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THE RELATIONSHIP BETWEEN THE DURATION OF HEMODIALYSIS AND BODY MASS INDEX IN CHRONIC KIDNEY DISEASE PATIENTS AT SANJIWANI HOSPITAL

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ABSTRACT

Chronic kidney disease (CKD) occurs when kidney function declines, as indicated by a glomerular filtration rate (GFR) below 60 mL/min/1.73 m² for 3 months or more. Hemodialysis is used to replace the lost kidney function. However, long-term hemodialysis can worsen the nutritional status of patients. Body mass index (BMI) is a good non-invasive indicator for assessing nutritional status. The purpose of this study is to determine the relationship between the duration of hemodialysis and BMI in CKD patients at Sanjiwani Hospital. This analytical observational study used a cross-sectional approach involving 95 CKD patients undergoing hemodialysis at Sanjiwani Hospital who met the inclusion and exclusion criteria. The relationship between the duration of hemodialysis and BMI was analyzed using the Spearman correlation test. The study subjects were predominantly male (63.2%), with a median age of 50 years (range: 21-63 years). The median duration of hemodialysis was 3 years (range: 1-17 years). The mean BMI was 24.15 ± 4.56 kg/m². The analysis showed a significant relationship between the duration of hemodialysis and BMI ($r = -0.211$, $p = 0.04$). This study concludes that there is a weak but significant negative correlation between the duration of hemodialysis and BMI, with a tendency for longer hemodialysis duration to be associated with a decrease in BMI.

Keywords: chronic kidney disease., hemodialysis., body mass index.

INTRODUCTION

Chronic kidney disease (CKD) is one of the major health issues worldwide. CKD occurs when kidney function declines, as indicated by a glomerular filtration rate (GFR) below 60 mL/min per 1.73 m² for three months or more, regardless of the underlying cause.[1] When the GFR falls below 15 mL/min per 1.73 m², severe complications arise, necessitating treatments such as dialysis or kidney transplantation.[2] CKD has a poor prognosis, requires high treatment costs, and shows a continually increasing incidence and prevalence of kidney failure.[3]

The prevalence of CKD at certain stages is estimated to affect 1 in 10 global population.[3] CKD has become the 16th leading cause of death worldwide. In 2015, out of 249 renal units in Indonesia, 30,554 patients were actively undergoing dialysis, the majority of whom had chronic kidney disease. CKD ranked 7th among the ten most common diseases requiring hospitalization in Bali in 2017, with 1,572 cases. According to data, the number of CKD cases in Bali Province affects 38.7% of the population, making it the second highest in Indonesia, after Jakarta.[3] This situation makes CKD one of the diseases that require increased attention.

Patients with CKD experience various clinical manifestations that impair their health and quality of life due to the decline in kidney function. Common symptoms include shortness of breath, sleep disturbances, pain, dizziness, fatigue, nausea, vomiting, weight loss, muscle weakness, and joint stiffness. According to the disease stages based on GFR, CKD is classified into five stages. In stages 1-3, symptoms are generally not yet apparent. However, in stages 4-5, kidney function significantly declines.[2] The 2015 guidelines from the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) recommend hemodialysis for patients with stage 4 CKD (GFR 30 mL/min/1.73 m²) who present with signs and symptoms of kidney failure (serositis, pruritus, and acid-base abnormalities), uncontrolled blood pressure, declining nutritional status despite dietary management, and cognitive decline. Hemodialysis is also indicated for patients with acute conditions related to acute kidney disease, uremic encephalopathy, hyperkalemia, pericarditis, refractory metabolic acidosis, hypervolemia causing complications, malnutrition, and for asymptomatic patients with a GFR of 5 to 9 mL/min/1.73 m².[4]

Hemodialysis is a medical procedure that replaces the function of non-working kidneys. This procedure uses a dialysis machine to filter the blood, removing metabolic waste, excess fluids, and electrolytes not effectively eliminated by poorly functioning kidneys.[5] Long-term hemodialysis can lead to a decline in the patient's nutritional status, resulting in malnutrition.

