RESEARCH PAPER

# A STUDY OF CORRELATION OF NUTRITIONAL PARAMETERS WITH ANTHROPOMETRIC MEASUREMENTS IN PATIENTS ON HAEMODIALYSIS

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***Received: 28th Feb, 2026; Revised: 6th March 2026; Accepted: 7th April, 2026; Available Online: 20th April, 2026***

**ABSTRACT**

**Background:** Malnutrition and protein-energy wasting (PEW) are common complications among patients with end-stage renal disease (ESRD) undergoing maintenance hemodialysis (MHD). Nutritional impairment contributes significantly to morbidity, mortality, and poor quality of life in this population. Subjective Global Assessment (SGA) is a widely used tool for nutritional evaluation, while anthropometric measurements provide objective indicators of body composition. The present study assessed nutritional status and its correlation with anthropometric measurements in hemodialysis patients.

**Materials and Methods:** This cross-sectional study was conducted in the Department of General Medicine, Tertiary Care Centre, Kolhapur, for 2yrs. A total of 100 patients aged ≥18 years receiving maintenance hemodialysis for at least eight weeks were enrolled using random sampling. Nutritional status was assessed using SGA. Anthropometric measurements, including BMI, BSF, TSF, MAC, and MAMC were recorded. Correlation analyses were performed to evaluate the relationship between SGA scores and anthropometric parameters, age, gender, and duration of hemodialysis.

**Results:** The mean age of participants was 51.99 ± 11.14 years, and 69% were males. The mean BMI was 20.63 ± 2.92 kg/m², while the mean duration of hemodialysis was 10.05 ± 3.64 weeks. Based on SGA classification, 77% of patients were severely malnourished, 21% had mild-to-moderate malnutrition, and only 2% were well nourished, resulting in an overall malnutrition prevalence of 98%. BMI demonstrated a significant positive correlation with SGA score ($r = 0.359$, $p < 0.001$). However, BSF, TSF, MAC, and MAMC showed no significant correlations with SGA. A significant positive correlation was observed between duration of hemodialysis and worsening nutritional status ($r = 0.202$, $p = 0.044$). Male patients had significantly poorer nutritional status than females ($p = 0.030$), whereas age showed no significant correlation with SGA score ($p = 0.912$).

**Conclusion:** Malnutrition is highly prevalent among patients undergoing maintenance hemodialysis. SGA is an effective and comprehensive tool for nutritional assessment, while BMI is the only anthropometric parameter showing a significant association with nutritional status. Routine nutritional screening using SGA, supported by selected anthropometric and biochemical parameters, is essential for early detection and management of malnutrition in hemodialysis patients.

**Keywords:** Hemodialysis, Chronic Kidney Disease, End-Stage Renal Disease, Malnutrition, Protein-Energy Wasting, Subjective Global Assessment, Body Mass Index, Anthropometric Measurements.

**How to cite this article:** Jawanjal SH, Khyalappa RJ. A Study of Correlation of Nutritional Parameters with Anthropometric Measurements in Patients on Haemodialysis. Int J Drug Deliv Technol. 2026;16(57s): 1536-1552. DOI: 10.25258/ijddt.16.57s.155

**Source of support:** Nil.

**Conflict of interest:** None

## INTRODUCTION

Chronic kidney disease (CKD) represents a significant global public health problem and is an important cause of morbidity and mortality worldwide.[1] Both the incidence and prevalence of CKD continue to increase progressively across different populations. In addition to its multisystem complications, CKD and end-stage renal disease (ESRD) are strongly associated with progressive body wasting and malnutrition.[2]

Patients with ESRD require maintenance hemodialysis (MHD) for survival. The standard minimum dialysis prescription for an adult patient with ESRD generally consists of thrice-weekly sessions of approximately four hours each. However, in selected situations such as advanced age, smaller body size, or low body weight, twice-weekly dialysis schedules may be considered. In many low- and middle-income countries, twice-weekly MHD is frequently practiced because of limited availability of dialysis facilities and financial limitations. Individuals undergoing MHD experience considerable physical, emotional, and economic stress. Factors including the burden of ESRD, complexity of treatment,

