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Original Article

Evaluation of Malnutrition by Skinfold Thickness Measurement and SGA-DMS among Haemodialysis Patients: A Cross-Sectional Study

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ABSTRACT

Protein-energy malnutrition occurs in a large portion of patients with chronic renal failure. It leads to the consequences of various factors like hormonal imbalance, reduced food intake caused by uremic toxicity, superimposed illnesses, infections, and protein and energy metabolism disturbances. Malnutrition could be acute or chronic in hemodialysis patients. One hundred fifty-two patients were involved in this cross-sectional study; we utilized SGA- DMS (Subjective Global Assessment-Dialysis Malnutrition Score). Percentage body fat through Skinfold Thickness Measurement was calculated using Durnin and Womersley equation. Pearson's correlation coefficient was calculated to determine the correlation between the assessed parameters and the scores obtained from SGA-DMS. Student t-test was used to analyze the mean percentage of body fat observed between men and women. The values were considered statistically significant if the p-value was <0.05. On assessing the anthropometric parameters, the bicep skinfold thickness was positively correlated (p value=0.012) with the SGA- DMS tool, while all others were negatively correlated with the SGA- DMS. Percentage body fat results imply that patients have higher body fat levels, with males recording 31.34 ± 2.9 and women recording 37.35 ± 2.5, being statistically significant. Our study has not found significance in correlating SGA- DMS and factors like age, weight, etc. However, subjects observed have healthy nutritional status and mainly were over-weight. By employing other methods along with SGA-DMS, a better assessment of malnutrition could be made possible. In addition, efficient nutritional advice from healthcare, adherence to diet patterns, and periodic evaluation may prevent or minimise malnutrition.

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G R A P H I C A L A B S T R A C T

Introduction

Malnutrition is a condition that occurs due to insufficient nutritional intake, which leads to acute or long-term conditions. Malnutrition characterized in hemodialysis patients could be acute or chronic and has been highly researched. However, it is defined in various terms such as protein-energy malnutrition, protein-energy wasting, malnutrition-inflammation-atherosclerosis, malnutrition-inflammation complex syndrome, hypercatabolism, and uremic wasting syndrome determined by the involvement of inflammation and increased uremia [1]. Protein-energy malnutrition leads to consequences of various factors like hormonal derangements, reduced food intake (due to anorexia, nausea, and vomiting caused by uremic toxicity), superimposed illnesses, infections, and disturbances in protein and energy metabolism [2].

Chronic nutritional loss occurs during the dialysis process. Some amino acids and proteins were lost during a single dialysis session. Renal dietitians suggest patients under hemodialysis consume food rich in protein, as it produces less waste for removal from the blood and helps maintain blood protein levels. Hemodialysis patients must avoid foods or beverages with more potassium, phosphorus, and sodium (vegetable oil and sports drinks). During hemodialysis sessions, potassium levels could rise, disturbing the heartbeat and leading to arrhythmia. In hemodialysis patients, excessive phosphorus levels in the blood wrenches calcium from bones, which can reduce bone mineral density due to lower calcium levels and makes them prone to damage and fracture. Consuming a higher amount of sodium makes the patient thirsty and acquires drinking more liquid, and it is highly found in packed, frozen, canned, and fast foods. Therefore, it is essential to measure the nutritional status of the patients under haemodialysis, to prevent the development of serious complications associated with an imbalance of nutrition [3].

Identification of malnutrition can be made using either of the mentioned techniques: anthropometric measurements such as weight for age (WFA), height for age (HFA), weight for height (WFH), middle upper arm circumference (MUAC), skin fold thickness (loose and overhanging skin fold), and body mass index (BMI) for age.

Nutritional and dietary history can show a deficiency in food intake quantity and quality. Malnutrition, clinical sign method, includes changes in hair (thin, easily pluckable, and silkiness), dermatosis (hypo/hyper-pigmentation, shedding in scales, rough patches, cracks, and fissures). Laboratory evaluations include lower albumin levels, decreased urea levels, reduced cholesterol levels, low hemoglobin, and transferrin [4-6].

