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The Relationship Between Hemodialysis Adequacy and Nutritional Status in Ibnu Sina Gresik Hospital, Indonesia

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Abstract Uremic malnutrition may happen to patients with kidney failure who underwent hemodialysis consistently. The aim of this study is to identify the adequacy of hemodialysis and its association with nutrition status. This was a cross-sectional study conducted in Ibnu Sina Gresik Hospital. Of 96 hemodialysis patients recruited, nutritional status such as body mass index (BMI), fat mass, fat-free mass, skeletal muscle mass, extracellular water, and visceral adipose tissues was assessed by the Medical Body Compose Analyzer (mBCA). Hemodialysis adequacy (Kt/V) and nutrition status association was tested by bivariate and multivariate analysis. The respondents' mean age was 50.28±10.28 years. Hemodialysis adequacy was in the category of ≥1.8 (61.46%). Demographic characteristics had no relationship with hemodialysis adequacy ($p>0.05$), and there was a relationship between hemodialysis adequacy and waist circumference ($p=<0.001$). All indicators of nutritional status were not significantly related to hemodialysis adequacy ($p>0.05$), except the total body water ($p = 0.030$). The multivariate analysis showed that hemodialysis adequacy had no significant relationship with the nutritional status in Multivariate Analysis of Variance (MANOVA) after a predictor (the other independent variable) was added. Hemodialysis analysis was significantly related to the total body water. Future research should conduct a comprehensive evaluation of nutritional status to prevent increased morbidity and mortality factors.

Keywords Hemodialysis, Hemodialysis Adequacy, Nutritional Status, Kidney Failure

1. Introduction

Kidney failure is a progressive disease and has emerged as one of the most prominent causes of death globally [1]. According to the Global Burden of Disease study, in 2010, end-stage kidney disease was known to cause death in 2.3-7.1 million people, with the disease resulting in the death of 5-10 million people annually [2]. In 1990, kidney failure was ranked 27th on the list of global causes of death, but it rose considerably to 18th place by 2010 [3]. This significant upward movement is a crucial indicator for raising queries.

The increasing prevalence, mortality, and Disability-Adjusted Life Years (DALYs) associated with end-stage kidney failure necessitate long-term therapy replacement, known as haemodialysis [4, 5]. Furthermore, dialysis costs pose a heavy burden for patients. Evidence from China indicates that total expenses and out-of-pocket expenses for patients undergoing haemodialysis are higher compared to peritoneal dialysis, with self-paid expenses exceeding those covered by insurance [5].

This disease also contributed to the second highest health expenditure in the Social Security Agency of Health [6]. Chronic kidney disease is defined as the presence of kidney damage or an estimated glomerular filtration rate (eGFR) less than 60 ml/min/1.73 m^2. It leads to an increase in electrolyte levels and the accumulation of nitrogenous waste products such as urea and creatinine due to kidney malfunction [7]. To mitigate the risks associated with uremic toxicity, maintaining glomerular function is crucial. Haemodialysis is a therapy used to treat severe kidney failure, where a semi-permeable membrane serves as a substitute nephron to remove waste products from the body and restore electrolyte balance [8].

Hemodialysis is a therapy for treating severe kidney failure where the semi-permeable membrane is used as a substitute nephron to remove the body waste and to balance electrolytes in the body [8]. The annual number of hemodialysis patients at Ibu Sina Hospital has been increasing sharply from 226 patients in 2016 to 1.466 patients in 2021, most of whom were 51-60 years of age [9].

Evidence suggests that the association between haemodialysis adequacy and dietary requirements remains inconclusive. The effects of haemodialysis on patients include an increase in urea in the blood or uremic malnutrition. One study presents a significant association between haemodialysis adequacy and patients' dietary needs, as measured by body mass index and albumin levels in the blood [3]. However, another study highlighted that haemodialysis showed no association with nutritional status, although appetite demonstrated a significant association with nutritional status [4]. Findings from a study by Widiyanto et al. showed an association between changes in interdialytic weight and fluctuations in blood pressure after haemodialysis [10]. The inadequacy hemodialysis status raised a question. Furthermore, this study aims to identify an association between hemodialysis adequacy and the nutritional status of hemodialysis patients such as body mass index, fat mass, fat-free mass, skeletal muscle mass, total body water, and visceral adipose tissues at Ibnu Sina Hospital in Gresik Regency, Indonesia.

