Original Article

Assessment of nutritional status and associated factors among hemodialysis patients in Isfahan, Iran

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Background: This study aims to evaluate the nutritional condition of individuals undergoing hemodialysis (HD) in Isfahan, Iran. **Materials and Methods:** This cross-sectional study involved 201 HD patients. The modified quantitative subjective global assessment was employed to evaluate nutritional status, along with the collection of sociodemographic data, anthropometric measurements, and biochemical tests. **Results:** The participants had a mean age of 60.2 ± 16.24 years, with 70 (34.83%) being female. The prevalence of malnutrition was 63.18%, with 60.2% classified as mild-moderately malnutrition and 2.98% identified as severely malnutrition. The participants had a mean body mass index (BMI) of 24.6 ± 5.0 (kg/m^2), while 7.96% of patients had a BMI below the normal range. Compared to patients who underwent HD for <5 years, patients who had been on dialysis for >5 years demonstrated 2.5 times higher odds of malnutrition (odds ratio: 2.47, 95% confidence interval: 1.25–4.9). Age, mid-arm circumference, education level, and comorbid diabetes mellitus were significantly associated with malnutrition. In addition, malnourished patients showed lower levels of serum albumin (Alb) ($P < 0.001$) and serum creatinine (Cr) ($P < 0.001$). Multivariate logistic regression demonstrated age, dialysis duration, upper diploma educational level, lower serum Alb, and lower serum Cr may independently be associated with malnutrition in HD patients. **Conclusion:** Malnutrition is prevalent among HD patients. Regular assessment of nutritional status may enhance nutritional outcomes and overall well-being in this patient population.

Key words: Hemodialysis, malnutrition, modified quantitative subjective global assessment, nutritional status

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INTRODUCTION

Chronic kidney disease (CKD) is a growing global public health concern, affecting approximately 10% of adults worldwide and leading to 1.2 million deaths annually. CKD is projected to become the fifth leading cause of death by 2040.[1] Studies have revealed that a substantial proportion of patients with end-stage renal disease (ESRD), specifically 77.5%, require renal replacement therapy. Among these patients, dialysis is the preferred treatment for 43.1% of individuals.[2,3]

Various complications, including malnutrition, electrolyte imbalance, and disturbance of calcium and phosphorus metabolism, are commonly observed in long-term dialysis patients. The prevalence of malnutrition among dialysis-dependent patients ranges from 28% to 54%.[3,4] In hemodialysis (HD) patients, multiple factors contribute to the development of

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malnutrition. These factors include anorexia, metabolic acidosis, secondary hyperparathyroidism, altered metabolism, inflammation, loss of nutrients during HD sessions, as well as psychosocioeconomic factors.[5-8] Malnutrition has emerged as a critical predictor of both mortality and morbidity, resulting in higher hospitalization rates, reduced physical activity, and compromised quality of life.[9,10] Assessing the nutritional status of HD patients is essential for identifying individuals at risk and implementing appropriate interventions.

The subject global assessment (SGA) is a validated tool that is widely utilized for evaluating the overall nutritional status of patients. It was initially developed by Detsky *et al*. to evaluate the nutritional status of individuals undergoing gastrointestinal surgery.[11] To assess the nutritional status of patients receiving HD, Kalantar-Zadeh *et al*. developed a modified quantitative SGA (MQ-SGA).[12] MQ-SGA provides several advantages, including convenience, simplicity, and cost-effectiveness, by considering subjective and objective parameters and has been validated in patients with ESRD.[3] Consequently, the Kidney Disease Outcomes Quality Initiative recommends the routine use of MQ-SGA to evaluate the nutritional status of HD patients, ideally at least every six months.[13]

In addition, anthropometric indices, including body mass index (BMI) and mid-arm circumference (MAC), are commonly employed to evaluate body structure and nutritional status. Furthermore, biochemical laboratory tests, such as serum albumin (Alb), total iron binding capacity (TIBC), cholesterol, and triglyceride levels, serve as objective indicators of nutritional status.[14-18] Therefore, several studies have proposed incorporating these variables alongside the MQ-SGA to enhance the assessment of nutritional status in ESRD patients.[12,18,19]

The objective of the present study is to evaluate the nutritional status of patients undergoing HD in Isfahan using a comprehensive approach that includes MQ-SGA, anthropometric indices, and biochemical laboratory tests. The study aims to provide valuable insights into the prevalence and severity of malnutrition in this patient population. The findings will guide the development of targeted interventions to optimize the nutritional status of HD patients.

