PROTEIN ENERGY INTAKE, MID-UPPER ARM CIRCUMFERENCES AND HAND-GRIP STRENGTH AMONG HEMODIALYSIS PATIENTS IN HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (HPUSM)

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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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"SHARIFAH AMIRAH AWATIF"

Date: ……1 JULY 2025……..

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HUBUNGAN ANTARA PENGAMBILAN TENAGA PROTEIN, UKUR LILIT LENGAN ATAS TENGAH (MUAC) DAN KEKUATAN GENGGAMAN TANGAN DALAM KALANGAN PESAKIT HEMODIALISIS DI HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (HPUSM)

ABSTRAK

Dalam kajian ini, pengambilan tenaga protein dan ukur lilit lengan atas tengah (MUAC) dikenal pasti sebagai pemboleh ubah bebas, manakala kekuatan genggaman tangan (HGS) dikenalpasti sebagai pemboleh ubah bersandar. Kajian ini dijalankan untuk mengenal pasti hubungan antara pengambilan tenaga dan protein, ukur lilit tengah lengan atas (MUAC) dan kekuatan genggaman tangan (HGS) dalam kalangan pesakit hemodialisis di Hospital Pakar Universiti Sains Malaysia (HPUSM). Kajian keratan rentas ini melibatkan 80 orang pesakit berumur 18 tahun ke atas. Data dikumpul melalui pengukuran antropometri iaitu ukur lilit tengah lengan atas (MUAC), kekuatan genggaman tangan (HGS), dan pengambilan diet (rekod diet 24 jam selama 3 hari). Daripada 80 orang subjek pesakit hemodialisis (35 lelaki dan 45 perempuan), didapati terdapat hubungan positif antara ukur lilit tengah lengan atas (MUAC) dan kekuatan genggaman tangan (HGS) dalam kalangan pesakit hemodialisis dengan nilai ($p = 0.004$, $r = 0.316$). Terdapat hubungan yang signifikan antara jantina dan susunan tempat tinggal ($p = 0.044$), antara jantina dan pendapatan isi rumah bulanan ($p = 0.034$), antara jantina dan penyakit jantung ($p = 0.002$) di mana lelaki mempunyai prevalens penyakit jantung yang lebih tinggi berbanding wanita, antara jantina dan gout ($p = 0.001$) di mana lelaki mempunyai prevalens gout yang lebih tinggi berbanding wanita, serta antara jantina dan masalah pernafasan ($p = 0.021$) di mana lelaki lebih cenderung mengalami masalah pernafasan. Terdapat juga hubungan yang signifikan antara jantina dengan pengambilan tenaga protein, ukur lilit lengan atas tengah (MUAC) dan kekuatan genggaman tangan (HGS) dengan nilai (p

= 0.023, p = 0.001, p < 0.001). Namun begitu, tiada hubungan yang signifikan secara statistik ditemui antara pengambilan tenaga dan protein dengan kekuatan genggaman tangan (HGS). Walau bagaimanapun, disarankan agar kajian ini membezakan antara pesakit dalam dan pesakit luar kerana rekod diet 24 jam mereka mungkin berbeza. Ini akan membantu memberikan pemahaman yang lebih jelas tentang faktor-faktor yang mempengaruhi kekuatan genggaman tangan (HGS) bagi meningkatkan jisim otot dan kekuatan otot dalam kalangan pesakit hemodialisis. Kajian pada masa hadapan seharusnya memberi tumpuan kepada kajian jangka masa panjang untuk menentukan hubungan sebab-akibat serta meneroka intervensi bagi mengoptimumkan pengambilan diet, jisim otot dan kekuatan otot dalam kalangan pesakit hemodialisis.

