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Research Article

Nutritional status of patients undergoing haemodialysis at Muhimbili National Hospital, Tanzania

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Highlights/Key Messages
- There was a high burden of undernutrition among chronic kidney disease patients undergoing haemodialysis in a major hospital in Tanzania.
- Mid upper arm circumference detected undernutrition better than a basal metabolic index in patients undergoing haemodialysis.
- There were no clear predictors; nutritional status was influenced by multiple factors.
- Findings support a need for routine nutrition screening in haemodialysis management.

Background
Chronic kidney disease poses an increasing public health challenge worldwide, with low- and middle-income countries facing a disproportionate burden of morbidity and mortality due to limited access to early diagnosis and comprehensive treatment. Patients on maintenance haemodialysis are especially vulnerable to undernutrition because of metabolic disturbances, chronic inflammation, dietary restrictions, and socioeconomic difficulties. In Tanzania, routine nutritional assessment among chronic kidney disease patients remains inconsistent, and local evidence on the prevalence of undernutrition using clearly defined and standardised indicators is limited.

Objective
This study assessed the nutritional status of patients undergoing haemodialysis at Muhimbili National Hospital in Dar es Salaam, Tanzania.

Methods
A hospital-based cross-sectional study was carried out from March to April 2025 among 149 adult patients undergoing haemodialysis. Nutritional status was evaluated through anthropometric measurements, including body mass index and mid-upper arm circumference, as well as biochemical markers such as albumin, haemoglobin, serum creatinine, and blood urea nitrogen. Both anthropometric and biochemical parameters were systematically analysed to determine the patient's nutritional status. Statistical significance was considered at a p-value of less than 0.05. Results are presented as adjusted odds ratios with corresponding 95% confidence intervals.

Results
Underweight was observed in 45.6% of patients, and protein-energy wasting in 58.4% of patients. Biochemical results showed low mean haemoglobin at 8.9 ± 2.19 g/dl and albumin at 3.6 ± 0.40 g/dl, elevated creatinine at 698.5 ± 439.31, cholesterol at 183.6 ± 87.73 mmol/l, potassium at 4.9 ± 0.66 mmol/l, and markedly low calcium at 1.3 ± 0.61 mmol/l.

Conclusion
These findings emphasise the importance of regular nutritional screening and the incorporation of nutrition services into kidney care at Muhimbili National Hospital and similar settings. Tackling undernutrition among patients with chronic kidney disease on haemodialysis is crucial for enhancing clinical outcomes, quality of life, and equity in chronic disease management

Keywords: chronic kidney disease; haemodialysis; nutritional status; protein–energy wasting

Introduction

Chronic kidney disease (CKD) is widely recognised as a major contributor to the global burden of non-communicable diseases (Ploth et al., 2018; Somji et al., 2020). Approximately 10–13% of the world's population, equivalent to over 850 million people, are living with CKD (Meremo et al., 2018; Furia et al., 2019). Chronic kidney disease can result from various factors, chiefly diabetes and hypertension (Stanifer et al., 2015; Shoo et al., 2024). Haemodialysis (HD) is a treatment option for end-stage kidney disease (ESKD), and its utilisation has increased in Tanzania in recent years (Furia et al., 2019; Mnkugwe et al., 2022).

Undernutrition is characterised by insufficient energy and protein stores, resulting in low body mass and muscle and fat breakdown among CKD patients on HD. It is often linked to decreased dietary intake caused by uraemia-related anorexia, inflammation, metabolic acidosis, hormonal imbalances, nutrient loss during dialysis, and restrictive renal diets (Zuvela et al., 2018; Yoke et al., 2019). In low-resource settings like Tanzania, these issues are further worsened by food insecurity, poverty, and limited access to specialised renal nutrition services (Somji et al., 2020; Bramania et al., 2021). Consequently, addressing undernutrition in these patients requires regular nutritional assessments, correction of metabolic acidosis and inflammation, management of uremic symptoms, and the provision of affordable oral nutritional supplements (Gityamwi et al., 2021).

