disturbances.

This disruption can have an effect on overall sleep quality, resulting in fatigue, daytime drowsiness, and decreased alertness (Shen et al., 2016). Patients on haemodialysis are more likely to develop sleep apnoea. Fluid buildup and changes in volume status, especially during the interdialytic period, can contribute to the development or worsening of sleep-disordered breathing. Sleep apnoea can disrupt sleep architecture and quality, resulting in fragmented sleep patterns and daytime sleepiness (Shen et al., 2016). Restless legs syndrome (RLS) occurs in some haemodialysis patients. This neurological disorder causes an unpleasant sensation in the legs, which leads to an insatiable desire to move them. RLS frequently worsens at night, affecting sleep quality and duration (Kaya et al., 2015).

Dietary restrictions are required for haemodialysis, particularly in terms of fluid and certain nutrient intakes (e.g., potassium, phosphorus). Patients' appetites and thirst may change as a result of these restrictions, affecting their dietary habits and overall nutritional intake (Lindseth et al., 2011). These changes can have an impact on meal planning and food choices, as well as sleep patterns and quality (Kaya et al., 2015). The dietary restrictions imposed by haemodialysis can result in nutritional imbalances, affecting patients' overall health. Sleep disturbances caused by poor nutritional status can affect both the quality and duration of sleep (Zhang et al., 2014). Anxiety, depression, or psychological distress can result from the stress and burden of managing dietary restrictions and adhering to the demanding haemodialysis schedule. These psychological factors can have a significant impact on sleep quality, exacerbating sleep disorders (Menon et al., 2015). Medications commonly used in haemodialysis patients may have

sleep-related side effects (Zheng et al., 2018). Some medications, for example, can affect sleep patterns or cause sleep disturbances as a side effect, influencing patients' overall sleep quality (Menon et al., 2015). Addressing these complications necessitates a comprehensive approach that includes fluid balance management, nutritional counselling, addressing comorbid conditions, considering medication adjustments, and implementing sleep hygiene strategies (Parvan et al., 2013). In order to reduce these complications and improve the overall well-being of haemodialysis patients, an interdisciplinary approach involving nephrologists, dietitians, and sleep specialists is essential (Ismail et al., 2020).

2.6 Dietary assessment method

Food records, food frequency questionnaires, 24-hour recalls diaries, and screening tools are traditional methods of dietary assessment; digital and mobile methods that leverage technology are available for these traditional methods (Moore, 2020). Accurate dietary intake assessment allows for a better understanding of diet effects in human health and disease, as well as the development of nutrition policy and dietary recommendations (e.g., foods and diet patterns) for individuals, groups, and communities (Bellafronte et al., 2023). Nutritional assessment is essential in the management of patients with chronic kidney disease (CKD) or haemodialysis-malnourished patients because it helps tailor dietary plans and improve clinical outcomes (Kalantar-Zadeh et al., 2021). To assess the efficacy of the plan and patient cooperation, it is critical to follow up with patients via dietary recalls and records (Molina et al., 2022). To provide an acceptable dietary assessment, expert dieticians should be aware of CKD and dialysis stages. Multiple dietary recalls diaries can help overcome biases such as recall bias and over- or under-estimation (Wendling et al., 2021). Data extraction techniques can help to reduce flaws in nutritional assessment. A case control study by Martins et al. (2015),