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accessibility to dialysis centres, socioeconomic challenges, dependence on caregivers, and associated logistic difficulties collectively contribute to impaired quality of life and a high prevalence of depression among patients receiving maintenance hemodialysis.[3]

Protein-energy wasting (PEW) is highly prevalent among patients undergoing hemodialysis, with reported prevalence rates ranging from 20% to 75%, depending on the characteristics of the study population, as well as variations in diagnostic criteria and assessment methodologies.[4] PEW represents a major consequence of the multiple interrelated factors affecting this patient population and is characterized by depletion of body protein stores and energy reserves, including both lean body mass and adipose tissue.[5]

Although initiation of dialysis may improve uremic manifestations such as nausea, vomiting, and anorexia over time, several mechanisms contributing to body wasting continue to persist, thereby predisposing patients to malnutrition. Nutritional impairment in MHD patients may result from dietary restrictions, poor appetite, malabsorption, and the effects of medications. In addition, alterations in meal patterns and dietary timing related to dialysis schedules may adversely affect nutritional intake. Hemodialysis itself contributes to nutrient depletion through dialysis-related nutrient losses and increased protein catabolism mediated by inflammatory cytokines, further aggravating nutritional deficiencies.[6] Certain patients may also experience gastrointestinal complaints such as dyspepsia, indigestion, and malabsorption, which can reduce food intake and significantly decrease overall caloric consumption.[7]

Several methods are available for evaluating nutritional status in hemodialysis patients. Commonly used assessment tools include serum albumin, Subjective Global Assessment (SGA), anthropometric parameters, body composition analysis, skinfold thickness measurements, and the malnutrition–inflammation score (MIS). Each method possesses inherent strengths and limitations, and currently there is no universally accepted gold standard for nutritional assessment in HD patients. Anthropometric assessment, although simple and non-invasive, may be affected by interobserver variability and differences in measurement precision or technique. Similarly, body composition analysis in HD patients may be influenced by fluctuations in hydration status and fluid imbalance commonly observed in this population.[8]

In the present study, the relationship between Subjective Global Assessment (SGA), an established tool for nutritional evaluation, and various anthropometric parameters including body mass index (BMI), biceps skinfold thickness (BSF), triceps skinfold thickness (TSF), mid-arm muscle circumference (MAMC), and mid-arm muscle area (MAM) was assessed among patients undergoing hemodialysis.

## METHODOLOGY

After getting ethical approval from the Institutional Ethics Committee a cross-sectional study was conducted at Tertiary care center, Kolhapur in the Department of General Medicine, on a total 100 patients aged 18 years and above who had completed at least eight weeks of maintenance hemodialysis were enrolled using a random sampling technique. After getting ethical approval from the Institutional Ethics Committee. The study was carried out over a period of two years. All study subjects were selected according to exclusion and inclusion criteria.

A total of 100 patients aged 18 years and above who had completed at least eight weeks of maintenance hemodialysis were enrolled using a random sampling technique.

Written informed consent was obtained from all participants before enrolment. Patients were screened for malnutrition using a structured questionnaire. The questionnaire included details regarding sociodemographic characteristics, medical history, present disease status, subjective assessment of nutritional status based on clinical history and physical examination, along with objective evaluation using anthropometric and biochemical parameters.

## RESULTS

### SECTION 1: DESCRIPTIVE STATISTICS

Descriptive statistics provide a summary of the demographic and clinical characteristics of the study population. A total of 100 hemodialysis patients were enrolled. The following tables and figures describe the distribution of key variables.