MATERIALS AND METHODS

This cross-sectional study was conducted among HD patients attending three HD centers in Isfahan, Iran. The sample size was determined based on the number of available participants who met the inclusion criteria during the study period. A total of 201 patients were included in the study. The inclusion criteria were being aged 18 years or above and having a minimum duration of 6 months on HD. Patients with HBV infection, HIV infection, psychological or mental disorder, malignancy, and recent surgery within the last 6 months were excluded from the study. Participants with missing critical data, such as key demographic or clinical variables, were excluded from the analysis. This approach ensured that the analysis was based on a reliable dataset.

Data collection took place between April and May 2023, following the approval of the study protocol by the Ethics Committee of the Isfahan University of Medical Sciences (approval number: IR.ARI.MUI.REC.1402.020) in accordance with the principles of the Helsinki Declaration. Before their enrollment in the study, all participants provided informed consent.

Data collection

Trained healthcare professionals collected data during the routine HD sessions using a questionnaire comprising four sections. The first section captured the sociodemographic characteristics of the participants. The second section focused on the MQ-SGA. The third section collected data about laboratory tests. Finally, the fourth section involved anthropometric measurements.

Sociodemographic characteristics

The data collection process for sociodemographic characteristics encompassed obtaining variables such as age, gender, marital status, education level, occupational condition, household income, duration of HD, comorbidities, and medications. The demographic data was gathered by employing a structured questionnaire specifically designed to capture these variables. Strict protocols were followed to maintain the confidentiality and privacy of the participants throughout the data collection process.

Modified Quantitative Subjective Global Assessment

The MQ-SGA was conducted by trained assessors who evaluated participants based on their medical history and physical examination. The medical history component assessed nutritional status from five perspectives: food consumption, weight changes, gastrointestinal symptoms, functional capacity, and comorbidity. Physical examination focused on two factors: loss of subcutaneous fat and any signs of muscle wasting.

Each component was assigned a score on a scale ranging from 1 (representing a normal state) to 5 (reflecting a very severe condition), thereby the cumulative scores from all components resulted in a total score ranging from 7, indicating a normal nutritional status, to 35, indicating the presence of severe malnutrition.[12] Participants were divided into three distinct groups based on their scores: a score range of 7–13 was indicative of a normal nutritional status, a score range of 14–23 indicated mild-to-moderate malnutrition, and a score range of 24–35 denoted severe malnutrition.

Laboratory tests

The laboratory test data were collected by obtaining the latest results from the participants' monthly laboratory tests. These results were extracted from the patient's medical records and included parameters such as hemoglobin, creatinine (Cr), predialysis blood urea nitrogen (BUN), serum Alb, TIBC, cholesterol, Kt/V index (to assess dialysis adequacy), and other relevant tests.

Anthropometric measurements

Anthropometric measurements, including dry body weight, height, BMI, and MAC, were performed within 10–20 min after the dialysis session ended. The dry body weight of the participants was measured using calibrated scales. Height was measured using a stadiometer. In cases where individuals were unable to stand upright, an alternative method using ulnar length was employed. The ulnar length refers to the distance from the olecranon process to the styloid process of the ulnar bone. Conversion tables were utilized to estimate height based on ulnar length. BMI was determined by dry weight (kg)/height (m^2) formula. Participants were grouped into different BMI categories following the classification provided by the World Health Organization: underweight (<18.5 kg/m^2), normal weight (18.5–<25 kg/m^2), overweight (25–<30 kg/m^2), and obese (≥30 kg/m^2). MAC was assessed utilizing a nonstretchable tape measure at the midpoint of the right arm unless there was functional impairment in that arm.

