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Original Research Article

Evaluation of malnutrition in chronic kidney disease patients in a tertiary health care center at Uttarakhand: a single center, cross-sectional and observational study

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ABSTRACT

Background: Malnutrition in CKD patients contributes to an increased risk of mortality and morbidity. This study aims to explore the prevalence of malnutrition among CKD dialysis dependent and not on dialysis patients at a tertiary health care center at Uttarakhand and examining the correlations between SGA score, biochemical markers, and anthropometric measures.
Methods: A cross-sectional and observational study was performed at Nephrology department, All India institute of medical sciences, Rishikesh from March, 2023 to July, 2024. It included 150 patients. Nutritional status was assessed with subjective global assessment score that included parameters like weight, dietary intake, gastrointestinal symptoms, functional capacity, subcutaneous fat, muscle wasting, oedema and ascites. Biochemical and anthropometric measures of patients were then correlated with SGA score.
Results: Prevalence of malnutrition in CKD patients in this study was 32%. GFR significantly predicted any presence of malnutrition for CKD patients not on dialysis. Blood urea, creatinine, triglycerides, total cholesterol, LDL, phosphorus were significantly associated with SGA Score ($p<0.05$). Weight, height, BMI, TSF and MAC decreased with increase in degree of malnutrition and it was statistically significant (p-<0.001, p-0.0031, p-<0.001, p-<0.001 and p-<0.001 respectively).
Conclusions: Malnutrition is prevalent among CKD patients. Prevalence of malnutrition increases with disease progression. Nutritional assessment is an important part of the holistic management of CKD. Biochemical and anthropometric parameters are reliable tools for monitoring and improving patient outcomes.

Keywords: Chronic kidney disease, Subjective global assessment score, Malnutrition, Anthropometric and biochemical parameters

INTRODUCTION

Chronic kidney disease affects millions of individuals worldwide. Malnutrition in CKD patients is a complex and multifactorial condition that not only causes deterioration of renal function but also contributes to an increased risk of mortality and morbidity. The Subjective Global Assessment (SGA) score is a widely used tool for

assessing nutritional status. It is a reliable indicator for detecting malnutrition in CKD patients. It predicts mortality and morbidity.[1] It is also essential to explore how it correlates with biochemical parameters (albumin, serum creatinine, and urea) and anthropometric measurements (BMI, skinfold thickness, and mid-arm circumference). These parameters provide better understanding of the underlying factors contributing to malnutrition in CKD patients and can help guide more targeted interventions.