**Table 1: Demographic and Clinical Characteristics of Study Participants**

| Variable | Mean | SD | Median | Range |
|---|---|---|---|---|
| **Age (years)** | 51.99 | 11.14 | 52.00 | 25 – 82 |
| **BMI (kg/m²)** | 20.63 | 2.92 | 20.08 | 14.53 – 26.73 |
| **Bicep Skinfold (mm)** | 6.64 | 0.93 | 6.74 | 5.10 – 8.08 |
| **Tricep Skinfold (mm)** | 6.38 | 1.89 | 6.35 | 3.10 – 9.70 |
| **MAC (cm)** | 22.44 | 1.37 | 22.34 | 20.22 – 24.78 |
| **MAMC (cm)** | 20.44 | 1.40 | 20.23 | 17.40 – 23.60 |

| | | | | |
|---|---|---|---|---|
| **HD Duration (weeks)** | 10.05 | 3.64 | 10.00 | 4 – 16 |
| **SGA Score** | 2.45 | 1.62 | 2.00 | 1 – 7 |

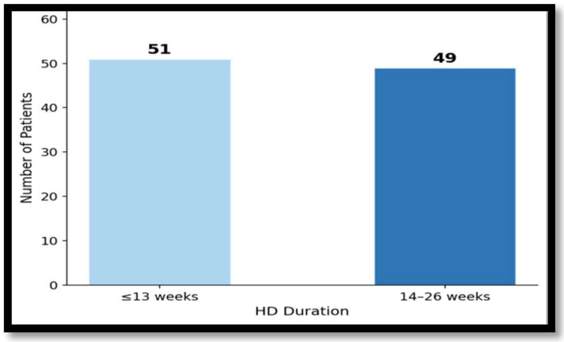


**Figure 1: Distribution of Hemodialysis Duration Among Patients**

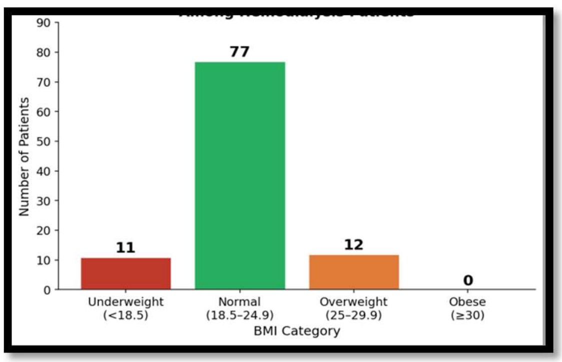


**Figure 2: Distribution of BMI Categories Among Hemodialysis Patients**

## SECTION 2: OBJECTIVE 1 – PREVALENCE OF MALNUTRITION BY SGA

### Statistical Method Used

Scores range from 1–7: Score 7 = Class A (Well Nourished); Scores 4–6 = Class B (Mild to Moderate Malnutrition); Scores 1–3 = Class C (Severe Malnutrition). Frequency and percentage distributions were calculated. Chi-square test was used to assess association of SGA category with gender and age groups.