Statistical analysis

The statistical analysis was performed using STATA 14.1 (Stata Statistical Software, StataCorp LP, College Station, TX, USA). Categorical and continuous variables are reported as numbers (percentages) and mean ± standard deviation, respectively. The Chi-square test is used to assess categorical variables, while the Student's *t*-test is employed for continuous variables. To determine the effect of different parameters on malnutrition, logistic regression was used. Variables with univariate $P \leq 0.2$ were kept in the multivariate analysis model. A significance level of $P \leq 0.05$ was regarded as the threshold for determining statistical significance between the variables.

RESULTS

Sociodemographic and clinical characteristics of study subjects

A total of 201 HD patients participated in the study, with a mean age of 60.2 ± 16.2 years (range: 18–97 years). The majority of the participants were male (65.2% male and 34.8% female). Among the participants, 137 (68.2%) had been undergoing dialysis for <5 years and 64 (31.8%) had a dialysis duration of 5 years or more. The patients' mean BMI was 24.6 ± 5.0 (kg/m^2), while 16 participants (8%) were classified as underweight, 99 as normal weight (49.2%), 58 as overweight (28.8%), and 28 as obese (14%). The most common comorbid conditions observed in the study patients were hypertension (145, 72.1%) followed by diabetes mellitus (DM) (100, 49.8%). Detailed baseline characteristics of anthropometric and sociodemographic factors of participants are shown in Table 1.

Nutritional status assessment of hemodialysis patients

The SGA scores ranged from 7 to 29, with a mean SGA score of 15.2 ± 4.0 (male: 14.9 ± 4.0 and female: 15.6 ± 3.9). Among the patients, 63.2% were classified as malnourished (SGA ≥ 14), with 60.2% categorized as mild-moderately malnourished and 3% as severely malnourished.

Table 1: Baseline characteristics of anthropometric and socio-demographic factors of participants

	Total (*n*=201)
Age (year), mean (SD)	60.2 (16.2)
Sex, *n* (%)	
Male	131 (65.2%)
Female	70 (34.8%)
Height (m), mean (SD)	165.6 (9.7)
Weight (kg), mean (SD)	67.4 (15.2)
BMI (kg/), mean (SD)	24.6 (5.0)
MAC (cm), mean (SD)	27.1 (5.3)
Dialysis duration (year), *n* (%)	
<5 year	137 (68.2%)
≥5 years	64 (31.8%)
Marital status, *n* (%)	
Single	52 (25.9%)
Married	149 (74.1%)
Education, *n* (%)	
Illiterate	50 (24.9%)
Diploma ≥	134 (66.7%)
>Diploma	17 (8.4%)
Occupation, *n* (%)	
Unemployed	76 (37.8%)
Employed	46 (22.9%)
Retired	79 (39.3%)
Economic situation, *n* (%)	
Low income	35 (17.4%)
Moderate income	136 (67.7%)
High income	30 (14.9%)
DM, *n* (%)	
Absent	101 (50.2%)
Present	100 (49.8%)
HTN, *n* (%)	
Absent	56 (27.9%)
Present	145 (72.1%)

The age of the participants showed a significant association with malnutrition (standardized mean difference [SMD]: −0.67, 95% confidence interval [CI]: −0.96 to −0.38, $P < 0.001$). In addition, MAC was significantly associated with malnutrition (SMD: 0.43, 95% CI: 0.14–0.72, $P = 0.004$).