Mutsert et al did a study on evaluation of malnutrition status of 1601 patients. Mild, moderate, and severe protein energy malnutrition was observed in 61%, 23%, and 5% respectively. Serum albumin, cholesterol and BMI mean values decreased with increase in degree of malnutrition. It was statistically significant. There was an increase in 7-year mortality in patients with SGA (4-5).[2] Janardhan et al included 66 patients. Janardhan et al assessed the degree of malnutrition in ESRD patients using SGA-DMS score. 91% of the patients were having moderate malnourishment. There was no significant correlation of BUN, creatinine, total protein, and cholesterol levels with the SGA score. There was negative correlation between modified SGA-DMS and anthropometric measures such as TSF, MAC, and MAMC; biochemical markers like albumin, ferritin and transferrin which was significant.[3] A cross-sectional study was done by Gupta et al from July 2014 to May 2015 at Allahabad, Uttar Pradesh. It included 100 patients. 7% were severely malnourished, 29% were mildly malnourished, and 64% were moderately malnourished. Triceps thickness, age, cholesterol, and serum urea correlated with SGA (P-value 0.002, 0.3, 0.001, 0.007 respectively). Serum albumin did not show any correlation with SGA.[4] Elrami et al did a cross-sectional study to assess the nutritional status and calculate the prevalence of malnutrition. Hawari Nephro Centre and Nephro Unit of Benghazi Medical Centre was the study location. It was conducted from December, 2019-January 2020. 155 CKD patients undergoing hemodialysis were included in the study. Significant correlation of SGA with BMI and albumin was observed. 58% of HD patients were well-nourished, 39% had mild to moderate malnourishment, 3% had severe malnutrition. Biochemical parameters phosphorous, cholesterol, hemoglobin correlated negatively with SGA scores.[5] Serum albumin is an indicator of malnutrition in chronic kidney disease patients. Serum albumin levels <3.5 g/dL predicts hospitalization rate and death rate of patients undergoing hemodialysis.[6] Total cholesterol levels <150 mg/dL is also an indicator of malnutrition.[7] A cross-sectional study was conducted by Sheikh et al at SRMSIMS at Uttar Pradesh. 18.1% were having CKD stage 3 and 13.3% were having CKD stage 4. 68.6% were CKD stage 5. 60.2% were malnourished as per SGA score. 78.9% were malnourished patients who belonged to stage 5 CKD. 10.8% and 10.3% of all malnourished cases were stage 3 and 4 CKD respectively. 55.4% had mild to moderately malnourishment (class B). 44.6% had severe malnourishment (class C). 65.5% were malnourished with eGFR ≤ 30 ml/min. 36% patients were malnourished with eGFR >30 ml/min.[8] Oluseyi et al calculated the prevalence of malnutrition in CKD patients before dialysis initiation at Nigeria which included 120 patients. Prevalence of malnutrition in the CKD group was 46.7%. In CKD stage 2 malnutrition prevalence was 30.8% which increased to 69.2% in CKD stage 5 (p=0.020).[9] Vanitha et al studied the correlation of SGA-DMS with biochemical and anthropometric parameters in CKD dialysis dependent patients which included 90 patients.[10] 14.4% were well nourished, 31% were mild to moderate malnourished and 54.4 % had moderate to severe malnourishment.[10] There was a significant negative correlation of serum albumin with SGA-DMS. Ferritin and SGA-DMS had a positive correlation. A significant negative correlation was observed of between BMI, TSFT, MAC and SGA-DMS.[10]

This study aimed to explore the prevalence of malnutrition among CKD dialysis dependent and not on dialysis patients at a tertiary health care center at Uttarakhand. Also, examining the correlations between SGA score, biochemical markers, and anthropometric measures. Additionally, providing insights into the correlation between e-GFR and nutrition status of CKD patients not on dialysis.

METHODS

Study design

This was cross-sectional and observational study.

Study location

Department of Nephrology, All India institute of medical sciences, Rishikesh from February, 2023 to July, 2024.

A total of 150 patients were included (75 patients were dialysis dependent and 75 patients were not on dialysis).

Study population

It included all stages of chronic kidney disease patients presenting to Nephrology OPD and IPD and chronic kidney disease who were undergoing maintenance haemodialysis in the Dialysis unit of AIIMS Rishikesh. All patients were more than 18 years of age. Patients having acute kidney injury, acute kidney disease, acute on chronic kidney disease, kidney transplant recipients and pregnant patients were excluded.

e-GFR was calculated by using CKD-EPI-2021 formula. Staging of CKD was done as per the KDIGO definition.

Data collection

Data of individual study subjects was recorded in a pre-designed case record proforma. Malnutrition was estimated using subjective global assessment tool. It included parameters as: weight, dietary intake, gastrointestinal symptoms, functional capacity,

subcutaneous fat, muscle wasting, oedema and ascites. SGA-A was well nourished, B was mild-moderately malnourished and C was severely malnourished.

Weight

A-<5% weight loss, B-5-10% weight loss, C->10% weight loss.

Dietary intake

A-intake increasing, B-intake no change, C-intake decreasing.

Gastrointestinal symptoms

A-nausea, vomiting and diarrhoea never, B-nausea, vomiting and diarrhoea some days for >2 weeks, C-nausea, vomiting and diarrhoea all days for >2 weeks.

Functional capacity

A-no dysfunction, B-difficulty in ambulation, C-bed-ridden.

Subcutaneous fat

Under the eyes- A-slight bulging area, B-slight hollowed lock, slight dark circles, C-hollowed lock, depression, dark circles.

Triceps- A-large space between fingers, B-loose fitting skin, C-very little space between fingers.

Ribs, lower back, trunk- A-chest full, B-ribs obvious but indentations not marked, iliac crest somewhat prominent, C- ribs obvious, iliac crest very prominent.

Muscle wasting

Temple- A-well-defined, B-slight depression, C- hollowed depression.

