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The effect of high-protein snack consumption during hemodialysis on nutrient intake and nutritional status in patients with stage V chronic kidney disease

Pengaruh snack tinggi protein selama hemodialisis terhadap asupan zat gizi dan status gizi pasien gagal ginjal kronis tahap V

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Abstract

Protein-energy wasting (PEW) in hemodialysis patients can cause weight loss, muscle mass, physical strength, and biochemistry. Adequate protein intake during hemodialysis is essential to reduce catabolic effects and improve nutritional status. This study aimed to analyze the effects of high-protein snack consumption on nutrient intake (energy, protein, fat, carbohydrate, sodium, potassium, and phosphorus), nutritional status (BMI, Hb, and muscle mass), and handgrip strength. Methods: This study was conducted from August to September 2024 at Alimuddin Umar Hospital in West Lampung using a quasi-experimental design with a control group of 30 patients with chronic kidney disease (CKD). The intervention group received high-protein snacks (18 g/session), whereas the control group received low-protein snacks (<12 g/session) for six weeks. Nutrient intake was assessed using 24-hour recall, handgrip strength was measured using a camera dynamometer, and nutritional status was analyzed using anthropometric and biochemical parameters. The results showed an increase in nutrient (energy, p = 0,036; protein, p = 0,000; fat, p = 0,000; carbohydrate, p = 0,040; sodium, p = 0,010; potassium, p = 0,043; phosphorus, p = 0,001), Hb (p = 0,001), and urea (p = 0,015) intake, There were no changes in BMI (p= 0,836), muscle mass (p= 0,575), creatinine level (p= 0,183), or handgrip strength (p= 0,899) in patients with CKD. In conclusion, high-protein snacks used during hemodialysis can improve nutrient intake and clinical parameters in patients with CKD.

Keywords: Biochemical parameters, hemodialysis, high-protein snack, nutrient intake, protein-energy wasting

Abstrak

Protein-energy wasting (PEW) pada pasien hemodialisis bisa menyebabkan penurunan berat badan, massa otot, kekuatan fisik, dan biokimia. Asupan protein yang cukup selama hemodialisis sangat penting untuk mengurangi efek katabolik dan meningkatkan status gizi. Penelitian bertujuan untuk menganalisis pengaruh konsumsi snack tinggi protein terhadap asupan zat gizi (energi, protein, lemak, karbohidrat, natrium, kalium, fosfor) dan status gizi (IMT, Hb, massa otot) dan kekuatan genggam tangan. Penelitian telah dilakukan dari Agustus–September 2024, di RSUD Alimuddin Umar Lampung Barat, menggunakan desain kuasi-eksperimen dengan kelompok kontrol yang melibatkan 30 pasien gagal ginjal kronis (GGK). Kelompok intervensi menerima snack tinggi protein (18 g/sesi), sedangkan kelompok kontrol menerima snack rendah proten (<12 g/sesi) selama enam minggu. Asupan zat gizi dinilai menggunakan recall 24 jam, kekuatan genggam tangan diukur dengan dinamometer Camry, dan status gizi dianalisis menggunakan parameter antropometri dan biokimia. Hasil menunjukkan terdapat peningkatan asupan zat gizi (Energi p= 0,036, protein p= 0,000, lemak p= 0,000, karbohidrat p= 0,040, natrium p= 0,010, kalium p= 0,043, fosfor p= 0,001), kadar Hb (p= 0,001) dan ureum ureum (p=0,015). Tidak terdapat perubahan pada IMT (p=0,836), massa otot (p= 0,575), kreatinin (p= 0,183) dan kekuatan genggam tangan (p= 0,899) pada pasien GGK. Kesimpulan, snack tinggi protein selama hemodialisis dapat meningkatkan asupan zat gizi dan parameter klinis pada gagal ginjal kronis.