Furthermore, malnutrition was significantly associated with education level, duration of dialysis, and comorbid DM. Patients undergoing dialysis for >5 years had approximately 2.5 times higher odds of being malnourished (χ^2: 7.22, $P = 0.007$; odds ratio: 2.47, 95% CI: 1.25–4.90). Similarly, diabetic patients had approximately 2 times higher odds of being malnourished (χ^2: 5.22, $P = 0.022$; odds ratio: 1.96, 95% CI: 1.09–3.56). There was no statistically significant association observed between nutritional status and BMI (SMD: 0.27, 95% CI: 0.02–0.56, $P = 0.07$) [Table 2].

Table 2: Comparison of anthropometric and socio-demographic characteristics between normal nutrition and malnutrition participants

	Normal nutrition	Malnutrition	*P*; *t* or
Sex (male), *n* (%)	51 (68.92%)	80 (62.99%)	0.395; 0.72
Age (year), mean (SD)	53.6 (1.85)	64 (1.35)	<0.001; *t*:4.60
MAC (cm), mean (SD)	28.5 (0.62)	26.3 (0.46)	0.004; *t*:2.96
BMI (kg/m²), mean (SD)	25.39 (0.60)	24.07 (0.42)	0.07; *t*:1.84
Education, *n* (%)			0.007; 7.15
Illiterate	13 (17.6%)	37 (29.1%)	
≤ Diploma	50 (67.6%)	84 (66.1%)	
>Diploma	11 (14.9%)	6 (4.7%)	
Occupation, *n* (%)			0.065; 5.45
Unemployed	28 (37.8%)	48 (37.8%)	
Employed	23 (31.1%)	23 (18.1%)	
Retired	23 (31.1%)	56 (44.1%)	
Dialysis duration (year), *n* (%)			0.007; 7.22
<5	59 (79.7%)	78 (61.4%)	
≥5	15 (20.3%)	49 (38.6%)	
DM, *n* (%)			0.022; 5.22
Absent	45 (60.8%)	56 (44.1%)	
Present	29 (39.2%)	71 (55.9%)	
HTN, *n* (%)			0.652; 0.20
Absent	22 (29.7%)	34 (26.8%)	
Present	52 (70.3%)	93 (73.2%)	

Regarding biochemical markers reflecting nutritional status, malnourished patients had lower levels of Alb (SMD: 0.69, 95% CI: 0.40–0.99) and serum Cr (SMD: 0.63, 95% CI: 0.33–0.92) compared to normal-nourished patients. However, there were no statistically significant differences observed in hemoglobin, predialysis BUN, phosphorus, TIBC, parathyroid hormone, total cholesterol, Kt/V, and urea reduction ratio between normal-nourished and malnourished patients [Table 3].

Factors associated with malnutrition

To explore the effect of different factors on malnutrition, both univariate and multivariate logistic regression were employed. In the multivariable analysis, statistically significant associations were observed for age, dialysis duration, educational level (upper diploma), lower serum Alb, and lower serum Cr [Table 4].

The duration of HD was found to be significantly associated with malnutrition. This suggests that with each year's increase in the duration of HD, the odds of experiencing malnutrition increased by 25% (odds ratio: 1.25, 95% CI: 1.11–1.41, $P < 0.001$). Furthermore, lower serum Alb showed a statistically significant association with malnutrition, indicating that for each unit of increase in serum Alb, the odds of being malnourished decreased by 80% (odds ratio: 0.21, 95% CI: 0.09–0.45, $P < 0.001$).

DISCUSSION

In this cross-sectional study, our objective was to evaluate the nutritional status among HD patients using the MQ-SGA. The study identified a considerable prevalence of malnutrition in these patients, emphasizing the significance of comprehensive evaluations that include MQ-SGA, anthropometric indices, and biochemical laboratory tests.