Clavicle- A-not visible, B-some protrusion, C- prominent bone.

Shoulder- A-rounded, B-slight protrusion of acromion process, C- square look and bones prominent.

Scapula- A-bones not prominent, B-mild depression, C-bones prominent and significant depression.

Quadriceps- A-well-defined, B-depression/atrophy medially, C-prominent knees, severe depression.

Interosseous space between thumb and forefinger- A-muscle protrudes, B-slight depressed, C- flat and depressed.

Oedema- A-no sign, B-mild-moderate, C-severe.

Ascites- A-no sign, B-mild-moderate, C-severe.

Source of SGA score

Adapted from Baxter Healthcare Corporation. Detsky, McCann, Ferguson, Bauer, Banks, Capra also contributed in formation of the above SGA score.

Anthropometric parameters included height, weight, body mass index, triceps skin fold thickness (measured using a triceps skin fold caliper), mid arm circumference (measured using a measuring tape). Biochemical parameters included urea, creatinine, albumin, ferritin, calcium, phosphorus, uric acid, i-PTH, vitamin D and fasting lipid profile.

Study population size

According to Elrami et al study on prevalence of malnutrition in CKD patients on maintenance hemodialysis which included 155 patients, sample size was 146 with an absolute error of 8%. Sample size was calculated using appropriate formula that is (z2*PQ/l2) with 95 % confidence level. A total of 150 patients were included in my study.

Statistical analysis

Data analysis was done by SPSS v23. Descriptive statistics were done using means/standard deviations. Medians were used for continuous variables. Frequencies and percentages were used for categorical variables. Group comparisons for data which were continuously distributed was done using independent sample ‘t’ test for comparison of two groups. Data which were non-normally distributed, non-parametric tests in the form of Wilcoxon Test were used when required. Group comparisons for categorical data were done using Chi-squared test. Fisher’s Exact test was used for expected frequency in the contingency tables <5 for>20% of the cells. Statistical significance was at p value <0.05. ROC analysis was used for prediction of optimal cutoff for a continuous predictor which predicted a binary outcome. Sensitivity Specificity, PPV, NPV and diagnostic accuracy were calculated for further assessment of diagnostic performance of predictors.

RESULTS

The mean age (years) was 48.86±14.03. 105 (70.0%) and 45 (30.0%) of the participants were male and female respectively. 76 (72.4%) males and 26 (57.8%) females were well nourished in my study. 28 (26.7%) males and 19 (42.2%) females were mild-moderately malnourished in my study. 71.3% of the participants were from Uttarakhand. 25.3% of the participants were from Uttar Pradesh. 32 (21.3%) of the participants had diabetes mellitus. 123 (82.0%) of the participants had hypertension.

Table 1 shows mean values of anthropometric parameters among patients in this study (n=150).

Table 1: Mean values of anthropometric parameters among patients in this study (n=150).

Parameters	Values (Mean±SD)
Mean weight (kg)	57.83±11.51
Mean height (cm)	160.93±8.31
Mean BMI (kg/m²)	22.22±3.89
Mean triceps skinfold thickness (mm)	19.64±5.70
Mean MAC (cm)	26.12±3.80

25, 67 and 58 patients had BMI <18.5, 18.5-22.9, >23 kg/m² respectively.

Table 2 shows mean values for biochemical parameters in this study (n=150).

Table 2: Mean values for biochemical parameters in this study (n=150).

Parameters	Values (Mean ± SD)
Haemoglobin (g/dl)	9.65±1.56
Blood urea (mg/dl)	87.09±34.38
S. creatinine (mg/dl)	5.86±3.44
Uric acid (mg/dl)	6.89±1.57
S. calcium (mg/dl)	8.68±0.84
Triglycerides (mg/dl)	139.31±40.3
Total cholesterol (mg/dl)	151.67±44.57
HDL (mg/dl)	46.71±11.10
LDL (mg/dl)	78.05±34.80
Ferritin (ng/ml)	424.47±306.6
S. phosphorus (mg/dl)	4.99±1.38
S. albumin (g/dl)	3.64±0.43
Intact PTH (pg/ml)	223.53±201.7
Vitamin D (ng/ml)	30.49±10.87

Mean (SD) GFR in my study was 29.52 (17.42) ml/min. Mean (SD) GFR in my study were 17.44 (8.38) ml/min and 31.60 (17.76) ml/min in CKD patients not on dialysis with and without malnutrition respectively.