Kata Kunci: Asupan zat gizi, hemodialisis, snack tinggi protein, parameter biokimia, protein-energy wasting

Introduction

Chronic Kidney Disease (CKD) is a growing global health concern, as evidenced by its rising prevalence and impact on healthcare systems. Kidney failure, which significantly contributes to CKD, impairs the ability of the kidneys to filter waste and regulate the fluid and electrolyte balance. The Global Burden of Disease Study highlighted the severity of kidney failure, accounting for 1.2 million deaths in 2015, with a notable 32% increase in fatalities in 2005 (Wang et al., 2016). In Indonesia. The Indonesia Renal Registry (IRR) 2020 reported that 98% of patients with kidney failure were receiving hemodialysis, with 130,931 active patients in the country (Indonesian Renal Registry, 2020). This trend reflects a wider global increase in CKD prevalence, with 1,784 documented cases in 2018.

At RSUD Alimuddin Umar in Lampung Barat, 48 patients undergoing regular hemodialysis underscored the significant burden of CKD at the local level. However, while these data provide valuable insight into the current situation, they highlight the urgency of addressing the growing incidence of CKD. Projections suggest that the number of patients with CKD is likely to increase further, stressing the need for enhanced healthcare strategies, early detection, and prevention programs. Given the current trajectory, addressing CKD and its progression to kidney failure should be a primary research focus, as it directly affects public health, healthcare resources, and patient outcomes. Adding recent trends and future projections will strengthen the background of the research efforts to address this pressing issue.

High-protein snacks are chosen as an intervention strategy to address malnutrition in hemodialysis patients because they can help meet protein needs that are often not achieved through regular meals. Hemodialysis is a medical procedure that removes waste and toxins from blood through a semipermeable membrane (Susetyowati, 2017). However, this process can result in challenges, such as PEW. PEW is characterized by a reduction in body weight, fat, and muscle mass as well as a decline in biochemical indicators (Andrade & Parker, 2023). PEW affects 30-76% of hemodialysis patients (Deleaval et al., 2021), and factors such as inadequate hemodialysis dose (measured by URR or Kt/V) and insufficient nutrient intake contribute to malnutrition(Van Duong et al., 2019). A decreased intake of adequate protein further exacerbates this risk. Several studies have indicated that hemodialysis patients require a protein intake of 1,2 g/kg body weight and energy intake of 30-35 kcal/kg (KDIGO 2022). However, in practice, most patients consume only 0,8-1 g/kg body weight of protein and 20-25 kcal/kg body weight of energy, making them vulnerable to malnutrition and low serum albumin levels (Choi et al., 2019).

In hemodialysis, proper attention to nutrition is crucial. Insufficient food intake can pose a significant problem, potentially leading to adverse effects on patient health and well-being. Nutritional deficiency in patients undergoing hemodialysis frequently occurs on the day of the procedure (Hari et al., 2022). Protein loss during hemodialysis is a critical concern that requires further investigation. Approximately 12 g of amino acids may be lost during a single hemodialysis session, thereby reducing the blood amino acid content (Struijk-Wielinga et al., 2016). As a result, providing high-protein snacks during hemodialysis may help replace lost proteins, boost muscle protein synthesis, lower catabolism, and maintain the body's nitrogen balance.

Nutritional therapy aims to maintain or improve the nutritional status of hemodialysis patients and prevent energy PEW (Zolfaghari et al., 2015). Patient education is crucial to manage nutritional intake and enhance health outcomes. With proper education, patients are expected to increase their nutritional intake, maintain weight, and improve their laboratory markers (Zolfaghari et al., 2015).

No nutritional intervention was conducted during hemodialysis at Alimuddin Umar Hospital. This study suggests that providing patients with high-protein snacks during hemodialysis sessions is a creative way to improve their nutritional intake and health. This strategy has not been extensively adopted in Indonesian hospitals, particularly in RSUD Alimuddin Umar, where this study was conducted. A study conducted at an outpatient clinic in the Netherlands in 2016 showed that providing 18 g of high-protein food could increase energy and protein intake during hemodialysis (Struijk-Wielinga et al., 2016).

This study shows that the provision of high-protein snacks during hemodialysis has a significant impact on several aspects of patient health. Specifically, it is expected to enhance nutrient intake (energy, protein, fat, carbohydrates, sodium, potassium, and phosphorus), improve nutritional status (BMI, hemoglobin levels, and muscle mass), reduce blood urea and creatinine levels, and increase handgrip strength in patients with stage V CKD undergoing treatment at the hospital.