Table 3: Comparison of laboratory data between normal nutrition and malnutrition participants

	Normal nutrition, mean (SD)	Mal nutrition, mean (SD)	*P*; *t*
Hb (g/dl)	10.35 (1.6)	10.54 (1.8)	0.477; *t*:0.71
Pre dialysis BUN (mg/dl)	59.13 (15.4)	55.14 (15.12)	0.074; *t*:1.80
Cr (mg/dl)	7.57 (2.63)	6.13 (2.07)	<0.001; *t*:4.29
Alb (g/dl)	3.95 (0.42)	3.61 (0.51)	<0.001; *t*:4.74
Chol (mg/dl)	128.1 (33.93)	125.73 (31.8)	0.644; *t*:0.46
Ph (mg/dl)	4.6 (1.3)	4.37 (1.27)	0.218; *t*:1.24
Kt/v	1.49 (0.36)	1.46 (0.31)	0.553; *t*:0.60
URR	0.71 (0.1)	0.71 (0.09)	0.932; *t*:0.08
TIBC (mcg/dl)	300.1 (48.9)	297.9 (50.3)	0.779; *t*:0.28
PTH (pg/ml)	505.65 (354.69)	471.68 (398.53)	0.564; *t*:0.58

Table 4: Association of anthropometric, laboratory data, and socio-demographic characteristics with malnutrition in hemodialysis patients

	Univariate logistic regression analysis		Multivariate logistic regression analysis	
	Crude OR (95%CI)	*P*	Adjusted OR (95%CI)	*P*
Age (year)	1.042 (1.022 to 1.063)	<0.001	1.028 (1.001 to 1.056)	0.042
BMI (kg/m^2)	0.947 (0.893 to 1.005)	0.071	0.960 (0.867 to 1.060)	0.415
MAC (cm)	0.923 (0.873 to 0.975)	0.004	0.951 (0.865 to 1.047)	0.308
Dialysis duration (year)	1.110 (1.021 to 1.205)	0.015	1.250 (1.111 to 1.406)	<0.001
Alb (g/dl)	0.236 (0.123 to 0.454)	<0.001	0.205 (0.093 to 0.451)	<0.001
Cr (g/dl)	0.858 (0.659 to 0.873)	<0.001	0.823 (0.680 to 0.996)	0.045
Pre dialysis BUN (mg/dl)	1.061 (0.901 to 1.250)	0.475	1.004 (0.978 to 1.030)	0.787
Education				
Illiterate	Ref		Ref	
≤ Diploma	0.590 (0.287 to 1.216)	0.153	0.658 (0.265 to 1.630)	0.366
> Diploma	0.192 (0.059 to 0.623)	0.006	0.208 (0.045 to 0.972)	0.046
DM				
Absent	Ref		Ref	
Present	1.967 (1.098 to 3.526)	0.023	1.582 (0.767 to 3.261)	0.214

Our findings indicated that 63.2% of the participants were classified as malnourished based on MQ-SGA scores. Among them, the majority (60.2%) were categorized as mildly to moderately malnourished, while a smaller proportion (3%) were severely malnourished. These results align with previous studies, reporting similar or even higher rates of malnutrition. For instance, studies conducted in India, Nepal, Saudi Arabia, Jordan, Iraq, Pakistan, and Palestine have reported prevalence rates ranging from 47.2% to 66.7%.[20-27] However, other studies from Iran, Brazil, and the Netherlands have reported lower rates of malnutrition.[28-30] These discrepancies may be attributed to differences in assessment methods, patient demographics, duration of illness, underlying diseases, eating habits, and socioeconomic factors. Addressing malnutrition in this patient population is crucial due to its significant impact on patient outcomes and mortality rates.

BMI serves as a convenient and valuable tool for assessing nutritional status although its sensitivity in detecting malnutrition may be limited in certain cases.[8,31] Our investigation revealed no significant association between BMI and malnutrition. These findings align with previous studies that have no significant association between BMI and malnutrition.[26,32] However, some studies have reported the association between BMI and nutritional status in HD patients.[28,29,33]

Our study revealed a substantial association between malnutrition and age, with a higher prevalence observed among elderly patients. This finding is consistent with previous research indicating a higher incidence of malnutrition among older individuals undergoing HD.[8,34] However, Ghazi *et al*. found no statistically significant correlation between nutritional status and age.[26] The differences in findings may be attributed to various factors such as infections, dental problems, emotional disorders, and limited access to food that are more prevalent in the elderly population.[35,36]