The mechanism of malnutrition in CKD patients undergoing hemodialysis involves protein catabolism, secondary insulin resistance, inflammation, and increased serum leptin levels.[6] Iatrogenic factors involved in malnutrition in CKD patients include inadequate dialysis, leading to uremia and correction of metabolic acidosis, and/or low serum albumin levels in patients undergoing dialysis with highly permeable membranes. Meanwhile, non-iatrogenic approaches should identify the implications of dietary insufficiencies, such as suboptimal dietary protein intake (DPI) and dietary energy intake (DEI), poor appetite, inflammation, low diet quality, and a high monotonous diet index, which indicate barriers to achieving dietary adequacy, and/or identify psychosocial and financial barriers to optimal nutrition.[7]

Malnutrition is a strong predictor of mortality and morbidity, as well as increased hospital admissions, low physical activity, poor quality of life, and inadequate dialysis.[8] Therefore, several guidelines recommend regular nutritional status assessments as part of routine care. Various methods can assess nutritional status, including physical examinations, laboratory data, food intake, energy expenditure, and anthropometric evaluations. Anthropometric measurements are a non-invasive, reliable, and easily applied method for assessing nutritional status. Body mass index (BMI) is the most commonly used anthropometric indicator. The formula for BMI is weight (kg) divided by the square of height (m).[9]

Research on the relationship between the duration of hemodialysis and BMI has been limited and shows varied results. A study by Putra, Asmara, and Cholidah on the relationship between the duration of hemodialysis and nutritional status found no association between the duration of hemodialysis and BMI.[10] This is supported by a study by Insani, Ayu, and Anggraini on the relationship between the duration of hemodialysis and nutritional status, which also found no association between the duration of hemodialysis and BMI.[11] On the other hand, according to Widyastuti, Butar-Butar, and Bebasari, there is a significant relationship between the duration of hemodialysis and BMI.[12] Research on the relationship between the duration of hemodialysis and BMI in Bali Province is still limited, despite the high number of CKD patients undergoing hemodialysis in the region. Based on this issue, the author is interested in conducting a study on the relationship between the duration of hemodialysis and BMI in CKD patients at Sanjiwani Hospital.

LITERATURE REVIEW

Hemodialysis

Hemodialysis is a therapy that filters excess water, solutes, and toxins from the blood, similar to the function of normal kidneys. Hemodialysis helps control blood pressure and maintain the balance of minerals such as calcium, sodium, and potassium in the blood. The principle of dialysis is based on the diffusion of solute particles through a semipermeable membrane. Metabolic waste products, such as urea and creatinine, diffuse down their concentration gradient from the circulation into the dialysate.

Perhimpunan Nefrologi Indonesia (PERNEFRI) has established several indications for hemodialysis in CKD patients, including all patients with creatinine clearance (CC)/GFR < 15 mL/min, GFR < 10 mL/min with uremia and/or malnutrition, CC/GFR < 5 mL/min in asymptomatic patients with acute complications (such as hyperkalemia, pulmonary edema, and refractory metabolic acidosis), and it may be initiated earlier in patients with diabetic nephropathy. Several complications during hemodialysis sessions (e.g., headache, nausea, hypotension) and some side effects of hemodialysis (e.g., pruritus and access site complications) are significantly correlated with malnutrition.[13]

Body Mass Index

Body Mass Index (BMI) is an anthropometric measurement that is non-invasive, reliable, and easy to apply for assessing nutritional status.[14] The BMI calculation formula is as follows:

BMI = weight in kilograms / [height in meters x height in meters]

According to the Centers for Disease Control and Prevention (CDC), anthropometry, including BMI, can assess the nutritional status of both adults and children. BMI measurements are non-invasive and, therefore, have no contraindications for their use. Factors such as age, gender, ethnicity, body posture, genetics, and environment can influence BMI measurements.[15]

The Relationship Between the Duration of Hemodialysis and Body Mass Index

Patients undergoing hemodialysis experience rapid weight loss after initiating dialysis. Greater weight loss during the first few months of dialysis initiation is associated with a higher risk of mortality.[16] Longer duration of hemodialysis has been associated with an increased risk of malnutrition. Malnourished patients experience a significant decrease in BMI.[17]

Factors involved in malnutrition in CKD patients include iatrogenic and non-iatrogenic factors. Iatrogenic factors are unintended consequences of dialysis in CKD patients, while non-iatrogenic factors develop spontaneously