Methods

This study employed a pre-and post-test quasi-experimental design, with a control group. In a quasi-experimental design, the sampling process involved matching the intervention and control groups. This approach was implemented to address certain factors, such as reducing the risk of bias that could occur during the research.

The study Location at Hemodialysis room, Alimuddin Umar Hospital, West Lampung, and the duration of the study was from August to September 2024. The study subjects were patients with stage V chronic renal failure undergoing hemodialysis at Alimuddin Umar Hospital, West Lampung. This analytical research design utilizes numerical measurement scales to compare two paired groups with two measurements conducted on the same sample. Consequently, the following sample size calculation formula is applicable:

$$n = 2(\frac{(z\alpha+z\beta)}{x1-x2})S^2$$

$$n = 2(\frac{(1,64+1,28)}{1,7})1,1^2$$

n = 14, 27 (15)

Based on the sample size calculation, 30 participants were required for this study and divided into two groups: an intervention group (15 respondents)) and a control group (15 respondents). Both groups will receive nutritional counseling and education and a nutritionist will calculate the nutritional needs of each participant. The inclusion criteria were as follows: age between 20 and 75 years, regular hemodialysis (2 times per week, 4 hours per session) for at least 3 months, and medical records that included urea. The exclusion Criteria were as follows: uncooperative patients, patients who dropped out of the study before completion, and patients who did not consume the snacks provided during hemodialysis for three consecutive sessions.

The intervention group received snacks with 18 g of protein (dimsum, rissoles, chicken martabak, tofu stuffed with meatball filling, solo sausage, and arem-arem) and nutritional counseling. The control group receive snacks with a protein content of fewer than 12 grams (potato croquette, choux pastry, nagasari, lemper, cake, potato martabak) and nutritional counseling. Both groups received snacks twice a week for six weeks.

The rationale for the selection of snacks for the intervention and control groups with respect to their fat and sodium contents requires further justification. As patients with Chronic Kidney Disease (CKD) progress, both fat and sodium intake are critical for accelerating disease progression. Hypertension, a common comorbidity of CKD, can be exacerbated by excessive sodium intake, whereas increased fat intake can worsen the risk of cardiovascular diseases. For the intervention group, dimsum, rissoles, and chicken martabak, which carry 18 g of protein, should ideally be low in fat and sodium to reduce nephrotoxicity. Likewise, control participants were fed potato croquette and choux pastry, which contain less than 12 g of protein (Table 1).

While changes in muscle mass and handgrip strength generally take longer to be observed, a duration of six weeks was chosen because it allowed for the initial response to the intervention to be assessed. Significant changes in these parameters often take longer, but a six-week period provides valuable information on the early effects of increased protein intake and nutritional interventions on muscle function and physical strength. In addition, studies of shorter durations may identify early changes that can form the basis for further studies of longer durations. Therefore, although six weeks is not enough time to see major changes, it is still relevant for measuring the early impact of interventions.

Table 1. Type of snack

Snack (two portion)	Nutrition Facts						
	Energy (kcal)	Protein (g)	Fat (g)	CH (g)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)
Snack Intervention Group							
Dimsum	316,4	18,2	8,4	51,1	110,6	189,8	161,8
Risoles	297,8	16,8	20	28,4	74,4	224	164
Chicken Martabak	258,4	17,8	15	16	63	130,4	129,8
Toffu Stuff with Meatball	341,8	17,2	31	1,4	63,6	157,8	158,6
Solo Sausage	247	17,6	19	8	59,2	103,2	116,4
Arem-arem	265	17,8	11	24,4	37,2	129,6	125,6
Average	287,7	17,5	17,4	21,5	68	155,8	142,7
Snack Control Group							
Potato Croqutte	174,8	6,4	2,4	32	36,2	247,4	98,4
Choux Pastry	238,6	4,4	10,2	32	45,6	120,8	89,6
Nagasari	234	1,6	0,2	57,4	3	202,8	33,6
Cake	253,8	5	12,4	31,8	26,4	83,4	69,4
Lemper	200,8	10,2	6,6	24,2	22,2	86	87,2
Potato Martabak	236,4	5,6	12,4	26,2	27,8	24,2	81,6
Average	223	5,5	7,3	33,9	26,8	127,4	76,6

