Italian Journal of Food Science, 2024; 36 (1): 80–91

Nutritional assessment concerning anthropometric, demographic, and food frequency questionnaires of hemodialysis patients in Sargodha, Pakistan

Rahema Hameed[1], Muhammad Yousaf Quddoos[1], Shahid Mahmood[1], Tayyaba Sami Ullah[2], Ammara Ainee[1], Ayesha Rafique[1], Sayyada Sana Mahmood[1], Muqaddas Fatima[3], Anand Kumar[4], Faiqa Chaudhry[5], Nida Firdous[6], Shazia Yaqub[7], Muhammad Siddique Raza[8], Suliman Yousef Alomar[9*], Syeda Ayesha Batool[10], Rida Batool[8]

[1]Institute of Food Science and Nutrition, University of Sargodha, Sargodha-Pakistan; [2]Superior University, Lahore, Faisalabad Campus-Pakistan; [3]Department of Food Science, Government College University Faisalabad, Pakistan; [4]College of Food Science and Technology, Guangdong Provincial Key Laboratory of Aquatic Product Processing and Safety, Guangdong Ocean University, Zhanjiang, China; [5]Department of Allied Health Science, University of Sargodha, Pakistan; [6]Department of Food Science and Technology, Muhammad Nawaz Sharif University of Agriculture Multan, Pakistan; [7]Punjab Food Authority, Lahore, Pakistan; [8]National Institute of Food Science and Technology, University of Agriculture Faisalabad, Pakistan; [9]Zoology Department, College of Science, King Saud University, Riyadh, Kingdom of Saudi Arabia; [10]Punjab Food Authority, Faisalabad, Pakistan

***Corresponding Author:** Muhammad Yousaf Quddoos, Institute of Food Science and Nutrition, University of Sargodha, Sargodha-Pakistan. Email: yousafquddoos@gmail.com; Suliman Yousef Alomar, Zoology Department, College of Science, King Saud University, Riyadh, Kingdom of Saudi Arabia. Email: syalomar@ksu.edu.sa

Received: 29 August 2023; Accepted: 27 November 2023: Published: 20 January 2024

ORIGINAL ARTICLE

Abstract

Hemodialysis is a process in which the blood is resected using a dialysis apparatus and a specific strainer known as dialyzer. Poor nutritional status is common among hemodialysis patients, but only a few studies are found on how hemodialysis is affected by other factors in the local environment. The aim of this study was to find out hemodialysis patients' nutritional status and the factors that influence it. A total of 100 hemodialysis individuals (50 patients and 50 volunteers) was enrolled in this study. Anthropometry and biochemical assays, as well as nutrition assessments, were used as additional evaluation methods. According to multiple linear regression analysis, malnutrition is linked to older age, poor and lean body mass, and higher body mass index. Factors, such as interdialytic weight gain, insufficient calorie and protein consumption, and existence of morbidities, are considered along with inflammation. This study was performed at various hospitals of Sargodha district in Pakistan. Various variables of hemodialysis patients' poor nutritional status are changeable, and these must be considered when developing and implementing effective intervention programs for this vulnerable group. Nutritional health status of hemodialysis patients was evaluated using Food Frequency Questionnaire (FFQ), concerning multiple factors, such as demographics, anthropometrics, body composition, vital signs, clinical manifestations, dietary intake, edema on the feet, triceps skin fold thickness, mild arm circumference, hand grip strength, and micronutrients. FFQs showed the overall effect of hemodialysis. Further statistical calculations and studies were conducted using SPSS, Minitab 8.1 for descriptive analysis tests for demographic features, and analysis of variance ANOVA.

Keywords: Hemodialysis, nutrition, chronic kidney disease, lifestyle

ISSN 1120-1770 online, DOI 10.15586/ijfs.v36i1.2462

Introduction

The kidneys, which are placed in the posterior wall of the body, perform a variety of functions in the body. Waste removal, chemical balance (such as electrolyte and acid–base equilibrium, and calcium–phosphate metabolism), and blood pressure (BP) regulator are the examples of such processes (Sahathevan *et al.*, 2020). Filtration, absorption, and secretion are the three primary functions of the kidneys, which have an intricate architecture comprising several tissue layers, permeable membranes, and arteries. Blood flow via the kidneys and waste product elimination through urine are the fundamental mechanisms that allow the aforementioned activities to take place. The failure to generate urine is indicative of a kidney condition in which waste items cannot be removed and are instead reintroduced into blood circulation. By interfering with elements, such as electrolyte balance, the overlapping influence would be detrimental to homeostasis (Fiaccadori *et al.*, 2021)

Hemodialysis process requires dialyzer, also known as dialysis machine, which acts as an artificial kidney to remove salts, fluids, and metabolic waste from the blood (Wardani *et al.*, 2019). Hemodialysis is the process of removing harmful fluids from the body of patients with renal failure. It is a process in which blood is cleansed through a dialysis machine comprising a specialized filter, called an artificial kidney or a dialyzer (Lim *et al.*, 2019). When kidney function drops below 10–15%, they lose their capacity to filter blood and generate urine. This condition is known as hyperuricemia. Purines are created by the breakdown of proteins, which lead to gout, renal failure, and various other illnesses. The consequence is the buildup of poisons and extra fluid in the body. Hemodialysis is a process that removes waste, eradicates excess body fluid, and reestablishes electrolyte balance (Na, K, HCO_3^-, Cl, Ca, Mg, and P) (Stevenson *et al.*, 2018). Patients may develop anemia, pulmonary edema, and hyperkalemia because of uric acid accumulation, salt increase, and magnesium deficit, respectively. Proper diet of hemodialysis patients plays an important role in minimizing problems (Dai *et al.*, 2017). This process is indicated to the patients having stage IV or V of chronic kidney disease (CKD). To avoid cardiovascular disease and electrolytic imbalance, the protein and calorie intake of such patients is lowered substantially, but intake of a suitable diet may limit the loss of various vital nutrients. Production of uric acid or oxalate crystals in the body promotes the onset of renal impairment (Rachida *et al.*, 2020).