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from contributing factors associated with the progression of CKD, but are not related to the primary treatment. Iatrogenic factors involved in malnutrition in CKD patients undergoing hemodialysis include inadequate dialysis leading to uremia and correction of metabolic acidosis, and/or low serum albumin levels in patients undergoing dialysis with highly permeable membranes. Non-iatrogenic factors should identify the implications of dietary insufficiencies, such as suboptimal dietary protein intake (DPI) and dietary energy intake (DEI), poor appetite, inflammation, low diet quality, and high diet monotony index, which indicate barriers to achieving dietary adequacy, and/or identify psychosocial and financial barriers to optimizing nutrition.[7]

MATERIALS AND METHODS

This study is an analytical observational research with a cross-sectional approach. The research data consists of primary data from the measurement of the body mass index (BMI) of patients and secondary data from the patient's medical records. The study sample consists of CKD patients undergoing hemodialysis at Sanjiwani Hospital who meet the inclusion and exclusion criteria, selected consecutively. The inclusion criteria include CKD patients who have been undergoing hemodialysis for ≥ 3 months, are willing to sign an informed consent form, and are male and female aged 18-64. The exclusion criteria include patients with impaired consciousness and incomplete medical records. The minimum required sample size is 91 samples. The independent variable in this study is the duration of hemodialysis. The dependent variable is BMI. Controlled variables in the analysis are stratified based on the results of statistical analysis, including age and gender. This study will be conducted in the Hemodialysis Room of Sanjiwani Hospital from January to September 2024. For normality testing, the Kolmogorov-Smirnov test will be used. Data is considered normally distributed if the p-value > 0.05. The relationship analysis will be conducted using Pearson's correlation test if the data is normally distributed or Spearman's correlation test if the data is not normally distributed, with a significance level of $\alpha = 0.05$.

RESULTS

Characteristics of the Study Subjects

A total of 95 chronic kidney disease (CKD) patients undergoing hemodialysis at RSUD Sanjiwani Gianyar, who met the inclusion criteria for this study, were enrolled. The normality test revealed that the age data was not normally distributed (p = 0.011). The duration of hemodialysis data was not normally distributed (p = 0.000). Meanwhile, the body mass index (BMI) data was normally distributed (p = 0.057). The characteristics of the study subjects are presented in Table 1 below. Among the 95 subjects, the number of male subjects was higher than female subjects. There were 60 male subjects (63.2%) and 35 female subjects (36.8%). The median age of the subjects was 50 years, with the youngest subject being 21 years old and the oldest subject being 63 years old. The median duration of hemodialysis was 3 years, with the shortest duration being 1 year and the longest duration being 17 years. Among the 95 subjects, the average BMI was 24.15 ± 4.56 kg/m². The distribution of BMI in the 95 subjects was categorized as underweight (<18.5) in 6 subjects (6.3%), normal weight (18.5-22.9) in 34 subjects (35.8%), overweight (23.0-24.9) in 19 subjects (20%), obesity class I (25.0-29.9) in 28 subjects (29.5%), and obesity class II (≥30.0) in 8 subjects (8.4%).

Table 1. Characteristics of the study subjects

Variable	Frequency (%)	Mean ± Standard Deviation (SD)	p-Value
Gender:			
Male	60 (63.2)		
Female	35 (36.8)		
Age (years)		50 (21-63)*	0.011
Duration of Hemodialysis (years)		3 (1-17)*	0.000
Body Mass Index (kg/m²)		24.15 ± 4,56	0.057
Underweight	6 (6.3)		
Normal	34 (35.8)		
Overweight	19 (20)		
Obesity I	28 (29.5)		
Obesity II	8 (8.4)		

*: the data are presented as median (minimum–maximum) due to non-normal distribution

The Relationship between the Duration of Hemodialysis and Body Mass Index

The results of the analysis examining the association between the duration of hemodialysis and BMI are shown in Table 2 below. Spearman's correlation test revealed a significant weak negative correlation between hemodialysis duration and BMI, with a correlation coefficient of $r = -0.211$ (p = 0.04). This indicates that the longer a patient undergoes hemodialysis, the more their BMI tends to decrease.