Body weight and height were measured before and after the intervention to calculate BMI. Nutritional screening was conducted using the Subjective Global Assessment (SGA) score. Nutrient Intake Monitoring: The 24-hour food recall method will monitor the participants' nutritional intake. Patients will be interviewed on the day after hemodialysis to record the type and amount of food and beverages consumed by the hospital-provided snack until the next day. Phone calls will be made on non-dialysis days to ensure a complete nutritional intake. Hb, urea, and creatinine levels were measured at the beginning and end of the study to assess the nutritional status and kidney function. Although the 24-hour recall method is susceptible to recall bias and has limitations in assessing long-term changes in nutrient intake, it was selected for this study because of its ability to provide a rapid overview of individual eating patterns. To mitigate recall bias, the data collection process was carefully designed, and the participants received training to enhance reporting accuracy. Although the method does not directly capture long-term changes, it offers valuable insight into daily food consumption within the context of the intervention. This, despite its limitations, it remains a relevant tool for assessing nutrient intake in relation to the intervention.

Hand grip strength was assessed at the start and end of the study using a hand dynamometer. Muscle mass was evaluated by Bioelectrical Impedance Analysis (BIA). Trained nutritionists performed these measurements to ensure data consistency. The BIA was chosen considering the ease and availability of these techniques in the context of this research. Alternatively, measurement methods that are more stable to changes in hydration, such as dual-energy X-ray absorptiometry (DXA) or MRI, could be considered for further research.

Univariate analysis was used to describe each research variable and calculate the mean and standard deviation (SD) if the data were normally distributed. The median, minimum, and maximum values were used for non-normally distributed data. Normality testing was performed to determine whether the data followed a normal distribution or not. The Shapiro-Wilk test was used, assuming that the subject group represented a small sample size (less than 30 participants). In this study, no homogeneity of variance test or covariate analysis was conducted. The test for homogeneity of variance, in this particular instance Levene's test, was omitted because the sample size was modest and the data distribution seemed to be reasonably homogeneous. Furthermore, covariate analysis was not performed because the primary purpose of the study was to assess the effect of the intervention, without controlling for other variables.

Bivariate analysis was used to examine the relationships between the variables. If the data were normally distributed, parametric statistical tests, such as the paired t-test, were used to assess the differences before and after the intervention. An independent t-test was used to compare treatment and control groups. For non-normally distributed data, non-parametric tests, such as the Wilcoxon signed-rank test, were applied to the paired groups. This analysis assessed the impact of high-protein snacks during hemodialysis on nutrient intake (energy, protein, fat, carbohydrates, sodium, potassium, and phosphorus) in patients with stage V CKD. We also analyzed the effects on nutritional status (BMI, Hb, and muscle mass), urea, creatinine, and handgrip strength in these patients. The ethics committee of Diponegoro University approved ethical clearance under number 404/EC/KEPK/FK-UNDIP/VIII/2024.

Result and Discussion

Table 2. Subject characteristics

Parameter	Control Group n = 15	Intervention Group n = 15
Age (y.o)	46,6 ± 14,7	50,4 ± 14,5
Gender		
Male	5 (33,3%)	6 (40%)
Female	10 (66,7%)	9 (60%)
Body Weight (kg)	59 ± 11,8	57,9 ± 9,3
Height (cm)	153,5 ± 5,8	154 ± 5,4
BMI (kg/m^2)	24,7 ± 3,8	24,4 ± 3,7
Nutritional Status		
Underweight	2 (13,3%)	0
Normal	5 (33,3%)	5 (33,3%)
Overweight	3 (20%)	0
Obesity 1	4 (26,7%)	10 (66,7%)
Obesity 2	1 (6,7%)	0
Hemodialysis Duration		
≤1 Year	3 (20%)	11 (73,3%)
1-4 Year	11 (73,3%)	0
≥4 Year	1 (6,7%)	4 (26,7%)
Nutrition Screening (SGA)		
Good (A)	13 (86,7%)	15 (100%)
Moderate (B)	2 (13,3%)	0