Various techniques, such as anthropometric measurements, subjective goal assessment (SGA), and other laboratory tests, are utilized to determine the nutritional position of malnutrition in CKD patients. Hemodialysis patients must undergo a dietary review on regular basis (Wolfson and Strong, 1996). Patients receiving dialysis treatment are more prone to malnutrition; consequently, they require a stringent compliance diet that is packed with nutrients. Numerous characteristics, such as protein-energy intake, catabolism, anorexia, and several dietary alterations, impact malnutrition in hemodialysis patients. There are two distinct types of dietary risks in hemodialysis patients (Agboton *et al.*, 2017). The first is the uremic syndrome and the second is the sudden decline in serum albumin concentration. This happens due to precipitous decline in energy levels and protein catabolism (Žulič and Marentič, 2016).

Objectives

To evaluate the nutritional status of hemodialytic patients and correlate the variables with their health status.

Materials and Methods

The research methodology was the procedure landscape of this study, which was performed to study different variables to achieve required objectives. This study was carried out according to the procedural parameters mentioned below:

Target population

Patients having end-stage CKD along with non-CKD volunteers were the target population (Moussa *et al.*, 2016).

Study design and locale

This was a cross-sectional study carried out at different hospitals of Sargodha district in Pakistan (Moussa *et al.*, 2016).

Research instruments and data collection tools

Body composition machine (Model BF 105; Beurer Co., Germany), digital thermometer (Model FT 85; Beurer), sphygmomanometer (Model BM 51, Beurer), oximeter (Model PO 30, Beurer), and stadiometer (Stand HF-5664 Analog) were used for research work, and data were collected regarding clinical manifestations of patients, demographics, family and medical history, food frequency questionnaire (FFQ), and anthropometrics (Kramer *et al.*, 2018).

Limitations and borderlines

The study locale, experts, target population, and researchers were available (Visiedo *et al.*, 2022).

Inclusion and exclusion criteria

Males and nonpregnant females (with or without kidney infection) of any age were included, while pregnant females or patients with multiple diseases were excluded from the study (Quddoos *et al.*, 2022).

Sample size

The sample size for the study was calculated by using the following formula (Magnani, 1997):

$$n = \frac{t^2 \times p(1-p)}{m^2},$$

$$D = n \times 2$$

$$N(final) = (n \times D) + 5\% \; of \; (n \times D)$$

Selection of volunteers

Volunteers getting hemodialysis along with non-CKD persons of the same family were randomly selected from different hospitals of Sargodha district, Pakistan, by following the procedure mentioned by Mahmood and Butt (2011).

Demographics, anthropometrics, and energy calculations

Demographic parameters, such as name, age, education, gender, physical activity, socioeconomic status, lifestyle, income, and ethnicity, were recorded through interviews (Žulič and Marentič, 2016). Height (cm) and weight (kg) were measured by a stadiometer. Body composition, that is, weight (kg), bone mass (%), body fat (%), muscle mass (%), body water (%), basal metabolic rate (BMR), and active metabolic rate (AMR), was measured by using bio-electrical impedance-based scale BF-105 (Beurer; Rizvi *et al.*, 2020).

Vital signs and clinical manifestations

Blood pressure, oxygen saturation, pulse rate, and body temperature of volunteers were recorded (Gibson, 1990). Clinical manifestations of pulmonary tuberculosis (TB), such as chest pain, coughing up blood, loss of appetite, unexpected weight loss, etc., were investigated (Stevenson *et al.,* 2018).

Medical and family history

A complete medical history of patients, such as allergy, surgical procedures, and other associated diseases, was collected (Stevenson *et al.,* 2018). Volunteers were asked about family medical history such as TB, diabetes, hypertension, asthma, and hepatitis (Gibson, 1990).

Biomarkers

General biomarkers, such as hemoglobin (Hb), complete blood count (CBC), indicative biomarkers for functioning of the kidneys (uric acid test), and urine investigations, were performed (Campbell *et al.,* 2018).

Dietary intake assessment

Dietary intake (number of servings) history of volunteers was conducted through Food Guide Pyramid-based FFQ (Kramer *et al.*, 2018).

Statistical analysis

Data were analyzed statistically by using appropriate statistical tools. Correlations were analyzed using Chi-square and the Pearson's coefficient, and *t*-test was used to compare the results; $p = 0.05$ was considered statistically significant (Steel *et al*., 1997)

Methodology

The study aimed to examine the hemodialysis patients in terms of their nutritional status. This study was conducted at Mubarak Hospital of Sargodha district. He is the best nephrologist in Sargodha and has treated thousands of CKD patients. Of the sample of 100 patients, 50 were from the experimental group and the rest were from the control group. Because hemodialysis patients were not able to fill the questionnaire, their family members did the same. We had patients' demographic status and rest of the questionnaire was about nutritional components.