68.0% of the participants had SGA Score: A (Well Nourished). 31.3% of the participants had SGA Score: B (Mild-Moderate Malnourished). 0.7% of the participants had SGA Score: C (Severe Malnourished). Proportion of malnutrition among CKD dialysis dependent population in my study was 49.3% which was higher in comparison to 14.7% in not on dialysis population. 34.2% (37/108) of CKD patients from Uttarakhand had malnutrition out of which only one patient had severe malnutrition. 26.3% (10/38) of CKD patients from Uttar Pradesh were mild-moderately malnourished.

Table 3 shows number of patients in each stage of CKD in this study (n=150).

Table 3: Number of patients in each stage of CKD in this study (n=150).

CKD stage	Frequency	Percentage
2	6	4.0
3A	10	6.7
3B	10	6.7
4	37	24.7
5 non-dialysis dependents	12	8.0
5 dialysis dependents	75	50.0

Association of e-GFR with the degree of malnutrition

Figure 1 shows ROC curve analysis representing diagnostic performance of GFR in predicting any malnutrition: present vs. absent (n=75).

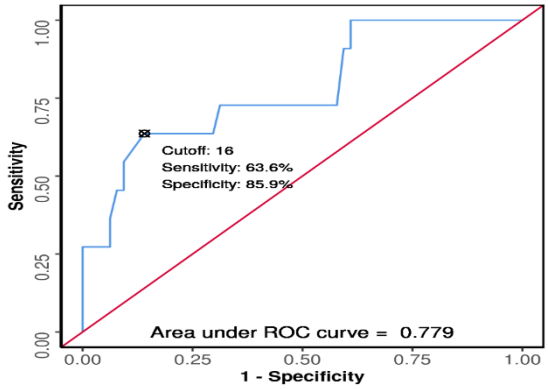

Figure 1: ROC curve analysis representing diagnostic performance of GFR in predicting any malnutrition: present vs absent (n=75).

Table 4 shows ROC curve analysis representing diagnostic performance of GFR in predicting any malnutrition: present vs absent (n=75).

Area under the ROC curve for GFR for predicting any malnutrition was 0.779 (95% CI: 0.62-0.938). It was found to be statistically significant (p=0.003). GFR significantly predicted any presence of malnutrition. At a cutoff of GFR ≤16, there was prediction of malnutrition with a sensitivity of 64% and specificity of 86%.

Table 4: ROC curve analysis representing diagnostic performance of GFR in predicting any malnutrition: present vs absent (n=75).

Parameter	Value
Cutoff (P value)	≤16 (0.003)
AUROC	0.779
Sensitivity (%)	63.6
Specificity (%)	85.9
Positive predictive value (%)	43.8
Negative predictive value (%)	93.2
Diagnostic accuracy (%)	82.7

Table 5 shows association between SGA score with anthropometric and biochemical parameters (n=150).

Weight, height, BMI, triceps skinfold thickness, MAC, hemoglobin, urea, creatinine, triglycerides, cholesterol, LDL, phosphorus, dialysis dependency were found to be significantly associated with SGA Score ($p<0.05$).

All Patients in CKD stage: 2, 3A and 3B had SGA Score: A (Well Nourished). 5 (13.5%) and 6 (50%) of CKD stage: 4 patients and CKD stage: 5 non-dialysis dependent patients were mild-moderately malnourished respectively. So, with increase in CKD staging and decrease in e-GFR, there was increase in degree of malnutrition. 48% (36/75) of participants in the group CKD stage 5 dialysis dependent had SGA Score: B (mild-moderate malnourished) and rest were well-nourished.

Table 5: Association between SGA score with anthropometric and biochemical parameters (n=150).