A recent report showed that the prevalence of undernutrition among CKD patients on HD worldwide is 43.1% (Lan et al., 2024). In Sub-Saharan Africa (SSA), the burden of undernutrition in CKD patients is particularly pronounced at 75% (Gityamwi et al., 2021). Despite its clinical significance, routine nutritional assessment among CKD patients in Tanzania remains inconsistent, including at MNH, and local evidence on the prevalence of undernutrition using clearly defined and standardised indicators is limited. Bramania et al. (2021) found that undernutrition affected 61.2% of CKD patients undergoing HD at MHN. This study aims to update this, utilising additional measures of undernutrition.

Methods

Study Design and Setting

A cross-sectional study was conducted from March to April 2025 involving 149 CKD patients undergoing HD at the Nephrology Unit of the MNH in Dar es Salaam, Tanzania. Muhimbili National Hospital is the leading tertiary referral and teaching hospital in the country, serving as a primary centre for specialised renal services, including maintenance HD, peritoneal dialysis, and kidney transplantation (Bramania et al., 2021; Shoo et al., 2024). The hospital receives patients from across Tanzania, making it a representative setting for investigating CKD and its complications (Ploth et al., 2018). The Nephrology Unit operates on an outpatient and inpatient basis, providing care to individuals with ESKD according to standard guidelines, typically involving thrice-weekly dialysis sessions (Mnkugwe et al., 2022).

Study Population and Eligibility Criteria

The study involved adults aged 18 to 75 years who had been undergoing regular HD at MNH for at least 3 months. This minimum three-month period ensured that participants had adapted to their treatment regimen and allowed for a reliable assessment of their nutritional status within the context of ongoing care. Patients were excluded if they were critically ill and, therefore, unable to participate in interviews and physical assessments, had significant cognitive impairment, or were unable to provide informed consent.

Sample Size Determination

The number of participants needed to assess nutritional status among CKD patients undergoing HD at MNH was calculated using Fisher's formula. This formula was chosen because it is suitable for estimating sample size in cross-sectional studies where the population is finite or prevalence is being measured (Bramania et al., 2021).

The specific equation used was $n = Z^2P(1-P) / d^2$. Due to the absence of data on the prevalence of undernutrition among CKD patients at MNH, the proportion ('P') was conservatively assumed to be 50%, ensuring sufficient statistical power (Bramania et al., 2021). With these parameters, a minimum sample size of 149 participants was calculated, considered adequate to evaluate nutritional status in this population.

Data Collection and Validation

Prior to data collection, the questionnaire was pretested to assess clarity, relevance, and consistency, and necessary adjustments were made before administration to the study participants (Bramania et al., 2021). A total of 149 patients consented to participate in the study and were recruited after signing informed consent forms prior to data collection. A structured questionnaire administered in Kiswahili was used to collect the required information, including age, education, sociodemographic data, anthropometric and biochemical measurements. The researcher conducted face-to-face interviews with participants at the Nephrology Unit during their routine clinic visits for HD, and data were captured electronically using the Kobo data collection tool.

Anthropometric measurements, including weight, were taken using a calibrated digital weighing scale; height was measured with a stadiometer in a standing position; and basal metabolic index (BMI) was calculated as weight (kg) divided by height (m) ^{2} (Hassanin et al., 2021). Moreover, BMI was classified into severe underweight (< 16 kg/m^2), moderate underweight (16-18.5 kg/m^2), Normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), or obesity (⩾30 kg/m^2), (Omari et al., 2019). Mid-upper arm circumference (MUAC) was measured in centimetres using an adult MUAC tape (Gityamwi et al., 2021). Additionally, MUAC risk were categorised as severe malnutrition when < 18.5 cm, moderate malnutrition (18.5-22 cm), and normal nutritional status means is within recommended range 23-30 cm (Ikizler et al., 2020). Biochemical markers, such as serum albumin, serum creatinine, total cholesterol, blood urea nitrogen, haemoglobin level, blood glucose, phosphorus, potassium, and sodium, were obtained as secondary data from the MNH medical records department,

using the most recent available measurements. Generally, all biochemical measurements had been routinely collected by trained healthcare professionals as part of standard patient care.