Requirements of procedure

Patients must be aged at least 18 years, routinely undergoing hemodialysis for 4 h thrice a week for at least 3 months before enrolling in the study, and be free of any acute illness or mental disorder. Before the collection of any data, consent was obtained from the dialysis institution/Hospital, the agreement of all dialysis institutions was obtained. Anonymity was ensured prior to having patients' written informed consent. 100 out of the 50 eligible patients who were contacted agreed to take part in the experiment, with a response rate of 50 %. Sociodemographic data, medical history of any present illness, a subjective assessment of patient's nutritional status based on their history and physical examination, an objective assessment based on anthropometric measurements (height, weight, etc.), and biochemical parameters were collected from the questionnaires (Visiedo *et al*., 2022).

Subjective goal assessment

The SGA included a range of subjects, including anorexia, nausea, vomiting, diarrhea, functional capacity, dialysis history, and loss of subcutaneous fat in the mid-arm muscular region, arm muscle area along the body's lateral side, and shoulder and quadricep muscles. A score of 7 indicated sufficient nutrition whereas a score of 32 indicated severe malnutrition (El-dien *et al*., 2019). Malnutrition was found to be mild in patients aged 9–13 years, moderate in patients aged 14–26 years, and severe in those aged 26–40 years. The information was collected by a trained medical officer under the direct supervision of nephrology and clinical nutrition specialists. All patients who imparted written permission were presented with a questionnaire to measure malnutrition by an interviewer.

Survey

Ten questions were asked for nutritional assessment and the rest of the questionnaire contained body composition.

Medical nutrition assessment questions included the following:

1. Consumed calories during the last 3 months
2. Weight reduction within the previous 3 months
3. Mobility (bed-bound or chair-bound, capable of getting out of bed/chair
4. Acute illness or psychological strain in the preceding 3 months
5. Neuropsychiatric illnesses
6. Body mass index (BMI) (<19, 19–21, 21–<23, or >)
7. Loss of appetite or an increase in appetite
8. Change in physical appearance or body swelling
9. Increased purine degradation or catabolism
10. Water retention or edema due to infection

Determination scale

Six components of the 7-point SGA scale: change in weight, nutritional intake, gastrointestinal symptoms, functional ability, co-morbidities, and physical examination; 1–7 points were assigned to calculate the overall SGA score. Lower the overall SGA score, more severe the SGA and prevalence of malnutrition. Individual patients were used for baseline analysis. An SGA score of 5 showed "not malnourished" status, and an SGA score of 6–7 showed "well-nourished" status. Information provided by the patients was examined, and those who completed 12 months of follow-up were classified according to the following criteria:

Two categories according to their nutritional quality during a course of 1 year:

- Remained or became well-nourished—those who remained well nourished during the complete year or who were well nourished at either the beginning or end of the year.
- Remained malnourished, or acquired malnourishment.

Patients aged 18–85 years were included in the study. Patients must be conscious and attentive, were having hemodialysis for at least 6 months for a minimum of 3 h, at least twice a week (Stevenson *et al*., 2018). Patients with the following conditions were excluded from the study:

1. Lacked mental or physical ability to communicate with questioner
2. Having multiple syndromes
3. Patients who were unable to speak
4. Patients at the end stage of CKD

Device was utilized for collection of three type data: The first section covered socioeconomic and demographic characteristics (i.e., age, gender, domicile, work, dialysis center visited, education, smoking, marital status, and salary per month). The second section recorded clinical state of the patients (number of dialysis in a year, frequency of dialysis per week, BMI, regular medications used, and chronic illnesses) (Bogacka *et al*., 2018).

Results and Discussions

Anthropometric Measurements

The clinical tests of hemodialysis patients were conducted and include all anthropometric analyses or SGA. These tests included body composition, body mass, pulse rate, BP, BMI, BMR, AMR, blood oxygen saturation, etc.

Systolic Blood Pressure

Table 1 shows high systolic BP of the patients undergoing hemodialysis. This could lead to acute conditions in patients, like brain hemorrhage, bleeding from the nose, etc.

Table 1. Analysis of variance for systolic BP.

Source	DF	Ad MS	F-value	*p*-value
BP	24	4.544	1.05	0.449
Error	25	4.317		
Total	49			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Some studies suggested that a pre-dialysis BP must be less than 140/90 mmHg with a post-dialysis BP of 130/80 mmHg (Stern *et al.*, 2014)

Systolic II Blood Pressure

The significant change in systolic BP post-hemodialysis is observed in Table 2. It shows significantly less systolic BP, compared to pre-dialysis systolic BP.

Many dialysis patients were found to be hypertensive. Hypotension is the most common complication observed in dialysis patients and recorded in 15–50% of the cases. The other complications include muscle cramps, itching, fever, chills, pyrogen reactions, disequilibrium syndrome, nausea and vomiting, headache, and hypertension (Cases and Coll, 2002).

Diastolic Blood Pressure I and II

Significant values were discovered for diastolic BP taken before and after hemodialysis (Table 3). Diastolic BP was high in patient having dialysis.

Both higher and lower BP values were found to be detrimental in patients having dialysis, and therefore recommendations to achieve a target BP were set forth. However, there are no strict guidelines and they vary from patient to patient. In a US study comprising 2535 hemodialysis patients, 86% were found to be suffering from hypertension. Even in the patients taking antihypertensives, 58% had poorly controlled BP and 12% had refractory hypertension (Stern *et al.*, 2014).