Parameters	SGA-A (well-nourished) (n=102)	SGA-B (mild-moderate malnourished) (n=47)	SGA-C (severe malnourished) (n=1)	P value
Weight (kg)* **	61.18±10.17	50.70±11.13	51.80±0	<0.001[1]
Height (cm)* **	162.30±7.92	157.70±8.29	172.00±0	0.003[1]
BMI (kg/m^2)* **	23.19±3.63	20.22±3.66	17.50±0	<0.001[1]
Triceps skinfold thickness (mm)* **	21.05±5.75	16.72±4.30	12.50±0	<0.001[1]
MAC (cm)* **	27.45±3.21	23.23±3.41	25.00±0	<0.001[1]
Hemoglobin (g/dl)* **	9.97±1.55	9.00±1.39	8.20±0	<0.001[1]
Blood urea (mg/dl)* **	82.71±36.54	96.25±27.61	103.00±0	0.026[1]
S. creatinine (mg/dl)* **	5.33±3.76	6.96±2.29	8.30±0	0.002[1]
Uric acid (mg/dl)	6.93±1.64	6.76±1.43	8.00±0	0.480[1]
S. calcium (mg/dl)	8.78±0.73	8.46±1.03	8.50±0	0.130[1]
Triglycerides (mg/dl)* **	147.62±38.10	122.30±39.98	92.00±0	0.001[1]
Total cholesterol (mg/dl)* **	162.79±41.15	128.87±42.69	88.00±0	<0.001[1]
HDL (mg/dl)	47.71±10.48	44.87±12.15	32.00±0	0.076[1]
LDL (mg/dl)* **	86.81±33.25	59.89±30.87	38.00±0	<0.001[1]
Ferritin (ng/ml)	382.42±240.32	513.94±406.75	509.00±0	0.403[1]
S. Phosphorus (mg/dl)* **	4.79±1.18	5.42±1.68	4.90±0	0.041[1]
S. Albumin (g/dl)	3.68±0.34	3.55±0.57	3.60±0	0.619[1]
Intact PTH (pg/ml)	205.40±178.73	263.96±243.51	173.00±0	0.511[1]
Vitamin D (ng/ml)	31.00±12.10	29.54±7.64	23.10±0	0.518[1]
Dialysis dependent (yes)* **	38 (50.6%)	36 (48%)	1	<0.001[3]

***Significant at $p<0.05$, 1: Kruskal Wallis Test, 2: Chi-Squared Test, 3: Fisher's Exact Test

DISCUSSION

Proportion of malnutrition in CKD patients at AIIMS, Rishikesh

Prevalence of malnutrition in CKD patient was 32%. 68% of CKD patients were well-nourished. Prevalence of malnutrition in dialysis dependent and non-dialysis patients were 49.3% and 14.7% respectively. Elrami et al showed 58% were well-nourished, 42% were mild-moderate malnourished, 3% were severe malnourished.[5] Vanitha et al showed 14.4% were well nourished, 31% had mild to moderate malnutrition, 54.4% had moderate to severe malnutrition.[10] Males were well nourished as compared to females. Males also had more malnutrition as compared to females. Correlation between sex and SGA score was not statistically significant. Male group were more malnourished than female group as per Elrami et al.[5]

Relationship of e-GFR and nutritional status in CKD (not on dialysis) patients

Mean (SD) GFR in ml/min in not on dialysis CKD patients was 29.52 (17.42). Mean GFR in well-nourished and mild-moderately malnourished individuals were 31.60±17.76 and 17.44±8.38 respectively (P value- 0.003). Median eGFR was 24.2 ml/min in the well-nourished group compared to 11.9 ml/min/ in the malnourished group; $p < 0.001$ as per Sheikh et al.[8] In my study, GFR significantly predicted any presence of malnutrition for patients not on dialysis.

Association of SGA scores with biochemical parameters

Mean urea and creatinine levels were higher in malnourished patients and it was found to be statistically significant with p value 0.026 and 0.002 respectively.