Table 2. Results of the analysis on the relationship between the duration of hemodialysis and body mass index

	Body Mass Index (kg/m²)	
	Spearman Correlation Coefficient	p-Value
The Duration of Hemodialysis	-0.211	0.04

DISCUSSION

The subjects of this study consisted of 95 individuals who met the research criteria. In a study conducted by Lajuck, Moeis, and Wongkar, there were 32 PGK patients

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undergoing hemodialysis.[18] Another study conducted by Ladesvita and Mulyani included a larger sample size, consisting of 95 PGK patients undergoing hemodialysis.[19]

The age of the study subjects ranged from 21 to 63 years. The median age of the study subjects was 50 years, with the largest group falling within the age range of 50-59 years. A study conducted by Mahesvara, Yasa, and Subawa also found that the largest sample group was within the 50-59 age range.[20] This is similar to the study conducted by Permatasari and Maliya, which showed that the largest sample group was in the age range of 39-59 years.[21] Similarly, the study conducted by Malfica, Rosita, and Yuantari also showed that the largest sample group was in the age range of 45-59 years.[22] These data are also supported by the data from the Indonesian Ministry of Health, which shows that the majority of hemodialysis patients are in the age range of 45-64 years.[3] Over the years, the kidneys undergo age-related changes, as evidenced by a decline in glomerular filtration rate (GFR), which reflects the loss of kidney function. Anatomical and functional changes increase with advanced age, leading to a reduction in GFR.[23] According to the research conducted by Jamshidi et al., aging, hypertension, diabetes, obesity, high lipid profile, and blood urea nitrogen (BUN) levels have direct and indirect effects on the decline of GFR.[24] Studies conducted from the 1930s to the 1950s have demonstrated that the decline in glomerular filtration rate (GFR) generally begins after the age of 30-40 years and may accelerate after the age of 50-60 years. The loss of kidney function with aging reflects a physiological decline in GFR associated with a decrease in biological function and progressive structural changes, regardless of the presence of disease.[23] This is difficult to distinguish from the pathological decline in GFR associated with kidney disease. Half of the population over 70 years of age has a GFR <60 mL/min/1.73 m².[25] The first report on the decline of GFR with age, published in 1950, described a reduction in GFR measured by inulin clearance, from 123 mL/min/1.73 m² to 65 mL/min/1.73 m² at the age of 90, decreasing by approximately 8 mL/min/1.73 m² per decade.[23]

The subjects of this study were predominantly male, accounting for 60 individuals (63.2%). This is consistent with the study conducted by Rahman, Kaunang, and Elim, which showed that the study subjects, consisting of CKD patients undergoing hemodialysis who met the inclusion and exclusion criteria, were predominantly male, comprising 88.2%.[26] The study conducted by Bayhakki and Hasneli also showed that the study sample was predominantly male, accounting for 64.7%.[27] This data is also supported by information from the Ministry of Health of the Republic of Indonesia, which states that the majority of kidney failure cases are dominated by males.[3] A study involving 12 countries, including Australia, Canada, Belgium, France, Italy, Germany, Japan, Spain, New Zealand, Sweden, the United States, and the United Kingdom, in the Dialysis Outcomes and Practice Patterns Study (DOPPS) showed that among all age groups, male patients undergoing hemodialysis were dominant, accounting for 59%.[28] A study conducted by Zhang et al. showed that sex hormone-dependent differences in the expression of Epidermal Growth Factor Receptor (EGFR) may be a contributing factor to the tendency of men to develop chronic kidney disease (CKD), as EGFR expression is lower in the kidneys of adult females, both in mice and humans.[29]

The study subjects who had been undergoing hemodialysis for ≤ 3 years totaled 44 people (46.3%), while those who had been undergoing hemodialysis for > 3 years totaled 51 people (53.7%). The duration of hemodialysis for the patients ranged from 1 year to 17 years, with a median of 3 years. This finding differs from the study conducted by Kusuma, which reported that the duration of hemodialysis for patients ranged from 1 year to 6 years.[30] Another study by Wulandari and Fatimah showed that 56.25% of chronic kidney disease (CKD) patients had been undergoing hemodialysis for ≤ 3 years, while 43.75% had been undergoing hemodialysis for > 3 years.[31] The study conducted by Khazaei et al. states that age, dialysis duration, the cause of End-Stage Renal Disease (ESRD), vascular access, hemoglobin levels, and marital status are factors that may be associated with the survival of CKD patients undergoing hemodialysis.[32]