Table 2. Analysis of variance for systolic II BP.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
Systolic II	4	216.3	54.07	1.68	0.172
Error	45	1449.7	32.22		
Total	49	1666.0			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Temperature

Another anthropometric measurement is temperature (Table 4). Temperature values taken before hemodialysis were significantly high in patients having dialysis, as observed in Table 4.

Blood Oxygen Saturation

Blood oxygen saturation values (Table 5) were observed through an oximeter for both groups of patients on dialysis. A significant oxygen saturation level ($p = 0.2$) was observed in both groups of patients, which showed that both groups had abnormal oxygen levels, and a significant difference in oxygen levels was discovered between the groups.

Table 3. Analysis of variance for diastolic BP.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
Diastolic I	7	93.24	13.32	0.62	0.740
Error	42	908.38	21.63		
Total	49	1001.62			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Table 4. Analysis of variance for temperature.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
F/C 1	4	5.621	1.405	0.61	0.655
Error	45	102.959	2.288		
Total	49	108.580			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Table 5. Analysis of variance for oxygen saturation.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
O_2 saturation 1	10	4217	421.7	1.36	0.235
Error	39	12102	310.3		
Total	49	16319			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Blood Sugar I and II

A significant value ($p = 0.99$) of blood sugar was observed in control and experimental groups (Table 6). Abnormal sugar levels were observed in both groups, and high blood sugar level could affect the kidney.

Type 2 diabetes mellitus is one of the leading causes of CKD as well as end-stage renal disease (ESRD) in developed and developing countries (Agboton *et al.,* 2017). In the United States, New Zealand, Japan, and some other Asian countries, type 2 diabetes mellitus accounts for almost 50% of patients having dialysis (United States Renal Data System (USRDS), 2014)

Body weight I and II

Table 7 shows body weight values of both groups of patients. A significant difference was observed in body weight between the groups ($p = 0.90$). A significant high value of weight may exert more pressure on the kidneys, leading to joint problems, diabetes, and a high lipid profile.

Body Fat of Control and Experimental Groups

Another anthropometric measurement includes body fat (Table 8). A significant level of difference was discovered in body fat values between both groups ($p = 0.3$). High body fat means high BMI, which may affect the kidneys.

Table 6. Analysis of variance for blood sugar.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
Blood sugar	24	2626	109.4	0.34	0.995
Error	25	8075	323.0		
Total	49	10700			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Table 7. Analysis of variance for body weight.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
Weight	31	1854	59.81	0.58	0.908
Error	18	1842	102.31		
Total	49	3696			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

BMI of Control and Experimental Groups

Table 9 shows BMI of both groups ($p = 0.6$), indicating a *p*-value of 0.6, which was more than 0.05, which shows that there is a significant figure present and the tests are inconclusive. Our reading of BMI resembling multi-centre Korean study has BMI values 23.6 ± 3.8. BMI is not a complete indicator of the health or nutrition of hemodialysis patients. The underweight group of hemodialysis with less BMI (less than 18.5) had high mortality hazard ration as compared to overweight group (greater than 25) (Kim *et al*., 2012).

Blood hemoglobin levels.

Table 10 shows the hemoglobin levels of both groups, with a significant statistical analysis of variance

Table 8. Analysis of variance for body fat.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
Body fat in control group	24	935.7	38.99	1.24	0.302
Error	25	789.2	31.57		
Total	49	1724.8			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Table 9. Analysis of variance for BMI.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
BMI of control group	34	1008.0	29.65	0.86	0.655
Error	15	516.6	34.44		
Total	49	1524.6			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Table 10. Analysis of variance for hemoglobin.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
Hb	18	58.73	3.263	1.53	0.147
Error	31	66.32	2.139		
Total	49	125.05			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

(p = 0.14; SD = 1.46). Both groups showed different hemoglobin levels; however, the experiment group had disturbed hemoglobin levels.

Hemodialysis patients are more anemic. If the hemoglobin level is less than 11 g/100 mL, then it represents impairment in the quality of life and reduces exercise capacity, energy level, thereby affecting rate of morbidity and mortality (Perlman *et al.*, 2005).

Glomerulus filtrate ratio (GFR) of control and experimental groups

GFR for both groups shows significant differences in values (p = 0.57, SD = 3.86; Table 11).

The percentage of incident patients starting dialysis with an estimated GFR (eGFR) of ≥10 mL/min/1.73 m^2 increased from 13% in 1996 to 43% in 2010 but declined to 39% in 2016. However, the mean eGFR at the initiation of dialysis in 2016 was 9.7 mL/min/1.73 m^2 (USRDS, 2018).

The recent guidelines suggest the initiation of dialysis when clinical manifestations of kidney failure are present and not merely on a decrease in GFR.

Nutritional Assessment of Hemodialysis Patients versus Normal Persons

Group 1, meat

The results of all anthropometric measurements showed that there was not a single grouped data whose p-value was less than 0.05, which indicated the correctness of data with significant differences between them.

After anthropometric measurements, we investigated dietary changes and implementations after the start of hemodialysis. The grouped data for patients were considered and converted into per day serving in calories. Table 12 shows the calorie intake of meat (p = 0.6).