2. Materials and Methods

2.1. Research Method

This current study used observational-analytic and cross-sectional approaches. Purposive sampling was used to select 96 samples from 204 populations. Primary data from surveys and secondary data from literature were used to examine hemodialysis adequacy as the process variable and nutritional status as the outcome variable. The nutritional status included body mass index, fat mass, fat-free mass, extracellular water, visceral adipose tissue, and skeletal muscle mass. This study has been approved by the Ethic Commission of Alma Ata University with certificate numbers (KE/AA/VII/10859/EC/2022).

This study was conducted at the Hemodialysis Unit and Dietary Clinic of Ibnu Sina Hospital, Gresik. Two hundred and four respondents were hemodialysis patients who underwent the treatment from June to August 2022. The selected respondents met the criteria: having regular hemodialysis, being at the age of 17-65 years, not bearing pregnancy, communicating well, having visited the hospital more than twice, and giving consent to participate in the study. Respondents who had characteristics outside of these criteria were excluded.

This study analyzed an independent variable of hemodialysis adequacy and a dependent variable of nutritional status (including body mass index, fat mass, fat-free mass, extracellular water, visceral adipose tissue, and skeletal muscle mass).

2.2. Instrument of the Study

Data collection was conducted using observation sheets to measure the hemodialysis adequacy with the unit measurement of K (clearance of urea) ml/minute, t (time on dialysis) minute, V (volume of distribution of urea) ml and Kt/V with unit measurement ml/minute [8]. Besides, measurement using a Medical Body Composition Analyzer (mBCA) was taken for body mass index, fat mass, fat-free mass, extracellular water, visceral adipose tissue, and skeletal muscle mass.

2.3. Data Process and Analysis

Mean and standard deviation are utilized to summarize continuous data assumed to follow a normal distribution, providing insights into the central tendency and variability of the dataset. Conversely, categorical data are typically summarized using frequency and percentage distributions, offering a clear representation of the distribution of different categories within the dataset.

In the context of data collection, a systematic approach was adopted to ensure data quality. Initially, data from the survey were meticulously sorted to confirm the completion of all required fields. Subsequently, rigorous coding procedures were implemented to input observation sheets into computer software, ensuring accuracy and consistency in data entry. Following this, a thorough data cleaning process was conducted to identify and rectify any potential inaccuracies or inconsistencies in the dataset.

Univariate and bivariate analyses were carried out to explore individual variables and assess relationships between variables, respectively. To evaluate the combined effects of multiple independent variables on one or more dependent variables, Multivariate Analysis of Variance (MANOVA) was employed for hypothesis testing, providing valuable insights into complex interrelationships within the data. All statistical analyses were performed using STATA 13.0 (Stata Corporation, College Station, TX).

3. Results

3.1. Demographic Characteristics

Table 1 shows the demographic characteristics of the respondents. Demographic characteristics of respondents show that the average age of the respondents is 50.28 ± 10.28 years. This survey involved 96 respondents consisting of 49 males (51.04%) and 47 females (48.96%), respectively. The respondents' average weight and height are 57.36 ± 12.28 kg and 157.16 ± 10.39 cm. The nutritional status (kg/m^2) of the respondents is seen from several indicators such as fat mass index 6.16 ± 3.82 kg/m^2, total body water 31.15±6.96 %, and total energy expenditure 2,378.33 ± 444.13 kcal. Then, we categorized total energy expenditure by the average of total energy expenditure (<2300 kcal and ≥2300 kcal). Total energy expenditure of less than 2,300 kcal that was experienced by 45 respondents and 51 respondents encountered that of greater or equal than 2,300 kcal. The filtration for hemodialysis was 2,219.79 ± 1,025.83 ml. The average of waist circumference was 0.84 ± 0.14 m.

Table 1. Demographic Characteristics of the Study Subjects (N = 96)

Characteristics	Mean ± SD	n (%)
Age, years	50.28 ± 10.28	
Gender		
a. Female		47 (48.96)
b. Male		49 (51.04)
Weight, kg	57.36 ± 12.28	
Height, cm	157.16 ± 10.39	
Fat mass index, kg/m^2	6.16 ± 3.82	
Total body water, %	31.15 ± 6.96	
Total energy expenditure, kcal	2378.33 ± 444.13	
Total energy expenditure status		
a. <2300 kcal		45 (46.88)
b. ≥2300 kcal		51 (53.12)
Resting energy expenditure, kcal	1387.05 ± 207.06	
Resting energy expenditure status		
a. <1245		29 (30.21)
b. >1245		67 (69.79
Ultrafiltration Rate, ml	2,219.79 ± 1,025.83	
Waist Circumference, m		0.84 (0.14)