The subjects in this study had BMI categories as follows: underweight (<18.5 kg/m²) with 6 subjects (6.3%), normal weight (18.5-22.9 kg/m²) with 34 subjects (35.8%), overweight (23.0-24.9 kg/m²) with 19 subjects (20%), obesity class I (25.0-29.9 kg/m²) with 28 subjects (29.5%), and obesity class II (≥30.0 kg/m²) with 8 subjects (8.4%). A study by Aini and Novita reported that, out of 46 samples, the BMI categories were as follows: underweight with 10 individuals (21.7%), normal weight with 31 individuals (67.4%), and overweight with 5 individuals (10.9%).[33] Another study conducted by Sitompul, Rotty, and Sugeng found that, out of 42 samples, the BMI categories were as follows: 7 individuals with underweight (BMI < 18.5 kg/m²), 23 individuals with normal weight (BMI 18.5-22.9 kg/m²), 7 individuals with overweight (BMI 23-24.9 kg/m²), and 5 individuals with obesity (BMI > 25 kg/m²).[34] The varying BMI in patients with chronic kidney disease (CKD) undergoing hemodialysis can be influenced by several factors. Factors that may lead to malnutrition include inadequate dialysis, poor appetite, inflammation, low diet quality, and a high diet monotony index, which indicate barriers to achieving dietary adequacy, and/or the identification of psychosocial and financial barriers to nutritional optimization.[7] Meanwhile, excessive energy intake combined with physical inactivity, low-grade inflammation, and insulin resistance, which are common in patients with end-stage renal disease (ESRD), can lead to "sarcopenic obesity," a condition characterized by the loss of muscle mass due to excess adiposity.[16]

The results of this study indicate a significant weak negative correlation between the duration of hemodialysis and BMI, with a correlation coefficient of r = -0.211 (p = 0.04). This study shows a difference compared to the previous research conducted by Widyastuti, Butar-Butar, and Bebasari, which reported a moderate positive correlation between the duration of hemodialysis and BMI in patients with CKD.[12] Factors such as the characteristics of the study subjects have the potential to cause differences in the research results. This study had a larger sample size, with male subjects predominating, and the duration of hemodialysis ranged from 1 to 17 years, with an average of 4.55 years. In contrast, the study conducted by Widyastuti, Butar-Butar, and Bebasari had a smaller sample size (58 participants), with female subjects predominating, and the duration of hemodialysis ranged from 2 to 120 months (with an average of 24.47 months).[12] Other factors, such as dietary adherence, physical activity, and appetite, as well as psychosocial and financial factors that were not further analyzed, may also influence the differences in the research results.

Dialysis affects chronic nutrient loss, particularly amino acids and proteins. Each dialysis session can result in the loss of approximately 6-12g of amino acids and 7-8g of protein, leading to hypoalbuminemia, which can predict malnutrition and mortality. Furthermore, the causes of malnutrition in dialysis patients include anorexia (inadequate calorie or protein intake), metabolic acidosis (which stimulates amino acid and protein degradation), and infection/inflammation (which stimulates protein degradation). Anorexia leads to decreased intake and is the most significant factor in determining the patient's nutritional status.[7] The protein requirements of patients undergoing hemodialysis are increased (1.2–1.3 g/kg/day) according to the Kidney Disease Outcomes Quality Initiative (KDOQI) Clinical Practice Guidelines for Nutrition. Protein-energy wasting (PEW) indicates the simultaneous loss of protein and energy reserves in patients with kidney dysfunction. This tends to develop as CKD progresses. In a suboptimal energy supply, CKD and end-stage renal disease (ESRD) patients catabolize muscle to provide the required energy, leading to protein malnutrition.[35] Patients undergoing hemodialysis experience rapid weight loss after starting dialysis. Greater weight loss during the first few months of dialysis initiation is associated with a higher risk of mortality.[16] Longer duration of hemodialysis has been associated with an increased risk of malnutrition. Malnourished patients experience a significant decrease in BMI.[17]

1. SUMMARY AND RECOMMENDATIONS

This study concludes that there is a weak but significant negative correlation between the duration of hemodialysis and body mass index (BMI) in patients with chronic kidney disease (CKD) at RSUD Sanjiwani, with a tendency for an increase in the duration of hemodialysis to be followed by a decrease in BMI. The recommendation from this study is that further research is needed to explore other variables related to the BMI of CKD patients undergoing hemodialysis, such as iatrogenic and non-iatrogenic factors. This study found a tendency for longer hemodialysis duration to be associated with a decrease in BMI, which should be considered when monitoring and intervening in the nutritional status of CKD patients undergoing hemodialysis. Nutritional support should also be adjusted to meet the needs of individuals undergoing prolonged hemodialysis.

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