Table 11. Analysis of variance for GFR.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
GFR	25	346.8	13.87	0.93	0.573
Error	24	358.5	14.94		
Total	49	705.3			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Table 12. Analysis of variance for meat intake.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
Meat	44	3018581	68604	0.81	0.688
Error	5	421231	84246		
Total	49	3439812			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Thus, the statistical analysis of the data shows $p > 0.05$, with significant level of difference.

Group I and II, cereals

Table 13 shows the calorie count for cereals. The cereal intake in both groups was different (p = 0.79), with a high protein intake, which is less recommended for dialysis patients.

Almost 50–70% of patients appeared to have total energy and protein content that was consistent with the minimum recommended intake. Our findings of generally low consistency of dietary intake were similar to dietary practice guidelines among the hemodialysis population (Bossala *et al.*, 2014)

Group III, dairy products

Table 14 shows significant statistical analysis of variance for dairy products. The difference level found between the grouped data and the results was inconclusive. Both groups showed different dairy intake values; however, more intake of dairy products with protein is not appropriate for dialysis patients.

Bones mostly comprise calcium and phosphorus. If the kidneys function well, a balance is maintained between calcium and phosphorus in the blood and bones. However, kidney disease causes imbalance of these two

Table 13. Analysis of variance for cereals.

Source	DF	Adj SS	Adj MS	F-value	*p*-value
Cereal	36	3382721	93964	0.71	0.794
Error	13	1711922	131686		
Total	49	5094643			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Table 14. Analysis of variance for dairy products.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
Dairy	29	268395	9255	0.99	0.519
Error	20	186740	9337		
Total	49	455135			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Table 15. Analysis of variance for vegetables.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
Vegetables	20	139315	6966	1.00	0.494
Error	29	202822	6994		
Total	49	342137			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

minerals and excess of phosphorus is accumulated in the blood. Diseased kidneys no longer activate vitamin D, which affects their ability to absorb calcium. Low blood calcium levels lead to absorption of calcium and phosphorus from bones, resulting in weakness (Yoke Mun *et al.*, 2019). According to Quddoos *et al.* (2022), calcium from natural sources eggshell powder (ESP) and bone extract powder (BEP) could be the cheapest and richest calcium sources to be explored as "natural calcium fortificants." fortified cookies with natural fortificants like ESP and BEP (75% Recommend daily allowance (RDA)) could be a beneficial for business of commercial FMCG companies to combat calcium deficiency amongst adolescent boys.

Group IV, vegetables

Table 15 shows significant values for vegetable intake by both groups. Uncooked toxic-free vegetables are good for dialysis patients.

Group V, fruits

Hemodialysis leaves the patient with few or no nutrients at all. Therefore, protein and high-energy food is required for dialysis patients to have normal weight. Most of the Hemodialysis patients lose weight and are malnourished. The survey (Table 16) shows the significance of calorie intake of patients through fruits. Both groups showed different intake of fruits.

Table 16. Analysis of variance for fruits.

Source	DF	Ad SS	Ad MS	F-value	*p*-value
Fruits	20	228912	11446	1.03	0.465
Error	29	323495	11155		
Total	49	552407			

DF: Degree of freedom
Ad MS: Adjusted Mean square
F-Value: Frequently Value (variance of the group)
P-Value: Probability value

Table 17. Age of gender and group.

	Variable	Mean	Median	Range
Age of male and female patients	Age	46.40	42.50	52.00
	Females	7.90	8.00	18.00
	Males	2.600	1.500	4.000
Age of the control group	Age	27.20	26.50	33.00
	Females	3.900	3.500	9.000
	Males	2.900	2.000	6.000

Age = maximum (72 years), minimum (20 years). Females = 69%; males = 31%.

Demographics

Age and number of male/female patients

Studies have shown that in 100 CKD patients, about 6% were males and 31% were females. Their average age was 46–50 years, and most of them were females. This shows that CKD is more prevalent in females than in males. In our study, we included 50 CKD patients having hemodialysis and 50 normal patients (Table 17).

Socioeconomic status

The survey showed that patients on hemodialysis and non-hemodialysis patients belonged to all strata of society. Thus, 40% of them belonged to lower income group, 30% were from middle-income families, and the rest 30% were from the upper socioeconomic strata of the society (Table 18).

Clinical Manifestations

Body swelling after dialysis

Patients on hemodialysis experience some post-dialysis effects, and swelling in the body is one of them. About 96% of hemodialysis patients have body swelling (Table 19).

Table 18. Socioeconomic status.

Socioeconomic status		Socioeconomic status	
Lower class	20	Lower class	20
Middle class	15	Middle class	15
Upper class	15	Upper class	15

Table 19. Clinical manifestations of hemodialysis patients.

Sign and symptoms	Occurrence	Frequency
Post and pre-dialysis swelling	Yes	48
	No	2
Post-dialysis body pain	Yes	34
	No	16
Urge to urinate often	Yes	23
	No	27
Water retention	Yes	49
	No	1
Have you lost weight after having dialysis?	Yes	45
	No	4
	Often	1
Do you have abnormal metabolic activities after dialysis?	Yes	43
	No	4
	Often	3
Do you have muscle cramps after dialysis?	Yes	39
	No	7
	Often	4
Do you consult any nutritionist for post-dialysis meal plans?	Yes	19
	No	27
	Often	4
Edema on feet	Yes	41
	No	9
Triceps skin fold thickness (TSFT)	Yes	38
	No	12
Mid-arm circumference (MAC)	Yes	43
	No	7
Hand grip strength (HGS)	Normal	20
	Weak	30

Body pain before and after hemodialysis

Body pain is another clinical manifestation experienced by CKD patients on hemodialysis. About 32% of patients don't experience body pain, while 68% patients complain about severe muscles cramps (Table 19).