3.2. Hemodialysis Adequacy

The status and value of the study subject's hemodialysis adequacy (ml/minute) are presented in Table 2. The mean of hemodialysis adequacy from all subject was 2.11 ± 0.68 ml/minute. There were 37 respondents categorized as having hemodialysis inadequacy (38.54%) due to being under 1.8, and 59 respondents had hemodialysis adequacy (61.46%) greater than or equal to 1.8.

Table 2. Hemodialysis Adequacy of the Study Subjects (N = 96)

Characteristics	Mean ± SD	n (%)
Kt/V, ml/minute	2.11 ± 0.68	
Hemodialysis adequacy status		
a. < 1.8		37 (38.54)
b. ≥ 1.8		59 (61.46)

3.3. Nutritional Status Characteristics

Table 3 presents the body mass index, fat mass, visceral adipose tissue, free fat mass, skeletal muscle mass, and total body water. The respondents had an average BMI of 22.98 ± 4.21 kg/m^2 or normal category. Based on the BMI indicator, 11 respondents had a low BMI; 58 respondents had a normal BMI; 20 respondents had a high BMI; and 7 respondents were obese. The average fat mass was 15.15 ± 8.97 kg. Nine respondents had low fat mass; 56 respondents had normal fat mass; and 31 respondents had high-fat mass category. The visceral adipose tissue of the respondents was 2.03 ± 1.17 kg. Forty-six respondents had normal visceral adipose tissue; 29 had intermediate visceral adipose tissue; and 21 respondents had high visceral adipose tissue. The average fat-free mass was 42.32 ± 9.73 kg, and the average skeletal muscle mass was 17.14 ± 6.06 kg. The total body water level was 14.90 ± 2.95 %.

3.4. The Association between Hemodialysis Adequacy Status and Demographic Characteristics

The independent variables were analyzed and compared by ANOVA test (Table 4). Most of the demographic characteristics including age ($p = 0.32$), weight ($p = 0.92$), height ($p = 0.44$), fat mass index ($p = 0.43$), free fat mass index ($p = 0.69$), total energy expenditure ($p = 0.85$), and resting energy expenditure ($p = 0.57$) had no significant relationship with hemodialysis adequacy. However, waist circumference had a significant relationship with hemodialysis adequacy ($p < 0.001$).

3.5. The Association between Hemodialysis Adequacy Status and Nutritional Status Indicators

The results of bivariate analysis of hemodialysis adequacy and nutritional status are demonstrated in Table 5. The statistical results of analysis of variance (ANOVA) showed hemodialysis adequacy status was not significantly associated with nutritional status indicators. Each dependent variable including body mass index (p = 0.21), fat mass (p = 0.59), fat-free mass (p = 0.51), skeletal muscle mass (p = 0.53), total body water (p = 0.65), and visceral adipose tissue (p = 0.90) had p-values of more than 0.05.

Table 3. Nutritional Status of the Study Subjects (N = 96)

Characteristics	Mean ± SD	n (%)
BMI, kg/m^2	22.98 ± 4.21	
BMI status		
a. Underweight		11 (11.46)
b. Normal body weight		58 (60.42)
c. Overweight		20 (20.83)
d. Obese		7 (7.29)
Fat mass, kg	15.15 ± 8.97	
Fat mass categories		
a. Low		9 (9.38)
b. Normal		56 (58.33)
c. High		31 (32.29)
Visceral adipose tissue, kg	2.03 ± 1.17	
Categories of visceral adipose tissue		
a. Normal		46 (47.92)
b. Intermediate		29 (30.21)
c. High		21 (21.88)
Fat free mass, kg	42.32 ± 9.73	
Skeletal muscle mass, kg		17.14 (6.06)
Total body water, %	14.90 ± 2.95	

BMI: Body mass index; SD: Standard deviation.