Table 2 shows patient characteristics**.** The age distribution in the control group ranged from 22 to 65 years, with an average age of 46,6 ± 14,7 years. The intervention group had an age range of 28 to 71 years, with a mean age of 50,4 ± 14,5 years (Tahir et al., 2024). Chronic Kidney Disease (CKD) occurs in various age groups. This study identified a case of CKD in a 22-year-old individual, consistent with the theory that immunological disorders and congenital abnormalities can contribute to the development of CKD. Chronic Kidney Disease (CKD) is becoming more prevalent among young adults, often due to unhealthy lifestyles such as poor diet, stress, prolonged sitting, and inadequate water intake, all of which have the potential to damage the kidneys. Older individuals are at a higher risk of developing CKD, because decreased kidney function is a natural part of aging. The glomerular filtration rate (GFR) naturally declines with age, and kidney damage or aging reduces the number of functioning nephrons. GFR decreases by approximately 10% per decade after the age of 40 years, and by the age of 80 years, only approximately 40% of nephrons remain functional (Nasution et al., 2020). Regarding sex, the control group showed a higher incidence of CKD in females (66.7%), and a similar pattern was observed in the intervention group (60%). Males are generally more at risk of developing CKD, with data showing that male patients have more CKD than females, although the prevalence varies across countries (Nasution et al., 2020).

Nutritional status is important in patients with CKD undergoing hemodialysis. Regular monitoring through nutritional screening, such as SGA, helps detect malnutrition, which increases the risk of morbidity and mortality (Jiang et al., 2023). In this study, 86,7% of the participants in the control group had a good nutritional status and 13,3% had a moderate nutritional status. In contrast, 100% of the participants in the intervention group had good nutritional status.

This study also found that obesity might increase the risk of CKD, although the results varied across studies (Jiang et al., 2023). While this study showed that obesity was associated with 0,59 times lower odds of CKD, other studies have indicated that obesity significantly increases the risk of CKD progression. For instance, a significant correlation was found between obesity and kidney dysfunction, attributed to severe metabolic and hemodynamic effects such as insulin resistance, hypertension, and increased body fat (Lew et al., 2017). Similarly, concluded that obesity is a critical risk factor for CKD, primarily because of its association with metabolic syndrome, which includes hypertension, dyslipidemia, and hyperglycemia, which further damage the kidneys. However, the findings from this study suggest a weaker association between obesity and CKD. This discrepancy could be due to differences in sample characteristics, such as varying durations of hemodialysis, or other confounding factors that were not measured in this study. These results highlight the need for further research to better understand the complex relationship between obesity and CKD, particularly the role of metabolic factors in kidney damage in obese patients.

In this case, subjects were categorized by the length of time spent on hemodialysis, specifically in the 1-4 years and ≤1 year groups, in order to compare individuals who had spent more time on hemodialysis with those who had recently started. The allocation of participants was performed according to medical files, and each participant was placed in the relevant category based on their hemodialysis duration. The duration of hemodialysis varied between the two groups. In the control group, 73,3% of the patients had been on hemodialysis for 1-4 years, whereas in the intervention group, 73,3% had been on hemodialysis for less than one year (Andu et al., 2024).

Table 3 presents the changes in nutrient intake (energy, protein, carbohydrate, fat, sodium, potassium, and phosphorus), BMI, Hb, urea, creatinine, muscle mass, and handgrip strength before and after treatment in both the groups. A normality test was conducted for all subject characteristic variables as an early step in data examination. In the control group, the levels of protein, fat, potassium, phosphorus, hemoglobin (Hb), muscle mass, and handgrip strength were all normally distributed, whereas energy intake, carbohydrates, sodium, urea, and creatinine did not fulfill the normal distribution conditions. In the intervention group, protein, fat, carbohydrates, potassium, phosphorus, and handgrip strength, as well as hemoglobin (Hb), had a normal distribution. Energy intake, sodium, urea, creatinine, and muscle mass were not normally distributed.