Urge to urinate

The urge or frequency to urinate states a lot about kidney functioning. Thus, the research data showed that 46% of hemodialysis patients get a sudden and intense urge to urinate, while the rest 54% have no such urge to urinate, which is rare but varies with patients (Table 19).

Water retention

Water retention or edema is the most common symptom among CKD patients on hemodialysis. In edema, the body fluid accumulates in the specific location of patient's body. The severity of edema depends upon the stage at which the patient is having hemodialysis. Thus, the data showed that 98% of hemodialysis patients experienced edema (Table 19).

Weight loss

Hemodialysis consumes a lot of body energy and the body starts losing fat, proteins, and essential vitamins. Therefore, a sudden decrease in weight takes place and this could be a warning sign for CKD patients. Weight loss affects 45 out of 50 patients. However, this could be treated with some good supplementations and dietary management practices (Table 19).

Frequency of hemodialysis/preferred place/metabolic activities

Hemodialysis happens in a constant loop and this could be done 3–4 times a week. Of the 50 patients, 48 usually have hemodialysis 3–4 times a week. When asked whether patients would like to have this fluid exchange treatment at home, out of 50, 48 patients were comfortable in having hemodialysis at the hospital. Most of the patients are affected by hemodialysis. Hemodialysis is process of exchanging fluid, and therefore there are maximum chances of losing a lot of weight/energy during this process. Thus, in hemodialysis all metabolic activities are affected and the patient starts losing energy plus body mass more than normal (Table 19).

Low blood pressure/muscle cramps/high protein diet

Table 19 shows that out of 50 hemodialysis patients 39 suffer from muscle cramps and uneasiness. Hemodialysis could leave the patient skinny by absorbing all essential nutrients. Patients on hemodialysis are recommended to take a high protein and energy diet to avoid malnutrition (Table 19).

Dietary consultation

Only few patients consult dietician to avoid malnutrition. Our conducted survey showed that out of 50 hemodialysis patients about 34 had high-protein diet (Table 19).

Triceps skinfold thickness (TSFT); mid-arm circumference (MAC); handgrip strength (HGS)

Edema on the feet was diagnosed in 41 hemodialysis patients, while nine volunteers had no such clinical manifestation. The majority of our patients had TSFT (n = 38), and 43 patients showed mild to moderate depletion of fat and MAC, indicating good protein store. Most of our patients had weak HGS (n = 30). Demographic features and anthropometric measures are described in Table 19. According to Birajdar *et al.* (2019), most of hemodialysis patients have edema because of multiple factors, such as excessive fluid intake, low albumin, poor cardiac status, intradialytic hypotension, and poor performance of dialysis. The authors discovered that 21 patients had pedal edema in spite of having hemodialysis thrice per week. In an MAC study conducted by Araujo *et al.* (2006), 18 out of 68 females had less than 90% MAC.

In females having hemodialysis, the TSFT was 10.5 ± 3.8, which was significant. According to Stevenson *et al.* (2018), TSFT is a reliable method for mass assessment in daily practice in patients of stage IV/V CKD, compared to bio-impedance.

Handgrip strength is a reliable and straightforward method for evaluating muscle function. HGS is routinely used as a function of skeletal muscle strength and function in the nutritional evaluation of the general population. The functional status of general muscle strength is correlated consistently with the extent of HGS. In an Indian study, HGS in most males was weak, compared to the general population of the same age group (Visiedo *et al.*, 2022).

Comparison between hemodialysis and control groups

Table 20 shows the nutrient intake of patients having dialysis. Sodium (p < 0.774) and β-carotene intake (p = 0.728) was higher in both control and hemodialysis groups. Other nutrient intake, including microelements and vitamins, showed no significant difference between the two groups.Conclusion

This study concludes that balanced nutrition plays an important role in maintaining the quality of life in hemodialysis patients. Nutritional assessment of hemodialysis patients was conducted to study nutritional requirements and its effect on such patients. Hemodialysis can play an important role in malnutrition. In both cases, patients suffer and their quality of life is degraded. Therefore, it is recommended to fulfil nutritional requirements and daily caloric intake of dialysis patients. These patients may go through severe traumas, which can affect their mental and physical well-being.

Dialysis patients must consult a dietician for proper meal plans to make sure to have daily calorie count. Hemodialysis patients should increase their calorie intake, but the studies have shown that they are not able to take the required amount of calories and end up losing weight. Poor nutrition, sedentary lifestyle, and unhygienic practices could compound this disease. On the other hand, good weight management practices, a balanced diet, and a healthy lifestyle could improve the quality of life of hemodialysis patients.

Table 20. Comparison of dietary intake between two groups.