Table 4. Results of ANOVA of hemodialysis adequacy status and demographic characteristics (N = 96)

Predictors	Sum of Squares	df	Mean of Squares	F	P-Value
Age, years	4.04	1	4.04	0.04	0.32
Weight, kg	9.83	1	9.83	0.06	0.92
Height, cm	9.67	1	9.67	0.09	0.44
Fat mass index, kg/m^2	8.95	1	8.95	0.61	0.43
Fat- free mass index, kg	41.06	1	41.06	0.43	0.69
Waist circumference, m	0.06	1	0.06	3.12	<0.001
Total energy expenditure, kcal	6,439.59	1	6439.59	0.03	0.85
Resting energy expenditure, kcal	7,760.09	1	7760.09	0.18	0.57

Table 5. Results of ANOVA of hemodialysis adequacy and nutritional status (N = 96)

Predictors	Sum of Squares	df	Mean of Squares	F	P-Value
Body mass index	5.75	1	5.75	0.32	0.21
Fat mass	17.31	1	17.31	0.21	0.59
Fat-free mass	41.06	1	41.06	0.43	0.51
Skeletal muscle mass	27.45	1	27.45	0.74	0.53
Total body water	0.07	1	0.07	0.01	0.65
Visceral adipose tissue	0.08	1	0.08	0.06	0.90

3.6. Chi-square Analysis Results between Variables

The chi-square results from body composition indicators and hemodialysis adequacy status were demonstrated in Table 6. The hemodialysis adequacy was associated with the total body water status (p = 0.03), however there were not associated with other dependent variables (p>0.05).

Table 6. Chi square analysis results between variables

Dependent Variables	p-value	Status
Body mass index status	0.43	No significant association
Fatt mass status	0.14	No significant association
Fat Free Mass	0.151	No significant association
Total Body Water	0.03	Significant association
Visceral Adipose Tissue	0.77	No significant association
Skeletal Muscle Mass	0.27	No significant association

4. Discussion

This study raised a question about the association between hemodialysis adequacy and the nutritional status of hemodialysis patients. This objective was formed by considering the high prevalence of chronic kidney in Indonesian society.

Hemodialysis is considered a suitable therapy to lengthen the life span of patients with a severe chronic kidney failure [11]. It turns out that hemodialysis adequacy does not correlate with some nutritional status except waist circumference of patients at Ibu Sina Hospital, Gresik. This finding is in line with research by Utami et al. [12] who also did not find any statistical association between hemodialysis and nutritional status i.e., BMI and albumin level in blood. However, research by Hemayati [13] showed an association between hemodialysis adequacy and change in protein metabolism. Similar to Hemayati's finding, Solihatin et al. found that hemodialysis adequacy correlated with quality of life (p < 0.001) [14].

Hemodialysis adequacy contributes to avoiding complications because of uremic malnutrition. Supporting the results of this current study, Hong and Lee [15] used a retrospective approach to studying whether hemodialysis adequacy correlates with weight, body mass index, and mortality. From 18,242 respondents, mortality tends to happen due to both low and high Kt/V.

This current study showed that hemodialysis adequacy did not correlate with extracellular water. Fluid in the body is a physiological need. The water management for one-day hemodialysis patients is important because 60% of the body is composed of two types of water which are 36% intracellular water and 24% extracellular water. The excessive amount of fluid in patients with kidney failure may cause swelling in other parts of the body because the kidney cannot perform well. This result may be considered that overhydration becomes an independent predictor of mortality in patients with chronic kidney failure [16]. Gultom and Sudaryo [17] suggest that patients who routinely take hemodialysis will be more aware of the water limitation than those new ones. Higher hemodialysis adequacy results in higher water limitation of the patients.

Hemodialysis adequacy status showed an association with weight in this study. Previous research by Widiyanto et al. presented that the median weight after hemodialysis was 53.350 kg with 9.8344 kg of the standard deviation. Weight correlates with the blood pressure of patients after hemodialysis [10]. Although hemodialysis adequacy does not correlate to all of the nutritional status indicators, these indicators still can predict the length of stay and discharge [18].

Some limitations are acknowledged in this study. This study was conducted to identify any association between hemodialysis adequacy and nutritional status. However, the measurement is limited to some nutritional status indicators despite using adequate instruments for data collection.

5. Conclusions

This study concludes that hemodialysis adequacy did not have a significant association with demographic characteristics. Subject's waist circumference was significantly associated with hemodialysis adequacy status. Among all dependent variables, hemodialysis adequacy is associated with total body water but body mass index, fat mass, fat-free mass, skeletal muscle mass, and visceral adipose tissue. The future study has to investigate the factors that contribute to hemodialysis adequacy.

Competing Interests

The writers say they have no competing interests.

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