Data Analysis

Data were entered, cleaned, and analysed using R statistical software (version 4.4.3). Descriptive statistics were employed to summarise participant's socio-demographic characteristics and biochemical markers. Categorical variables were summarised using frequencies and percentages, while continuous variables were summarised with means and standard deviations. Nutritional status was assessed through BMI, MUAC, and biochemical markers. For BMI, participants were initially classified into five categories: severe malnutrition, moderate malnutrition, normal nutritional status, overweight, and obesity (Cupisti et al., 2017). Due to sparse observations in extreme categories and violation of the proportional odds assumption, BMI was combined into three ordinal categories: underweight, normal nutritional status, and overweight/obesity, which served as the outcome variable in regression analyses (Bingol et al., 2022). Biochemical markers were categorised according to standard clinical cut-offs.

An ordinal logistic regression model was employed to examine factors associated with BMI categories. The dependent variable was BMI category, classified into ordered levels of nutritional status. Independent variables included socio-demographic characteristics (age, sex, education level, marital status, and occupation) and biochemical markers. Crude regression coefficients with corresponding standard errors, t-values, and p-values were estimated. Statistical significance was considered at a p-value of less than 0.05. Results are presented as adjusted odds ratios with corresponding 95% confidence intervals (Omari et al., 2019).

Ethical Consideration

The researcher obtained a clearance letter and permission from the Directorate of Research and Publication at the Open University of Tanzania. Subsequently, the MNH Research, Training and Consultancy Unit granted approval to conduct the study. The Internal Medicine Department was contacted for permission to carry out the study in their Nephrology Unit, and the Medical Records Department was approached for biochemical marker data. Additionally, the Nutrition Unit was fully engaged and offered technical support throughout the process. All participants gave written or verbal consent after being thoroughly informed about the study's objectives, methods, potential risks, and benefits. Participants were assured that their participation was entirely voluntary and that they could withdraw at any point without affecting their medical care. To maintain privacy and confidentiality, each participant was assigned a unique identification code, and all collected data were securely stored in password-protected files accessible only to the research team. Furthermore, any participants found to have significant nutritional deficiencies or other health issues during the study were referred to the hospital's nutritionist and nephrologist for appropriate management.

Results

Demographic Characteristics of Participants

A total of 149 patients undergoing HD were included in the analysis. More than half of the participants were male (54.4%). Nearly half of the participants had attained secondary education (49.0%), followed by primary education (28.2%) and college or university education (21.5%). A few (1.3%) had not attended school. The majority were married (58.4%), while 22.1% were single, 12.8% widowed, and 6.7% divorced. Regarding occupation, unemployment was the most common status (34.2%), followed by entrepreneurship (26.8%), retirement (21.5%), and formal employment (17.4%).

Nutritional Status of the Respondents

The nutritional status of the respondents, based on BMI and MUAC classification, is shown in Figure 2. These findings point to a significant burden of undernutrition among patients receiving HD.

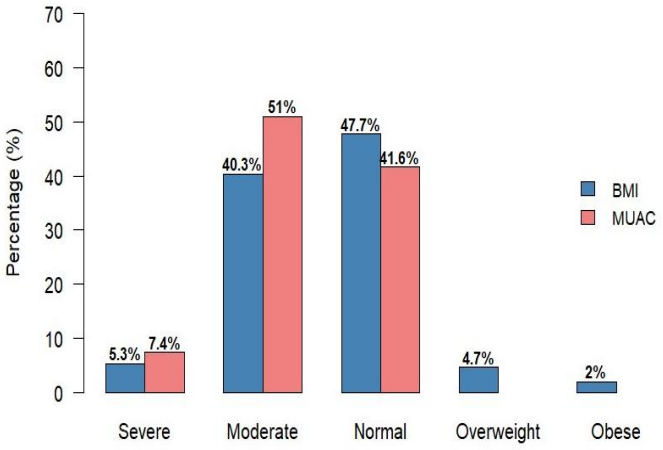


Figure 1. Nutritional status of CKD patients on HD based on BMI and MUAC Classification

Regarding biochemical markers, participants showed significant abnormalities consistent with CKD (Table 1). Especially notable was the low calcium, with a mean of 1.3 ± 0.61 mmol/l, suggesting impaired vitamin D activation and phosphate retention. Low calcium can lead to muscle cramps, bone pain, pathological fractures, and general body weakness. (Ikizler et al., 2020).