THE CORRELATION BETWEEN PROTEIN ENERGY INTAKE, MID-UPPER ARM CIRCUMFERENCES (MUAC) AND HAND-GRIP STRENGTH AMONG HEMODIALYSIS PATIENTS IN HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (HPUSM)

ABSTRACT

In this study, protein energy intake and mid-upper arm circumferences (MUAC) are known as independent variable while hand-grip strength (HGS) is known as dependant variables. This study investigates the relationship between protein energy intake, mid-upper arm circumferences (MUAC) and hand-grip strength (HGS) among haemodialysis patients at Hospital Pakar Universiti Sains Malaysia (HPUSM). A cross-sectional study was conducted among 80 patients aged 18 years old and above. Data were collected using anthropometry measurement which is mid-upper arm circumferences (MUAC), hand-grip strength (HGS), and dietary intake (3 days 24-hours diet recall). Out of 80 subjects from hemodialysis patients (35 male and 45 female) , it was discovered that there is a positive correlation between mid-upper arm circumferences (MUAC) and hand-grip strength (HGS) among hemodialysis patients with the values (p = 0.004, r = 0.316). There is significantly association between gender and living arrangement (p = 0.044), between gender and monthly household income (p = 0.034), between gender and heart disease (p = 0.002) with men had higher prevalence of heart disease than women, between gender and gout (p = 0.001) with men had higher prevalence of gout than women, between gender and breathing difficulties (p = 0.021) with men has higher prevalence of having breathing difficulties. There is significant association between gender and protein energy intake, mid-upper arm circumferences (MUAC) and hand-grip strength (HGS) with the values (p = 0.023, p = 0.001, p < 0.001). However, there is no statistically significant correlation was found between protein energy intake and hand-grip strength (HGS). Nonetheless, it is suggested to separate between outpatients and inpatients setting in the study because their diet 24-hours diet recall might be different. It will helps to provide clear

understanding on the factors affecting hand-grip strength (HGS) to improve muscle mass and muscle strength among haemodialysis patients. Future research should focus on longitudinal studies to establish causal relationships and explore interventions to optimize dietary intake and muscle mass and muscle strength in haemodialysis patients.

CHAPTER 1: INTRODUCTION

1.1 Background of study

Kidney failure happened when your kidney is unable to function effectively, and it associated with chronic kidney disease (CKD) or acute kidney injury (AKI). When kidney is no longer able to filter blood or waste product, it can build up in the body and cause significant symptom (Mary, 2022). CKD is defined when there is an abnormality detected in your kidney function or structure persisting for more than 3 months. The abnormalities include glomerular filtration rate is less than 60 mL/min/1.73 m^2 or urinary albumin creatin ratio (UACR) equals or exceed 30mg/g (Juan et al., 2021). Based on estimation the World Health Organization (WHO) project, CKD will become the 5th most common chronic disease in 2040 with the global estimation prevalence is 13.4% (11.7%-15.1%) and it leading to public health problem worldwide (Ji et al., 2019). Having CKD in a long term is highly associated with developing end-stage of renal disease (ESRD) and the survival rate of ERSD patients is very low which are the estimation of annual mortality to be more than 10%, with five-year survival approximately 50% (Rikke et al., 2023).

Hemodialysis is one of the renal replacement therapies for people with kidney failure and it will be a lifelong management for end-stage renal disease patients. It acts as artificial equipment responsible to filter blood from the body to remove excess water, toxins, and solutes when kidney is no longer functioning well. This process is to ensure the homeostasis balance in our body. There were 28,822 patients who undergoes hemodialysis treatment in Malaysia since December 2013 (Sharmela et al., 2015). Part of hemodialysis machine or called as dialyzer which act to filter the blood and it will flow through the tiny tube inside the dialyzer. At the same time, waste product and the excess fluid in the blood will pass the mesh tube into dialysate which consists of water, salt, and electrolytes. Next, the blood will return to the body

and the machine will dispose the dialysate and this procedure usually last 3 to 5 hours at hospitals or dialysis center three times a week.