The results revealed significant changes in nutrient intake, including energy, protein, carbohydrate, fat, sodium, potassium, and phosphorus, as well as in BMI. Hemoglobin (Hb), urea, creatinine, muscle mass, and handgrip strength were also measured before and after treatment in both groups. Statistical analysis using the Mann-Whitney U test showed significant differences in energy intake ($p= 0,036$), protein intake ($p= 0,000$), fat intake ($p= 0,000$), and carbohydrate intake ($p= 0,040$) before and after treatment in both the control and intervention groups. This indicates that the treatment had a significant effect on both the groups. High-protein foods during hemodialysis sessions can increase energy and protein intakes (Struijk-Wielinga et al., 2016).

Table 3. Changes in nutrient intake, nutritional status, urea, creatinine, and hand grip strength

Variables		Control Group n= 15	Intervention Group n = 15	p-value
Energy (kcal)	Before	1460,5 (987,9 - 1624,7)	1488,8 (1453,2 - 1675,2)	0,237[a]
	After	1352,2 (1313,7 - 1857,9)	1547,3 (1451,2 -1783,3)	0,036[a]
	p-value	0,691[c]	0,047[c]	
Protein (g)	Before	47,3 ± 7,6	59,5 ± 9,4	0,001[b]
	After	52,1 ± 4,1	68,2 ± 6	0,000[b]
	p-value	0,031[d]	0,000[d]	
Fat (g)	Before	40,6 ± 9	57,4 ± 10,5	0,000[b]
	After	48,2 ± 4,3	59,6 ± 8,6	0,000[b]
	p-value	0,003[d]	0,043[d]	
Carbohydrates (g)	Before	191,2 (128,9 - 317,6)	202,9 ± 36,8	0,715[b]
	After	183,6 (162,7 - 313,9)	229 ± 28,3	0,040[a]
	p-value	0,629[c]	0,031[d]	
Sodium (mg)	Before	180,1 (88,7 - 1360,8)	249,3 (123,1 - 1267,5)	0,178[a]
	After	179,4 (137,2 - 378,8)	315,6 (195,4 - 487,4)	0,010[a]
	p-value	0,570[c]	0,047[c]	
Potassium (mg)	Before	782,2 ± 284,4	928,2 ± 229,1	0,133[b]
	After	786,4 ± 110,2	861,8 ± 81,5	0,043[b]
	p-value	0,948[d]	0,296[d]	
Phosphorus (mg)	Before	682,9 ± 136,4	782,1 ± 97,6	0,031[b]
	After	654 ± 66,8	741,2 ± 56	0,001[b]
	p-value	0,265[d]	0,137[d]	
BMI (kg/m^2)	Before	24,7 ± 3,8	24,4 ± 3,7	0,828[b]
	After	24,7 ± 3,8	24,4 ± 3,8	0,836[b]
	p-value	0,714[d]	0,846[d]	
Hb (g/dL)	Before	8,6 ± 1	9,6 ± 1,2	0,026[b]
	After	8,4 ± 0,7	9,7 ± 1,1	0,001[b]
	p-value	0,464[d]	0,258[d]	
Urea (mg/dL)	Before	86 (54 - 324)	83 (55 - 167)	0,868[a]
	After	124,6 (56 - 287)	89 (65 - 123)	0,015[b]
	p-value	0,100[c]	0,088[c]	
Creatinin (mg/dL)	Before	2,3 (1,26 - 6,84)	2,56 (1,26 - 9,89)	0,771[a]
	After	3,4 (1,6 - 5,35)	2,8 (1,4 - 4,6)	0,183[b]
	p-value	0,510[c]	0,532[c]	
Muscle Mass (kg)	Before	30,1 ± 7,4	24 (20 - 42,9)	0,319[a]
	After	29,9 ± 6,3	24,1 (20 - 41)	0,575[a]
	p-value	0,798[d]	0,510[a]	
Hand Grip Strength (kg)	Before	20,7 ± 6,7	20,8 ± 7,7	0,980[b]
	After	20,5 ± 6,6	20,8 ± 7,8	0,899[b]
	p-value	0,067[d]	0,313[d]	
URR (%)	Before	46,7 ± 4,4	40,8 ± 7,6	0,015[b]
	After	39,8 ± 5,6	46,7 ± 4,9	0,001[b]
	p-value	0,005[d]	0,011[d]	
Adequacy Kt/V	Before	0,8 ± 0,1	0,6 ± 0,1	0,001[b]
	After	0,6 ± 0,1	0,7 ± 0,0	0,006[b]
	p-value	0,001[d]	0,019[d]	