Determinants of Body Mass Index among Participants

Comprehensive ordinal logistic regression models were used to assess relationships between BMI categories, age, sex, occupation, and biochemical markers. None of the predictors showed statistically significant links with most biomarkers. However, serum creatine exhibited a borderline association ($\beta = 0.0014$, $p = 0.076$), suggesting a possible trend toward higher odds of being in higher BMI categories with increasing creatinine levels.

Table 1. Biochemical markers among 149 chronic kidney disease patients undergoing Haemodialysis at Muhimbili National Hospital in Tanzania

Variable	Mean ± SD	Range	Normal Range
Haemoglobin (g/dl)	8.90 ± 2.19	4.60 – 14.00	10-17.5
Serum albumin (g/dl)	3.58 ± 0.40	2.50 – 4.40	⩾ 4.0
Serum creatinine(mg/dl)	698.51 ± 439.31	8.00 – 1675.00	< 300
Fasting blood glucose (mmol/dl)	5.15 ± 0.85	3.50 – 7.00	3.0- 6.9
Total cholesterol (mg/l)	183.56 ± 87.73	110.00 – 700.00	< 200
Blood urea nitrogen(mmol/l)	17.89 ± 13.30	6.00 – 124.00	2.5-7.5
Phosphorus (mmol/l)	1.29 ± 0.27	0.80 – 2.00	0.8- 1.5
Sodium (mmol/l)	135.04 ± 6.81	125.00 – 145.00	135- 145
Potassium (mmol/l)	4.90 ± 0.66	3.50 – 6.20	3.5- 5.5
Calcium (mmol/l)	1.32 ± 0.61	0.80 – 2.45	2.2-2.6

Table 2. Ordinal logistic regression analysis of demographic and biochemical factors associated with BMI among CKD patients attending HD (n = 149)

Predictor Variable	Value	Std. Error	t value	P-value
Age	0.05658	0.03807	1.4863	0.1371
Sex Male	0.14761	0.61135	0.2414	0.8092
Education level Primary	0.74791	0.97730	0.7652	0.4441
Education level Secondary	0.32693	0.66742	0.4898	0.6242
Marital status Married	-0.71818	1.31844	-0.5447	0.5859
Marital status Single	-1.63232	1.71988	-0.9490	0.3425
Marital status Widowed	-1.40654	1.62483	-0.8656	0.3866
Occupation Entrepreneur	-0.02747	0.89544	-0.0306	0.9755
Occupation Retired	-0.97924	1.08268	-0.9044	0.3657
Occupation Unemployed	-1.47137	0.96261	-1.5285	0.1263
Haemoglobin	-0.09093	0.15236	-0.5968	0.5506
Serum creatinine	0.00138	0.00078	1.7768	0.0755
Calcium	-0.01007	0.00833	-1.2075	0.2272
Potassium	0.56388	0.73322	0.7690	0.4418
Cholesterol	-0.00403	0.00582	-0.6923	0.4887
Urea nitrogen	-0.00784	0.02486	-0.3155	0.7523
Fasting blood glucose	0.45833	0.45847	0.9996	0.3174
Phosphorus	-0.55098	1.32338	-0.4163	0.6771
Serum albumin	0.50966	0.76186	0.6689	0.5035

Discussion

The present study demonstrates a high prevalence of undernutrition among patients with CKD undergoing HD at MNH, as evidenced by both anthropometric and biochemical indicators, thereby supporting the working hypothesis that malnutrition remains a significant clinical concern in this population. Anthropometric assessment shows that a substantial proportion of participants were undernourished, with MUAC identifying more individuals at risk compared to BMI. The discrepancy may be explained by fluid retention in CKD, which can mask weight loss and lead to underestimation of malnutrition when BMI is used alone. In contrast, MUAC more accurately reflects muscle mass depletion, a key feature of protein–energy wasting in CKD. These findings are consistent with Maurya et al. (2019) and Gityamwi et al. (2021) who similarly reported a high burden of malnutrition and highlighted the limitations of BMI for CKD patients undergoing HD.

Regarding biochemical markers, the findings indicate a high prevalence of anaemia and evidence of moderate

nutritional compromise. The observed anaemia may be attributed to reduced erythropoietin production, iron deficiency, and the inhibitory effects of chronic inflammation on erythropoiesis, all of which are characteristic of advanced CKD. Low serum albumin levels may also be influenced by inflammation and increased vascular permeability, which reduce circulating albumin concentrations independent of dietary intake (Joshi et al., 2020; Mbogo et al., 2024). Furthermore, elevated serum creatinine and potassium levels are associated with kidney failure (Gityamwi et al., 2021).