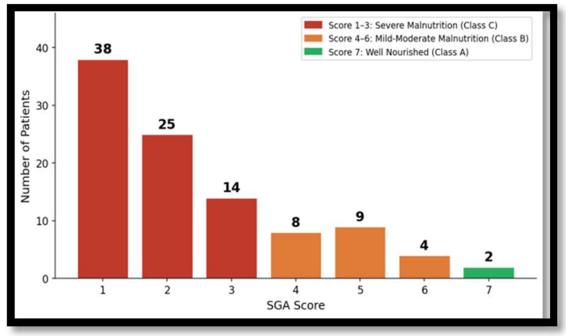


**Figure 3: Distribution of SGA Scores Among Hemodialysis Patients (N=100)**

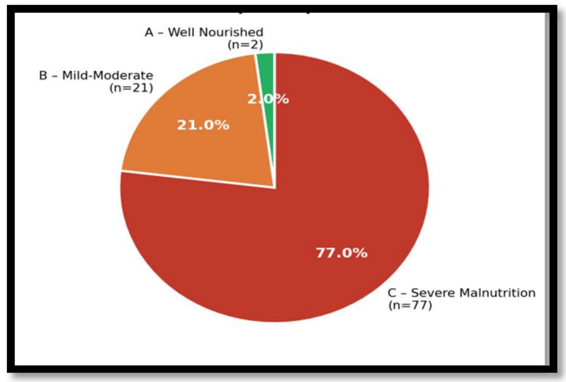


**Figure 4: Prevalence of Malnutrition by SGA Category (N=100)**

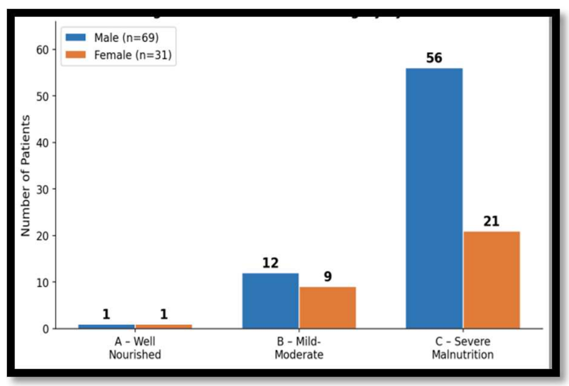


**Figure 5: SGA Nutritional Category by Gender**

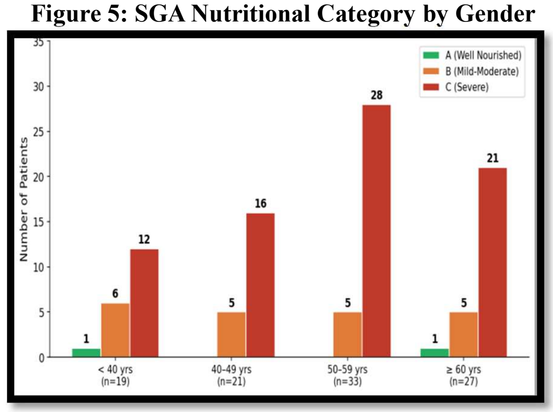

**Figure 6: SGA Nutritional Category by Age Group**

## SECTION 3: OBJECTIVE 2 – CORRELATION OF SGA WITH ANTHROPOMETRIC MEASUREMENTS

### Statistical Method Used

Spearman's rank correlation coefficient was used to assess the relationship between SGA scores and each anthropometric measurement, as SGA is an ordinal variable. A p-value < 0.05 was considered statistically significant. Additionally, Kruskal-Wallis H test was applied to compare anthropometric means across the three SGA nutritional categories (A, B, C), followed by descriptive comparison of means ± SD.

**Table 8: Spearman Correlation – SGA vs Anthropometric Measurements**

| Anthropometric Variable | Spearman's r | p-value | Significance | Direction |
|---|---|---|---|---|
| BMI (kg/m²) | **0.359** | **< 0.001*** | **Significant** | Positive |
| Bicep Skinfold (mm) | −0.004 | 0.972 | Not Significant | Negligible |
| Tricep Skinfold (mm) | 0.073 | 0.467 | Not Significant | Negligible |
| MAC (cm) | 0.162 | 0.108 | Not Significant | Positive |
| MAMC (cm) | 0.129 | 0.199 | Not Significant | Positive |