Hand-grip strength (HGS) is a tool responsible for assessing integrated performance of muscle by measuring the maximum value of grip force that can be produced in one muscular contraction which can be used to determine the general muscle strength. HGS has a prognostic value that determine all cause of mortality, cardiovascular mortality, and cardiovascular disease (CVD). Weak HGS in individuals that associated with any range of major illness has high case fertility rates which show that low muscle strength is important indicator of the vulnerability of the individuals to develop the disease and the frailty. HGS is known as a rapid and simple procedure to measure muscle strength. Thus, it is widely used to stratify the risk of developing cardiovascular disease and individual's susceptibility to death from previous incident illness (Leong et al., 2016). In addition, HGS also has been clinically used to assess nutritional status in dialysis patients and it can act as potential indicator of protein energy wasting (Sharmela et al., 2015).

Muscle loss is a common complication among CKD patients which resulted in decreased muscle strength and function (William et al., 2021). There are several factors which contribute to this condition among CKD patients including dialysis treatment, typical chronic-low grade inflammation, metabolic acidosis, insulin resistance, vitamin D deficiency, hormonal imbalance, amino acid loss during dialysis, and reduced in dietary intake. All these factors can increase in protein degradation, decrease in protein synthesis and lead to negative protein imbalance. In addition, this condition will contribute to sarcopenia among CKD patients especially elderly because they are highly exposed to muscle degradation compared to the younger in CKD patients (Guilia et al., 2023). Previous study demonstrated higher prevalence of severe sarcopenia among dialysis compared to the non-dialysis patients (Marvery et al., 2024). Duration of dialysis is one of the contributing factors to development of sarcopenia

among maintenance hemodialysis patients due to the several pathological state such as hormone imbalance, malnutrition, metabolic acidosis, electrolyte disturbance and muscle atrophy (Hongqi, 2016).

Patients receiving hemodialysis treatment are advised to consume high protein diet due to dialysis related protein loss. Hemodialysis patients are advised to consume at least 20 g of protein per meal to overcome the anabolic resistance in skeletal muscle, thus promoting positive nitrogen balance (Hendriks et al., 2021). Unfortunately, hemodialysis patients often do not meet protein requirement due to the lack of appetite which associated in developing syndrome of malnutrition, muscle wasting and inflammation or called as protein energy wasting (PEW). Patients undergoing haemodialysis treatment prone to have progressive decreased in nutritional parameters include weight, body mass index, and muscle mass (Ramy et al., 2019).

1.2 Problem statement

Chronic kidney disease affected around more than 10% of general population worldwide, estimate more than 800 million individuals. This disease usually happened in low- and middle-income countries. In addition, chronic kidney disease has been demonstrated to become one of the most major causes of death and suffering in the 21st century. Risk factor such as diabetes mellitus and obesity increase the number of patients effected by the kidney disease led to estimation of patients effected around 843.6 million individuals worldwide 2017 (Csaba, 2022). End stage of renal disease that require hemodialysis treatment in Malaysian having an increasement in Malaysia supported by the incidence rate of 216 per million population in 2016 compared to 96 per million population (Saminathan et al., 2020). However, there are significantly fewer studies in examining association between protein energy intake, mid-upper arm circumferences (MUAC) and hand-grip strength (HGS).

PEW is highly associated among CKDs patients due to removing nutrients from the body during haemodialysis procedure. During haemodialysis treatment, loss of amino acid happened around 6 to 12 gram depends on the flow rate of blood and dialysate, duration of dialysis, patients fasting state and permeability and clearance characteristic of dialyzer membrane. In addition, glucose lost happened around 15 to 25 if glucose-free dialysate is used during haemodialysis (Joel, 2023). Next, accumulation of toxic metabolite product in the body and loss of metabolic action among CKD patients lead to malnutrition. Based on the previous study, hand-grip strength has been used as a diagnosis criterion of PEW among hemodialysis patients (Sharmela et al, 2015).