Despite these abnormalities, no statistically significant associations were observed between BMI and the socio-demographic or biochemical variables, suggesting that nutritional status in this population is multifactorial and not adequately explained by common predictors. This finding is consistent with previous studies, which have shown that complex interactions among inflammation, dialysis-related factors, and metabolic disturbances may attenuate the strength of associations between individual variables and nutritional outcomes (Bramania et al., 2021).

Moreover, the consistency of these findings across multiple studies underscores undernutrition as a persistent challenge among patients undergoing HD, particularly in resource-limited settings such as Tanzania. These results highlight the importance of routine and comprehensive nutritional assessment incorporating both anthropometric and biochemical measures. Future research should prioritise longitudinal approaches to better elucidate causal pathways and to evaluate the effectiveness of targeted nutritional and clinical interventions aimed at improving patient's outcomes.

Strengths and Limitations of the Study

This study provides updated evidence on the nutritional status of patients with CKD undergoing HD in a national hospital referral centre in Tanzania, thereby adding to existing literature from the same setting. In contrast to earlier work by Bramania et al. (2021), the present study offers more recent data. It further strengthens existing evidence by employing a more comprehensive assessment of nutritional status through the combined use of anthropometric measures BMI and MUAC and biochemical markers, alongside regression analysis to explore potential determinants. The inclusion of MUAC enhances the sensitivity of nutritional assessment, particularly in the presence of fluid imbalance, thus providing a more robust evaluation of protein–energy wasting in this population.

However, several limitations should be considered. The cross-sectional design precludes causal inference regarding the relationship between nutritional status and associated factors. The single-centre setting may limit the generalisability of the findings to other populations. Fluid retention can obscure true body weight, and BMI does not differentiate between fat and lean mass, reducing its sensitivity for detecting protein–energy wasting. The lack of statistically significant associations in the regression analysis may also reflect limited statistical power or the influence of unmeasured confounders.

Implication for Policy and Practice

These findings have significant policy implications for HD care, especially in low-resource settings. First, the high prevalence of undernutrition and anaemia emphasises the need for stronger alignment with existing HD management guidelines, from Kidney Disease Improving Global Outcomes and Kidney Disease Outcomes Quality Initiative, which both produce evidence-based recommendations for kidney disease care, which advocate for routine nutritional assessment using validated tools, regular anthropometric monitoring (including MUAC where appropriate), and prompt management of undernutrition. Additionally, at the clinical level, policies should endorse structured nutrition assessments when initiating HD and at regular intervals, alongside feasible interventions, such as measuring serum ferritin to assess whether iron deficiency is involved, since it is cheap and simple to treat (Megawati et al., 2019; Ikizler et al., 2020).

Furthermore, at the system level, the strong link between unemployment and undernutrition emphasises the need for social protection. It is important to clearly differentiate between bedside clinical responsibilities, such as regular biochemical marker measurements, and early management to address these issues. Additionally, broader health system actions, such as funding, workforce training, and social welfare linkages, are essential to translate these findings into practical and sustainable HD management policies.

Conclusions

Undernutrition is very common among adult patients receiving regular HD at MNH. This condition manifests as patients being underweight, having lower muscle mass, low blood protein levels, and anaemia. Therefore, it is vital to enhance nutritional support for patients with CKD. This includes regular assessment of nutritional status and early management of undernutrition and anaemia.

Author Contributions

IVN, HSM and EJM contributed to the study design. Data collection tools were designed by IVN, HSM and ELM. Data collection was carried out by IVN, ESL and AEK. Biochemical data were obtained and verified by JWM, ESL and AEK. Initial analysis and coding were conducted by IVN. IVN wrote the first draft of the manuscript with critical reviews by HSM, EJM, JWM, ESL and AEK.

Declaration of Generative AI and AI-Assisted Technologies in Scientific Writing

Claude and ChatGPT was used for editing. ChatGPT was used to assist with language editing. The authors prepared all scientific content, carried out all analyses and interpretations with integrity, and agreed to be responsible for the content.

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Data Availability Statement

All relevant data are available within the manuscript

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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