Variables	Control group	Hemodialysis group	*p*-value
Cholesterol (mg)	279.0120 ± 122.11^{f}	225.223 ± 111.90^{f}	0.021
Dietary fiber (g/kg)	0.2704 ± 0.10^{i}	0.2261 ± 0.20^{i}	0.240
Phosphorus (mg)	764.2541 ± 242.15^{d}	741.82 ± 142.72^{d}	0.581
Sodium (mg)	3184.20 ± 1132^{a}	3243.812 ± 742^{a}	0.774
Potassium (mg)	2154.1291 ± 514^{c}	1843.1661 ± 450^{c}	0.234
Zinc (mg)	22.7151 ± 6.27^{h}	8.5052 ± 2.48^{h}	0.165
Vitamin A (μg)	612.6312 ± 203^{e}	615.4010 ± 112.18^{e}	0.852
Retinol (μg)	111.5174 ± 84.21^{gh}	91.1438 ± 58.22^{h}	0.061
β-carotene (μg)	2537.7511 ± 2221^{b}	2951.812 ± 1438^{b}	0.728
Vitamin B1 (mg)	0.5121 ± 0.36^{l,m}	0.6175 ± 0.34^{m}	0.177
Vitamin B2 (mg)	0.9140 ± 0.46^{l}	0.8708 ± 0.39^{l,m}	0.142
Vitamin B6 (mg)	1.5746 ± 0.44^{k}	1.5556 ± 0.22^{l}	0.755
Vitamin C (mg)	86.7411 ± 71.34^{h}	62.5221 ± 21.83^{h,i}	0.067
Vitamin E (mg)	12.5208 ± 7.57^{i,j,k}	11.2016 ± 3.90^{j,k}	0.276
Niacin (mg)	13.517 ± 5.08^{i,j}	13.123 ± 5.26^{j}	0.707
Folate (μg)	162.554 ± 51.05^{g}	169.234 ± 58.20^{g}	0.804

Availability of data and materials

Data can be provided on demand.

Conflict of interest

The authors declared no conflict of interest and gave their consent for publishing the article.

Funding

The authors would like to thank the Researchers Supporting Project Number (RSP2024R35), King Saud University, Riyadh, Saudi Arabia.

Acknowledgment

The authors are thankful to PMAS Arid Agriculture University Rawalpindi, Pakistan for providing the research facilities used for this study. The authors would like to thank the Researchers Supporting Project Number (RSP2024R35), King Saud University, Riyadh, Saudi Arabia.

References

Agboton B.L., Agueh V.D., Vigan J., Sourou B.A., Ahoui S., Agboton C.G. and Djrolo F. 2017. Assessing the nutritional status of hemodialysis patients in a sub-Saharan country. J Kidney. 03(02). https://doi.org/10.4172/2472-1220.1000145

Araujo D., Davids K. and Hristovski R. 2006. The ecological dynamics of decision making in sport. Psychol. Sport and Exercise. 7(6): 653–676. https://doi.org/10.1016/j.psychsport.2006.07.002

Bogacka A., Sobczak-Czynsz A., Kucharska E., Madaj M. and Stucka K. 2018. Analysis of nutrition and nutritional status of hemodialysis patients. Rocz Panstw Zakl Hig. 69(2): 165–174. http://wydawnictwa.pzh.gov.pl/roczniki_pzh/

Bossola M.D.S.E., Viola A., Leo A., Carlomagno G., Monteburini T., Cenerelli S., Santarelli S., Boggi R., Miggiano G., Vulpio C., Mele C. and Tazza L. 2014. Dietary intake of trace elements, minerals, and vitamins of patients on chronic hemodialysis. Int Urol Nephrol. 46: 809–815. https://doi.org/10.1007/s11255-014-0689-y

Birajdar N., Anandh U., Premlatha S. and Rajeshwari G. 2019. Hand grip strength in patients on maintenance hemodialysis: An observational cohort study from India. Indian J Nephrol. 29(6): 393–397. https://doi.org/10.4103/ijn.IJN_251_18

Cases A. and Coll E. 2002. Chronic hypotension in the dialysis patient. J Nephrol. 15(4): 331–335.

Stevenson, J., Tong, A., Campbell, K.L., Craig, J.C., and Lee, V.W. 2018. Perspectives of healthcare providers on the nutritional management of patients on haemodialysis in Australia: an interview study. https://doi.org/10.1136/bmjopen-2017-020023

Dai L., Mukai H., Lindholm B., Heimbürger O., Barany P., Stenvinkel P. and Qureshi A.R. 2017. Clinical global assessment of nutritional status as a predictor of mortality in chronic kidney disease patients. PLoS One. 12(12): 1–17. https://doi.org/10.1371/journal.pone.0186659

El-dien A.E.D., Kotb M. and Eldeen H.M.M. 2019. Prevalence of malnutrition in hemodialyzed chronic renal failure patients and its relation with the patient outcome. 30(3): 46–50.

Fiaccadori E., Sabatino A., Barazzoni R., Carrero J.J., Cupisti A., De Waele E., Jonckheer J., Singer P. and Cuerda C. 2021. ESPEN guideline on clinical nutrition in hospitalized patients with acute or chronic kidney disease. Clin Nutrit. 40(4): 1644–1668. https://doi.org/10.1016/j.clnu.2021.01.028

Gibson R.S. 1990. Assessment of iron status. In: Principles of nutritional assessment, 2nd edition. Oxford University Press, New York, NY, pp. 349–376.

Kim, M.S. and Lee, Y.S. 2005. Effects of soy isoflavone and/or estrogen treatments on bone metabolism in ovariectomized rats. J. Med. Food. 8(4): 439–445. https://doi.org/10.1089/jmf.2005.8.439

Kramer H., Jimenez E.Y., Brommage D., Vassalotti J., Montgomery E., Steiber A. and Schofield M. 2018. Medical nutrition therapy for patients with non–dialysis-dependent chronic kidney disease: barriers and solutions. J Acad Nutr Diet. 118(10): 1958–1965. https://doi.org/10.1016/j.jand.2018.05.023

Lim H.-S., Kim H.-S., Kim J.K., Park M. and Choi S.J. 2019. Nutritional status and dietary management according to hemodialysis duration. Clin Nutr Res. 8(1): 28. https://doi.org/10.7762/cnr.2019.8.1.28

Magnani R. 1997. Sampling guide: Food and nutrition technical assistance project (FANTA). Academy for Educational Development, Washington, DC, 46 p.