**BMI vs SGA Score**

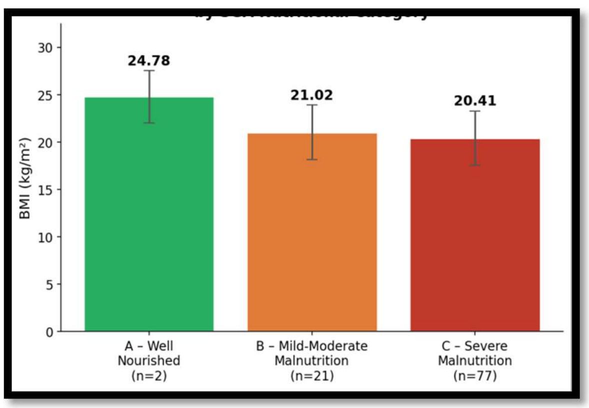


**Figure 7: Mean BMI (± SD) by SGA Nutritional Category**

**Bicep Skinfold Thickness vs SGA Score**

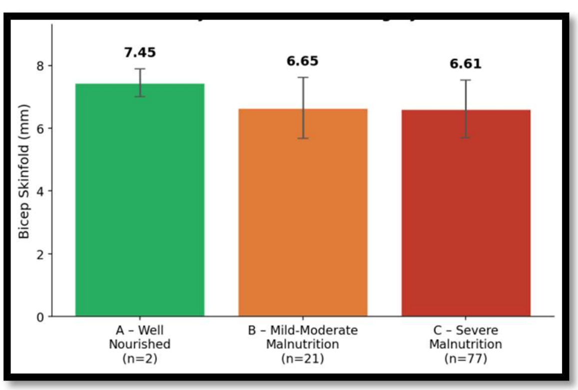


**Figure 8 : Mean Bicep Skinfold (± SD) by SGA Nutritional Category**

**Tricep Skinfold Thickness vs SGA Score**

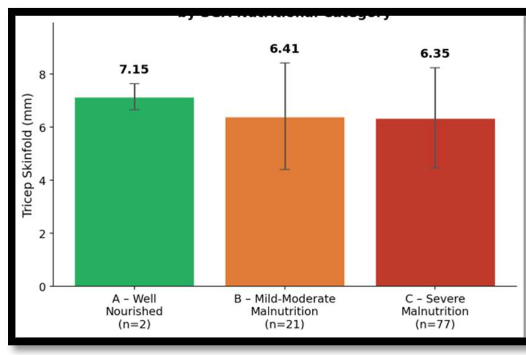


**Figure 9 : Mean Tricep Skinfold (± SD) by SGA Nutritional Category**

**Mid-Arm Circumference (MAC) vs SGA Score**

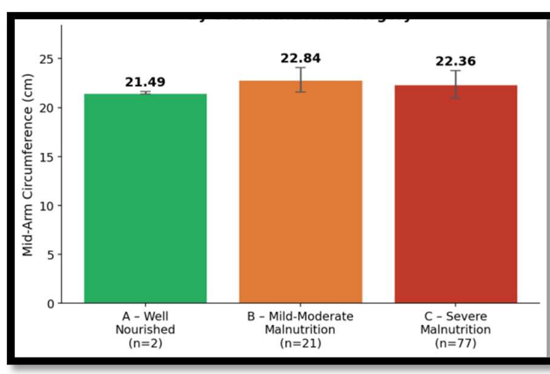


**Figure 10: Mean MAC (± SD) by SGA Nutritional Category**

**Mid-Arm Muscle Circumference (MAMC) vs SGA Score**

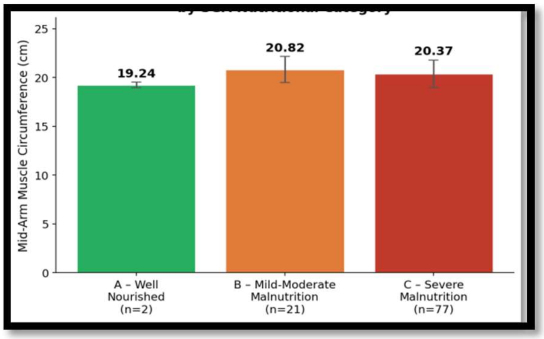


**Figure 18: Mean MAMC (± SD) by SGA Nutritional Category**

## SECTION 4: OBJECTIVE 3 – CORRELATION OF SGA WITH AGE, GENDER & DIALYSIS DURATION

### Statistical Method Used

Spearman's rank correlation was used for continuous variables (age, HD duration) and the Mann-Whitney U test was used for gender comparison (two independent groups). A p-value < 0.05 was considered statistically significant.