Serum urea correlated with the malnutrition score (p value-0.007) as per Gupta et al.[4] BUN and creatinine had no correlation with SGA score as per Janardhan et al.[3] Mean Cholesterol, triglycerides, LDL correlated with SGA score and were statistically significant (p-0.001, p-<0.001 and p-<0.001 respectively). Lower levels of Cholesterol, TG and LDL were found in my study with higher degree of malnutrition. HDL association with SGA score was not statistically significant in this study. Cholesterol levels were lower with higher degree of malnutrition as per Mutsert et al.[2] Cholesterol levels correlated well with malnutrition score as per Gupta et al.[4] Cholesterol levels correlated negatively with SGA score in studies done by Elrami et al.[5] Mean triglyceride levels in malnourished group and well-nourished group were 121.67±39.80 and 147.62±38.10 mg/dl respectively with a p-value of 0.001 in this study. Triglyceride levels were 149.6±15.3 mg/dl and 138.01±17.2 mg/dl in malnourished group and well-nourished group respectively, p-value <0.001 as per Sheikh et al.[8] Ferritin level had no correlation with SGA score in my study. Serum ferritin level correlated well with degree of malnutrition; p-value <0.001 as per Sheikh et al.[8] Vanitha et al showed positive correlation of ferritin with SGA-DMS.[10] There was increase in mean phosphate levels with increase in degree of malnutrition in this study which was found to be statistically significant (p<0.041). There was a negative correlation of phosphorous with SGA as per Elrami et al.[5] Serum albumin had no correlation with SGA score in my study. Serum albumin values were on lower with increase in degree of malnutrition which were statistically significant as per Mutsert et al.[2] There was a significant correlation of SGA with albumin as per Elrami et al.[5] Vanitha et al showed negative correlation of albumin with SGA-DMS.[10] Uric acid, calcium, I-pth and serum vitamin D levels showed no statistical correlation with SGA score in this study.

Association of SGA scores with anthropometric parameters

Weight, height, and BMI decreased with increase in degree of malnutrition and it was statistically significant (p-<0.001, p- 0.0031 and p- <0.001 respectively). Patient had lower BMI with increase in degree of malnutrition as per Mutsert et al.[2] There was a significant correlation of SGA with patient's post dialysis BMI as per Elrami et al.[5] BMI correlated negatively with SGA and were statistically significant as per Vanitha et al.[10] TSF and MAC decreased with increase in degree of malnutrition. Both were found to be statistically significant, (p-<0.001 and p-<0.001 respectively) in my study. Triceps thickness correlates well with SGA as per Gupta et al.[4] A significant correlation between BMI, TSFT, MAMC, and eGFR was observed as per Sheikh et al.[8] Significant negative correlation was observed between SGA-DMS and anthropometric measures such as TSFT, MAC, MAMC as per Janardhan et al.[3] Mean MUAC of well-nourished CKD patients was higher than malnourished CKD patients that was statistically significant (P<0.001). Decrease in MUAC was noted as the stage of CKD increased.

Prevalence of malnutrition and association of various biochemical and anthropometric parameters in different Stages of CKD

In study, 100% of CKD patients in stages 2, 3A and 3B were well-nourished. 5 (13.5%) of CKD stage-4 patients were mild-moderately malnourished. 6 (50%) of CKD stage- 5 non-dialysis dependent patients were mild-moderately malnourished. With progression of CKD stage and deterioration of GFR, there was increase in degree of malnutrition which was statistically significant (p value-<0.001). As per Sheikh et al 60.2% were found to be malnourished as per SGA score.[8] 10.8% of CKD stage 3 and 10.3% of CKD stage 4 were malnourished. Weight, triceps skinfold thickness, MAC, urea, creatinine, uric acid, calcium, triglycerides, cholesterol, HDL, LDL, ferritin, phosphorus, albumin, and intact PTH were significantly associated with CKD Stage (p<0.05).

Limitations

Inclusion of more patients in both dialysis dependent and not on dialysis group would have rendered more accurate correlation of malnutrition with all parameters analyzed in my study. Prospective study and longer follow up study would have yielded better results in comparison to observational and cross-sectional study.

CONCLUSION

Malnutrition is prevalent among CKD patients, particularly as the disease progresses. BMI, Triceps Skinfold Thickness, MAC, hemoglobin, urea, creatinine, triglycerides, cholesterol, LDL, phosphorus were found to have significant associations with the nutritional status of CKD patients in the study. With decrease in GFR, there was increased prevalence of malnutrition. Multidisciplinary approaches involving nephrologists, dietitians, and other healthcare professionals are essential to optimize the nutritional care of CKD patients. In conclusion, this research emphasizes the critical role of nutritional assessment as a part of the holistic management of CKD, and the potential of biochemical and anthropometric parameters as reliable tools for monitoring and improving patient outcomes.

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