[a]: Mann-Whitney, [b]: Independent t-test, [c]: Wilcoxon, [d]: Paired t-test

Several steps have been taken to minimize the potential impact of external factors. In this study, the consumption of high-protein snacks was closely monitored using a compliance form, ensuring that both the control and intervention groups consumed the snacks according to the schedule twice a week during hemodialysis sessions. Additionally, a 24-hour recall analysis was conducted to monitor the intake of major nutrients, including foods outside the snack intervention, allowing a more accurate assessment of the total nutrient intake of the patients. Other factors, such as patients' eating habits outside of the snack intervention, could have affected the results. The control over these variables in this study was deemed sufficient to provide an accurate representation of the impact of the high-protein snack intervention.

Providing high-protein snacks can improve the nutritional status and quality of life of patients with CKD undergoing hemodialysis (Hari et al., 2022). Metabolic in kidney disease and hemodialysis procedures increase protein requirements by 0,4 g/kg Body of weight compared to healthy individuals. Additionally, 6-8 grams of protein is lost during hemodialysis. Inflammation due to blood contact with the dialysis membrane causes a negative nitrogen balance, and when protein intake is less than 0,8 g/kg Body weight, patients become catabolic. Providing a high-protein snack during hemodialysis helps restore protein and energy balance as muscle breakdown is minimized and protein synthesis is enhanced (Struijk-Wielinga et al., 2016).

Nutritional imbalances during hemodialysis can lead to significant weight loss. The intervention group, who received high-protein snacks during hemodialysis sessions, demonstrated better nutritional intake and a better understanding of their dietary needs. This contributes to improved health outcomes. Several studies have shown that high-protein snacks can help maintain an adequate nitrogen balance, prevent malnutrition in patients with CKD, and optimize their nutritional status (Struijk-Wielinga et al., 2016).

In addition, there was a significant increase in sodium intake in the intervention group, whereas no significant change was observed in the control group. Although high-protein diets tend to be high in potassium and phosphorus, the risk of mortality due to protein deficiency is greater than that due to hyperphosphatemia and hyperkalemia. Therefore, dietary adjustments should focus on balancing nutrient intake and controlling the intake of these minerals, without reducing protein intake (Wang et al., 2023). The intake of calcium, potassium, phosphorus, sodium, and iron increases significantly after receiving high-protein supplements (Hari et al., 2022).

High-protein foods tend to have high phosphorus and potassium levels, which hemodialysis patients should avoid. However, to control potassium and phosphorus, it is recommended not to reduce protein intake because the risk of death from protein deficiency is greater than that from hyperphosphatemia, and it is advisable to limit foods high in phosphorus and potassium (Hari et al., 2022). It is important for CKD patients to choose high-protein snacks with low sodium levels. These include unprocessed plant-based protein sources and low-sodium dairy products. Patient education regarding the importance of reading food labels and understanding the sodium content of foods is essential for helping patients make better choices. A multidisciplinary approach and support from the healthcare team, including a dietitian, are essential for designing a balanced diet plan that meets protein requirements without excessively increasing sodium intake (Wang et al., 2023).

Analysis of Hb levels in the intervention group showed an increase, suggesting that higher protein intake may support erythropoiesis and improve anemia (Prodyanatasari et al., 2024). However, urea levels decreased in the intervention group, indicating that high protein intake may have contributed to improved protein snacks, which helped stabilize nitrogen metabolism and prevent excessive muscle protein breakdown. In contrast, creatinine levels did not change, indicating that protein intake did not affect creatinine production, which is more closely related to kidney function than is food intake (Kashani et al., 2020). A previous study reported a decrease in pre-hemodialysis hemoglobin levels, with the lowest level of 7,4 g/dL. After hemodialysis, the hemoglobin level of patients with GGK will increase, with the highest level reaching 10,7 g/dl (Widyantara et.al.2021).