Mahmood S. and Butt M.S. 2011. Vitamin A fortification; indispensable during pregnancy and lactation: Efficacy studies of vitamin A fortified cookie in pregnant and lactating women. LAP LAMBERT Academic Publishing, Saarbrücken, Germany. ISBN-13: 978-3-8443-3223-0

Moussa H.D., Tondi Z.M.M., Kane Y., Sani M.A.M., Abdou I., Touré I., Illa A. and Omar A.E. 2016. Assessing the nutritional status of hemodialysis patients in sub-Saharan Africa: experience of two hemodialysis centers in Niger. Open J Nephro. 06(04): 161–166. https://doi.org/10.4236/ojneph.2016.64021

Perlman R.L, Finkelstein F.O, Liu L, et al. 2005. Quality of life in chronic kidney disease (CKD): a cross-sectional analysis in the Renal Research Institute-CKD study. Am J Kidney Dis. 45: 658–666. https://doi.org/10.1053/j.ajkd.2004.12.021

Phosphorus P. and Fluid S. n.d. Diet for hemodialysis. April 2022, 1–12.

Quddoos M.Y., Mahmood S., Yaqoob M., Murtaza M.A., Zahra S.M., ud Din G.M. and Mustafa S. 2022. The effects of natural and synthetic calcium utilization on quality parameters of cookies. Appl Food Res. *2*(1): 100093. https://doi.org/10.1016/j.afres.2022.100093

Rachida M, Mohamed M, Mohammed El Ayachi and Rekia B. 2020. Assessment of nutritional status, dietary intake, and adherence to dietary recommendations in hemodialysis patients. GSC Adv Res Rev. 3(2): 009–019. https://doi.org/10.30574/gscarr.2020.3.2.0030

Rizvi, N., & Baig, M. (2020). Nutritional status of patients on maintenance hemodialysis as assessed by mini nutritional assessment survey-short form and anthropometric measurements. Pakistan J Kidney Diseases. 4(2): 249–253. https://doi.org/10.53778/pjkd4268

Sahathevan S., Khor B.H., Ng H.M., Gafor A.H.A., Daud Z.A.M., Mafra D. and Karupaiah T. 2020. Understanding development of malnutrition in hemodialysis patients: a narrative review. Nutrients. 12(10): 1–30. (MDPI AG) https://doi.org/10.3390/nu12103147

Steel R.G.D., Torrie J.H. and Dickey D.A. 1997. Principles and procedures of statistics: A biometrical approach, 3rd edition. McGraw Hill, New York, NY.

Stern A., Sachdeva S., Kapoor R., Singh J. and Sachdeva S. 2014. High blood pressure in dialysis patients: cause pathophysiology, influence on morbidity, mortality, and management. J Clin Diag Res (JCDR). 8(6): ME01. https://doi.org/10.7860/JCDR/2014/8253.4471

Stevenson J., Tong A., Campbell K.L., Craig J.C., Lee V.W. 2018. Perspectives of healthcare providers on the nutritional management of patients on hemodialysis in Australia: an interview study. BMJ Open. 8(3): e020023. https://doi.org/10.1136/bmjopen-2017-020023

United States Renal Data System (USRDS). 2014. Annual data report: epidemiology of kidney disease in the United States. usrds.org [online]. Available at: http://www.usrds.org/adr.aspx.

United States Renal Data System (USRDS). 2018. Annual data report: Atlas of chronic kidney disease and end-stage renal disease in the United States. National Institutes of Health, National Institue of Diabetes and Digestive and Kidney Disease, Bethesda, MD. Available at: https://www.usrds.org/2018/view/v2_01.aspx (accessed September 5, 2019).

Visiedo L., Rey L., Rivas F., López F., Tortajada B., Giménez R. and Abilés J. 2022. The impact of nutritional status on health-related quality of life in hemodialysis patients. Sci Rep. 12(1): 3029. https://doi.org/10.1038/s41598-022-07055-0

Wardani N.W.S., Budiyasa D.G.A., Sudhana I.W. and Widiana I.G.R. 2019. Nutritional status using ISRNM criteria and MIS of chronic hemodialysis patients at Sanjiwani Gianyar General Hospital. J Phy Conf Ser. 1157(4): 042132. https://doi.org/10.1088/1742-6596/1157/4/042132

Wolfson M. and Strong C. 1996. Assessment of nutritional status in dialysis patients. Adv Renal Replac Ther. 3(2): 174–179. https://doi.org/10.1016/S1073-4449(96)80058-6

Yoke Mun C., Mohd Shariff Z., Lim Thiam Seong C. and Bak Leong G. 2019. Factors associated with poor nutritional status among hemodialysis patients in Malaysia. Mal J Med Health Sci 15(SP1): 77–83.

Žulič H. and Marentič V.M. 2016. Assessment of the nutritional status of dialysis patients in dialysis center Novo Mesto. Clin Nutrit ESPEN. 14: 46. https://doi.org/10.1016/j.clnesp.2016.04.010