Furthermore, proper dietary intake, especially protein and energy intake play crucial role in CKD patients against protein energy wasting (PEW). CKD patients have implemented restriction of components in their diet due to the presence of certain underlying condition such as diabetes mellitus, hypertension or increased risk of hyperkalemia and negative calcium balance or sodium. This implementation resulted in inadequate of energy and protein intake among CKD patients leading to malnutrition and protein energy wasting. In addition, CKD patients who are receiving haemodialysis treatment experiencing muscle loss. This contribution is due to the CKD progression itself resulted decrease in protein intake and anorexia. it is reported approximately one-third of haemodialysis patients who experience muscle loss during dialysis treatment. Next, limitation of fluid intake can lead to decrease in calorie intake and the haemodialysis treatment also led to catabolic state because of the reduce in protein synthesis and increase in proteolysis (Wesley et al., 2020) All of these multiple factors are contributing to muscle loss among CKD patients.

1.3 Research Question

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

I. What is the mean protein energy intake among hemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

II. What is the mean mid upper arm circumference (MUAC) among hemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

III. What is the mean of muscle strength among hemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

IV. Is there a significant correlation between protein energy intake and hand-grip strength (HGS) among hemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

V. Is there a significant correlation between mid-upper arm circumference (MUAC) and hand-grip strength (HGS) among hemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

VI. Is there a significant association between gender with sociodemographic, medical history and clinical data among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

1.4 Research Objective

1.4.1 General Objective

To determine correlation between protein energy intake, mid upper arm circumferences (MUAC) and hand-grip strength (HGS) among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia.

1.4.2 Specific Objective

I. To determine mean protein energy intake among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)

II. To assess the mean mid upper arm circumference (MUAC) among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)

III. To assess mean hand-grip strength (HGS) among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HUSM)

IV. To determine correlation between protein energy intake and hand-grip strength (HGS) among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)

V. To determine correlation between mid-upper arm circumference and hand-grip strength (HGS) among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)

VI. To determine association between gender with sociodemographic, medical history and clinical data among haemodialysis patients in Hospital Pakar University Sains Malaysia (HPUSM)

1.5 Research Hypothesis

1.5.1 Hypothesis

Null Hypothesis (H_0)

1. There is no correlation between protein energy intake and hand-grip strength (PEW) among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)

2. There is no correlation between mid-upper arm circumference and hand grip strength (HGS)) among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)

Alternative Hypothesis (H_A)

1. There is correlation between protein energy intake and hand grip strength (HGS) among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)

2. There is correlation between mid-upper arm circumference and hand grip strength (HGS) among haemodialysis patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)

1.6 Justification of study

The research findings will provide the information regarding dietary protein intake, muscle loss and hand-grip strength among haemodialysis patients in Hospitals Universiti Sains Malasia (HUSM). Patients receiving hemodialysis treatment are at high risk of developing malnutrition due to uremia which affects appetite. Severe malnutrition among HD patients is between 4.6 to 19% while mild malnutrition is within 72.0-90.9% (Yusop et al 2013). Uremic symptoms among CKD patients contribute to anorexia. Loss of skeletal muscle mass among patients contributes to weakness and mortality. Dietary protein intake among these patients are influenced by various factors such as living status, chewing ability, education level, employment status, comorbidities. Patients with hemodialysis treatment often struggle to meet the recommendation value of dietary protein intake. Based on the guideline, CKD patients undergoing hemodialysis treatment should achieved the dietary protein intake around 1.2 g per kg body weight per day to preserve their muscle mass and overall health outcomes. However, most of the patient fails to meet the recommendation with around 50% of end-stage renal disease patients has low dietary protein intake which below than 1.0 g per kg per body weight per day (Hendriks et al., 2020). As a result, the current study investigates hand-grip strength by assessing their protein energy intake and mid-upper arm circumference. Next, the current study aimed to investigate the correlation between protein energy intake, mid-upper arm circumferences, hand-grip strength among hemodialysis patients in Hospital University Sains

Malaysia (HUSM). Next, it can be used in addressing family support and community-based health management programmes for the population of community-dwelling haemodialysis patients in Kelantan. In addition, findings of this study will enable health care professionals to develop dietary intervention to overcome these issues. Addressing PEW is essential to improve clinical outcome, reduce hospital admission, health care cost and improve quality of life of patients.