### SGA vs Age

**Table 16: Spearman Correlation – SGA vs Age**

| Parameter | Spearman's r | p-value | Significance |
|---|---|---|---|
| SGA Score vs Age (years) | 0.011 | 0.912 | Not Significant |

### SGA vs Gender

**Table 17: Mann-Whitney U Test – SGA Score by Gender**

| Group | n | Mean SGA | U statistic | p-value |
|---|---|---|---|---|
| Male | 69 | 2.59 | 1350 | **0.030*** |
| Female | 31 | 2.13 | | |

### SGA vs Hemodialysis Duration

**Table 18: Spearman Correlation – SGA vs HD Duration**

| Parameter | Spearman's r | p-value | Significance |
|---|---|---|---|
| SGA Score vs HD Duration (weeks) | **0.202** | **0.044*** | **Significant*** |

## DISCUSSION

### Demographic and Clinical Characteristics

The present study included 100 patients undergoing maintenance hemodialysis, with a mean age of 51.99 ± 11.14 years (25–82 years). This is comparable to the findings of **Sultan et al. (2021)**[6] (51.2 ± 14.8 years) and Rani et al. (2015)9 (52.62 ± 11.7 years), indicating that the study population represents a typical adult hemodialysis cohort.

The mean BMI was 20.63 ± 2.92 kg/m², suggesting a tendency toward undernutrition. The mean SGA score was 2.45 ± 1.62, indicating mild to moderate malnutrition in a substantial proportion of patients. These findings are consistent with **Dorri et al. (2017)**[10], who reported 93.7% of patients as mildly to moderately malnourished, **Koor et al. (2015)**[11], where over 90% of patients demonstrated malnutrition, and **Rani et al. (2015)**[9]**,** who reported moderate to severe malnutrition in 54.4% of patients.

Overall, the findings demonstrate reduced anthropometric indices and early evidence of malnutrition among hemodialysis patients, emphasizing the importance of routine nutritional assessment using both subjective (SGA) and objective anthropometric measures.

### Distribution of BMI Categories

Most patients (77.0%) had a normal BMI, while 11.0% were underweight and 12.0% overweight. No patients were obese. Similar observations were reported by **Sultan et al. (2021)**[6]. **Keita et al. (2023)**[4] found 47.1% of patients to be malnourished based on BMI, highlighting variability among populations.

Several studies suggest that BMI alone may underestimate malnutrition. **Koor et al. (2015)**[11] reported a significant inverse correlation between BMI and malnutrition severity (r = −0.238), while **Kalantar-Zadeh et al. (1999)**[12] demonstrated stronger associations between malnutrition and measures such as MAMC and SGA than with BMI alone. Thus, BMI should be interpreted alongside other nutritional assessment tools.

### Distribution of SGA Scores and Prevalence of Malnutrition

Malnutrition was highly prevalent in the present study. Severe malnutrition (SGA Class C) was observed in 77.0% of patients, mild to moderate malnutrition (Class B) in 21.0%, and only 2.0% were well nourished. The overall prevalence of malnutrition was therefore 98.0%.

These figures exceed those reported by **Rani et al. (2015)**[9], who found 54.4% moderate to severe malnutrition, and **Koor et al. (2015)**[11], who reported approximately 91.6% malnutrition, predominantly mild to moderate. The higher prevalence of severe malnutrition in the present study may reflect pre-existing nutritional deficits, socioeconomic factors, dietary inadequacies, delayed referral, and the catabolic effects of uremia and dialysis.

The findings indicate that malnutrition is almost universal among hemodialysis patients and emphasize the need for early nutritional screening, monitoring, and intervention.

**Association Between SGA and Gender**
A significant association was observed between gender and nutritional status (p = 0.030). Severe malnutrition was more common among males (81.2%) than females (67.7%). Females showed relatively higher proportions of mild to moderate malnutrition and well-nourished status.

This differs from **Keita et al. (2023)**[4], who reported a higher prevalence of malnutrition among females. However, most studies suggest that nutritional status is influenced by multiple factors, including dietary intake, comorbidities, inflammation, and disease burden, rather than gender alone.

**Association Between SGA and Age**
No significant association was observed between age group and nutritional status (p = 0.912). Severe malnutrition was present across all age categories, including younger patients. While **Dorri et al. (2017)**[10] reported a positive correlation between age and malnutrition severity (r = 0.335), the present findings indicate that nutritional impairment affects hemodialysis patients irrespective of age. Therefore, nutritional assessment should be performed universally rather than focusing only on elderly patients.