Feeding high-protein snacks can help increase hemoglobin (Hb) levels in patients with stage V GGK, as proteins support the synthesis of erythropoietin, which is essential for forming red blood cells. In addition, proteins provide the amino acids necessary for hemoglobin production (Nakhoul & Simon, 2016). Although there were no significant changes in muscle mass or handgrip strength, the long-term effects of protein and energy intake still play a role in health, and the 6-week duration of the study may not have been sufficient to fully observe such changes (Struijk-Wielinga et al., 2016).

A 3-year prospective epidemiological study conducted in America showed that many older adults aged ≥ 50 years, comprising 32-41% of women and 22-38% of men, needed to meet the recommended daily protein intake of only 0,8 g/kg body weight. The results also revealed that protein intake was positively associated with muscle mass stability in women and men aged 70-79. Another study led by John, involving 88 patients in a 2-year cohort method, found that more than 50% of CKD patients undergoing hemodialysis or peritoneal dialysis therapy experienced improvements in muscle mass compared to CKD patients who did not undergo hemodialysis or peritoneal dialysis (Baum et al., 2016). Factors affecting muscle mass include physical activity, hormone levels, and lifestyle. Smoking, alcohol consumption, and physical activity also play a role in determining muscle mass. Additionally, accurate BIA measurements, good hydration status, and exercise routines should be considered (Chen et al., 2015).

The control group experienced a decrease in URR, while the intervention group showed a significant increase. This finding suggests that the intervention was more effective in enhancing urea removal than the treatment applied in the control group. The control group also experienced a decrease in the Kt/V, whereas the intervention group showed a slight increase. The increase in Kt/V in the intervention group indicated that the treatment improved dialysis efficiency by eliminating waste products from the body. A standardized hemodialysis duration (4-4,5 hours per session, twice a week) is important to optimize metabolic waste elimination. A short duration can lead to toxin buildup, fluid overload, and complications, such as heart failure. The KDOQI recommends a blood flow velocity (QB) of >300 mL/min, but in this study, a QB of 200 mL/min was used, which may have affected the Kt/V results.

The determination of ultrafiltration volume was adjusted according to the patient's dry body weight to achieve euvolemia, blood pressure control, and solute clearance. Excessive fluid removal increases the risk of hypotension and potential damage to vascular access. The sodium balance is also crucial; high sodium intake and inadequate excretion can lead to hypertension and fluid retention, necessitating a low-sodium diet and fluid restriction. Inadequate Kt/V values may result from insufficient hemodialysis duration, poor vascular access, interruption during the session, dialyzer characteristics, or errors in urea sampling. These factors must be optimized to achieve more effective outcomes (Ikizler et al., 2020).

Limitations of the Research: Short Intervention Duration. The six-week intervention may have been insufficient to observe significant long-term changes in muscle mass and handgrip strength. A longer duration is required to assess the full effects of high-protein snacks (Phillips et al., 2016). Potential Confounding Factors, while efforts were made to monitor snack consumption, factors like patients' dietary habits outside the intervention and other health conditions may have influenced the results. Recall Bias in 24-Hour. The 24-hour recall method may be subject to recall bias, which could affect the accuracy of nutritional intake reporting. Despite these precautions, this remains a potential limitation. Side effects of high-protein intake. The study did not explore the potential risks of high protein consumption in CKD patients, who may experience worsened kidney function with excessive protein intake. Limitations: The BIA used for muscle mass measurement can be influenced by hydration status, which may affect the results, particularly during hemodialysis.

Conclusion

This study concluded that the provision of high-protein snacks can improve nutrient intake, nutritional status, handgrip strength, and muscle mass in patients with stage V CKD undergoing hemodialysis. However, no significant differences were found in body mass index (BMI), muscle mass, creatinine levels, and handgrip strength before and after the intervention.

Hospitals and hemodialysis centers should consider providing high-protein snacks as part of the patient's diet program to prevent malnutrition and improve their nutritional status. Further research should explore interventions with equivalent protein levels in both groups to observe clearer effects on the dietary parameters and muscle strength. Health nutritionists, especially nutritionists or dieticians, are also advised to educate patients on the importance of high-protein snacks and regularly monitor changes in nutritional status and handgrip strength in clinical practice.

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