On the other hand, gender did not show a significant association with malnutrition in our study. This finding aligns with some studies that have reported no effect of gender on nutritional status in HD patients.[25,27] However, conflicting results have been reported in other studies, with some indicating higher malnutrition rates among female patients and others among male patients.[23,24,26,28,37]

In addition, several factors were identified as potential influencers of nutritional status in our study. Lower education levels, longer dialysis duration, lower MAC, and comorbid conditions such as DM were associated with a higher risk of malnutrition among HD patients. These findings are consistent with prior investigations, highlighting the multifactorial nature of malnutrition in this population.[27,38] However, there are also studies that have not found a significant correlation between nutritional status and comorbid conditions or dialysis duration.[8,26,27,39] Multivariable logistic regression showed no significant association between MAC and comorbid DM with malnutrition, indicating that these factors may not independently contribute to the likelihood of malnutrition in HD patients. Further investigation is required to better understand the interplay between MAC and comorbid DM in relation to malnutrition.

Biochemical markers are essential tools in evaluating the nutritional status of HD patients. Our study demonstrated a significant association between malnutrition and serum Alb and serum Cr levels. Reductions in these markers indicate a decline in the storage of proteins in visceral and muscle tissues, suggesting protein deficiency and malnutrition.[8] These findings are consistent with previous research, which has consistently identified serum Alb and Cr as valuable indicators of nutritional status in HD patients.[8,10,40]

While the majority of studies suggest a significant association between low serum Alb levels and malnutrition, it is important to consider that there have been some exceptions. For instance, a study conducted by Azzeh *et al*. found no significant effect of serum Alb levels on malnutrition in a sample of HD patients.[39] They suggest serum Alb levels can be impacted by nonnutritional factors such as liver disease, chronic inflammation, and edema.[8] However, some studies have suggested the use of additional biochemical markers, such as TIBC, hemoglobin levels, and total cholesterol as strong correlates of nutritional status in HD patients.[10,18,27,40] For instance, a study conducted by Afaghi *et al*. found a strong association between low serum TIBC levels and malnutrition in HD patients.[10] Another study by Rezeq *et al.* highlighted the association between hemoglobin levels and malnutrition in HD patients.[27]

The findings of our study have important implications for clinical practice in the care of HD patients. The high prevalence of malnutrition observed highlights the need for assessment of the nutritional status of HD patients. Healthcare professionals should consider incorporating MQ-SGA and other relevant tools into routine practice to evaluate nutritional status accurately. Furthermore, targeted interventions and strategies should be developed to improve nutritional outcomes, such as individualized dietary counseling, nutritional supplementation, and close monitoring of biochemical markers.

There are limitations that should be acknowledged. The cross-sectional design of the study restricts the ability to establish causal relationships between variables. In addition, the study was carried out in a single city, which may limit the generalizability of the findings. Future research should consider longitudinal studies to explore the factors influencing nutritional status in HD patients.

Furthermore, our study focused primarily on demographic, clinical, and biochemical factors, but there are other factors, such as psychosocial factors, and additional biochemical markers that may contribute to malnutrition in this population that were not investigated. In addition, investigating the impact of dietary interventions, exercise programs, and other strategies on improving nutritional outcomes in HD patients would be worthwhile. These interventions could be tailored to address the specific influencing factors identified in our study.

CONCLUSION

Our study provides valuable insights into the factors influencing nutritional status among HD patients. It highlights the importance of age, duration of HD, comorbid DM, and biochemical markers including serum Alb and serum Cr in assessing malnutrition in this population. The findings underscore the need for comprehensive nutritional assessments and targeted interventions to improve nutritional outcomes and overall well-being in HD patients. By addressing and managing malnutrition effectively, healthcare professionals can help enhance the quality of life and clinical outcomes for individuals undergoing HD.

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Conflicts of interest

There are no conflicts of interest.

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