**Correlation of SGA with Anthropometric Measurements**
Among all anthropometric parameters, BMI demonstrated a significant positive correlation with SGA score (r = 0.359, p < 0.001). In contrast, biceps skinfold thickness (r = −0.004, p = 0.972), triceps skinfold thickness (r = 0.073, p = 0.467), MAC (r = 0.162, p = 0.108), and MAMC (r = 0.129, p = 0.199) showed no significant correlations.

The association between BMI and nutritional status is consistent with Koor et al. (2015)11. However, the lack of significant correlations for other anthropometric measurements differs from findings reported by **Rani et al. (2015)**[9]. These differences may reflect sample characteristics, measurement variability, and the relatively early dialysis stage of the study population.

**BMI Across SGA Categories**
BMI decreased progressively with worsening nutritional status, from 24.78 ± 2.76 kg/m² in well-nourished patients to 20.41 ± 2.87 kg/m² in severely malnourished patients. However, the difference was not statistically significant (p = 0.115). Similar findings were reported by **Koor et al. (2015)**[11]. These results suggest that although BMI follows the expected trend, it is not sufficiently sensitive to discriminate between varying degrees of malnutrition.

**Biceps and Triceps Skinfold Thickness Across SGA Categories**
Both biceps and triceps skinfold thickness demonstrated slight reductions with worsening nutritional status but showed no statistically significant differences across SGA categories (p = 0.432 and p = 0.832, respectively). These findings are supported by the absence of significant correlations between SGA and skinfold measurements and are consistent with the observations of **Kalantar-Zadeh et al. (1999)**[12] and **Rani et al. (2015)**[9], who emphasized the superiority of combined assessments over isolated anthropometric measures.

**MAC and MAMC Across SGA Categories**
Neither MAC nor MAMC showed significant differences across nutritional categories (p = 0.206 and p = 0.123, respectively). The highest mean values were unexpectedly observed in the mild to moderate malnutrition group rather than among well-nourished patients. Fluid retention, edema, measurement variability, and the small number of well-nourished subjects may explain these findings.

Although **Koor et al. (2015)**[11] and **Kalantar-Zadeh et al. (1999)**[12] reported associations between these measures and nutritional status, the present study suggests that MAC and MAMC alone are insufficient indicators of malnutrition.

**Correlation Between SGA and Age**
No significant correlation was found between SGA score and age (r = 0.011, p = 0.912), indicating that nutritional impairment was not age-dependent in this cohort.

**Comparison of SGA Score by Gender**
Male patients demonstrated significantly higher SGA scores than females (p = 0.030), indicating poorer nutritional status. This finding is consistent with the categorical analysis and reinforces the observed gender-related differences. However, previous studies such as **Keita et al. (2023)**[4] have reported contrasting findings, suggesting population-specific influences.

**Correlation Between SGA Score and Hemodialysis Duration**
A significant positive correlation was observed between SGA score and duration of hemodialysis (r = 0.202, p = 0.044), indicating worsening nutritional status with longer dialysis exposure. Similar findings have been reported by **Koor et al. (2015)11** (r = 0.404) and **Dorri et al. (2017)10** (r = 0.332).

The findings support the concept that prolonged hemodialysis contributes to progressive nutritional deterioration through chronic inflammation, nutrient loss, metabolic disturbances, and ongoing catabolic stress. Consequently, regular nutritional monitoring and early intervention remain essential, particularly in patients undergoing long-term dialysis.

## CONCLUSION

A significant positive correlation was observed between the duration of hemodialysis and worsening nutritional status, indicating progressive nutritional deterioration with prolonged dialysis therapy. Male patients demonstrated significantly poorer nutritional status compared to female patients in the study population.

Subjective Global Assessment (SGA) proved to be a valuable and practical tool for nutritional assessment as it incorporates clinical history, dietary intake, functional status, and physical examination, providing a comprehensive evaluation of nutritional status.

Routine nutritional screening using SGA, supplemented by selected anthropometric and biochemical parameters, should be incorporated into the regular management of patients undergoing maintenance hemodialysis to facilitate early identification and intervention for malnutrition.

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