1.7 Conceptual framework

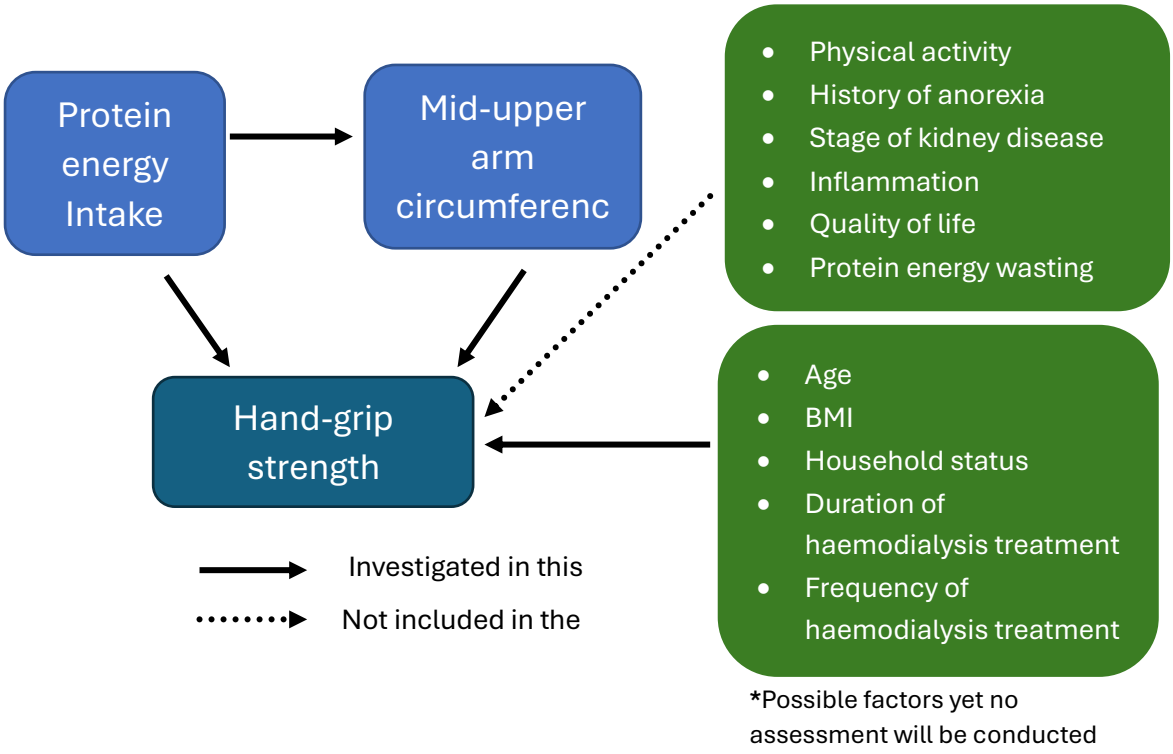

Figure 1: Conceptual framework of cause and effect related to protein energy intake, mid-upper arm circumferences and protein energy wasting.

Chronic kidney disease (CKD) is contributing to the major cause of global mortality among noncommunicable disease. It is affected around more than 10% of general population worldwide, estimate more than 800 million individuals (Csaba, 2022). According to one study, low protein intake is highly associated in low muscle strength by using HGS and lead to Protein energy wasting among hemodialysis patients (Sung, 2019). Most of hemodialysis patients are experiencing uremia and suppression of appetite. Uremia happened due to the accumulation of waste product in the body due to kidney that no longer function anymore to filter the waste product move out from the body. Patients might experience nausea, vomiting, and it will alter their taste function. All of the symptoms can supress their appetite thus make it difficult for them to consume adequate amount of food to get the dietary protein from their diet (Hendriks et al., 2020). In addition, patients who diagnosed as PEW will experiencing muscle loss due to the inadequate protein intake. Thus, the aim of this study is to investigate the association between protein energy intake, mid-upper arm circumferences (MUAC) and hand-grip strength (HGS).

CHAPTER 2: LITERATURE REVIEW

2.1 Prevalence of chronic kidney disease (CKD) and haemodialysis treatment in Malaysia.

Chronic kidney disease (CKD) affects 1 out of 10 adults and it also resulted in millions of premature deaths in the world. The incidence rate of end stage of renal disease (ERSD) who undergoes haemodialysis treatment in Malaysia has been increased to 216 per million population during 2016 compared to 206 per million in population during 2002. The prevalence of chronic kidney disease (CKD) in Malaysia demonstrated an increasing trend from 9.07% to 15.48% since 2011 to 2018 (Thamil et al., 2020). Ministry of Health reported, one in seven of the 33 million population or 4.7 million adults in Malaysia consist of various stage of CKD. In addition, there are 49,447 dialysis patients in Malaysia and 43,663 patients are undergoes haemodialysis treatment and 5748 patients are undergoing peritoneal treatment (Junaid, 2023). Based on the data reported from Malaysia Dialysis and Transplant Registry (MDTR), we can conclude that the west coast state of peninsular Malaysia has higher acceptance rate than east coast state of Peninsular Malaysia followed by East Malaysia state (Ong Lok Meng et al., 2023).

2.2 Dietary protein intake among haemodialysis patients.

High protein diet is usually defined as protein intake is more than 1.2 g/kg/day. It impaired the renal function and kidney health as it increased the glomerular filtration rate (GFR). Higher protein intake will induce renal hemodynamic by increasing blood flow and intraglomerular pressure resulted in higher GFR or called as glomerular hyperfiltration rate. In addition, high protein diet also associated with increase urinary albumin excretion which is the presence of albumin in urea that may impaired the kidney health and other organs in long term (Ko et al., 2017). However, chronic kidney disease patient who received maintenance haemodialysis treatment will impact their metabolism of protein, fat, and carbohydrate because specifically

the hemodialysis procedure itself involving catabolism of whole body and muscle protein and a net loss of protein store in the body. During the process, there are lack of protein anabolism thus resulted in increased a net result of protein catabolism during haemodialysis treatment. At the same time, resting energy expenditure also increase during haemodialysis lead to persistent elevated net protein catabolism during haemodialysis treatment

Haemodialysis treatment itself is the associated factor of malnutrition because it induced nutrition loss, induced inflammation, impaired efficacy of uraemia and metabolic acidosis correction, and dialysis adequacy, frequency, and duration (Sahathevan et al., 2020). Based on the study in Malaysia, it reported, average protein intake among hemodialysis patient is about 1.2 gram per kilogram of body weight. The average value is below than the recommendation intake which contribute to the protein energy wasting and malnutrition (Sahathevan et al., 2015). In addition, hemodialysis patients also usually develop physical function impairment due to the declined of lean tissue mass, the capacity of cardiorespiratory function and muscle strength. Loss of muscle strength is not only associated with normal aging process but it also occurs in hemodialysis patients due to the several factors for instance inflammation, malnutrition and nutrient loss. Amino acids are the substance losses during the hemodilaysis treatment. Amino acids are responsible in muscle maintenance, thus loss of amino acids in the body will impaired the muscle performance and resulted in low muscle strength (Hendriks et al., 2020). Therefore, inadequate dietary protein intake among hemodialysis patients is very common resulted in wide variety of adverse outcome.

These patients are slightly different with other non hemodialysis patients because they required higher protein intake to maintain their muscle mass because hemodialysis patients are at a higher risk of protein loss during hemodialysis treatment as they usually undergo inflammation, metabolic acidosis and oxidative stress that can promote or increase degradation of muscle protein in their body. Based on the previous study, patients receiving hemodialysis