BMI is one of the most common approaches to analyze an individual's health status and is a first-line screening marker to assess nutrition status. Its limitations indicate reduced sensitivity in the diagnosis of malnutrition and obesity [7, 8].

In various nutritional assessments, biomarkers play a significant role in describing the severity of malnutrition to establish and validate nutritional assessment tools. Several biomarkers to access nutritional status include serum visceral proteins, serum albumin, serum pre-albumin, transferrin, retinol-binding protein (RBP), and some laboratory markers of malnutrition other than visceral protein are urinary creatinine, urinary 3-methylhistidine, serum cholesterol, serum zinc, serum nesfatin-1, serum leptin, serum insulin-like growth factor 1, essential micronutrients (trace elements and vitamins), delayed hypersensitivity, and blood lymphocyte count [9].

Subjective Global Assessment (SGA) is a tool widely used to analyze the nutrition status of people. Dialysis Malnutrition Score (DMS) is an extensive branch of the SGA tool specifically used to determine malnutrition in patients with chronic kidney disease who are under dialysis. In each tool, patients are assigned a score based on which they are classified as well-nourished or normal, mild to moderately malnourished, and severely malnourished. It is considered as one of the effective tools to determine malnutrition and is also believed to aid in preventing malnutrition [10].

Anthropometric measurements and SGA-DMS evaluation are considered as the most efficient techniques when determining malnutrition with BMI, biological markers, and other methods, as they are unaffected by other factors [11, 12]. These methods are also advantageous owing to their ease of use. Comorbid conditions often influence other methods. Factors like diet, drugs, and lifestyle also influence the other methods. This study here analyses diagnoses made by anthropometric measurements and stands as evidence to explain how this method of diagnosis can be efficient and beneficial.

Materials and Methods

In this cross-sectional study, 152 subjects between 18 and 75 years old were involved with their consent, and all of them had CKD and were under haemodialysis with the frequency of two or thrice a week in a multi-specialty tertiary care teaching hospital. The subjects who were under peritoneal dialysis or transplantation hospitalized patients within one month prior to the commencement of the study, patients with diseases that could alter the outcomes of our study, chronic alcoholic patients, patients with restricted mobility, and patients with neurodegenerative complications, genetic alterations, or metabolic disorders were not included in the study. The study commenced after obtaining approval from the institutional review board and procuring informed consent from all the subjects.

All the participants' demographic details were procured from direct patient interaction and with medical case records. The frequency and duration of haemodialysis, existing comorbid conditions, etc. were also recorded. After completing the haemodialysis session, the anthropometric measurements were recorded, including body weight and skinfold thickness of the biceps, triceps, supra iliac, and subscapular. The skinfold thickness was measured with a skinfold caliper (FLOVEIN SKINFOLD CALIPER- no.: B09ZDJPT63). All measurements were recorded in millimetres, and then based on the malnutrition score, the subjects were categorised as normal, mild- moderately nourished, and severely malnourished. Nutritional assessment was done in all the subjects with the help of a modified quantitative subjective global assessment- dialysis malnutrition score (SGA-DMS).

SGA-DMS (Subjective global assessment – dialysis malnutrition score)

This SGA-DMS covers 07 factors for assessment, including the alterations in subjects' weight, symptoms associated with the GI tract, nutritional intake, functional capacity, muscle wasting, and accumulation of subcutaneous fat and comorbid conditions. Every factor is a segment and has a score for each stage. A score of 1 indicates a normal state, and the score of 5 indicates severity linked to a certain factor. Scores are given based on the patient's condition; the summative is estimated to be the malnutrition score. This malnutrition score generally ranges from 7 to 35, where 7 means the subject is healthy and 35 is severely malnourished.

Scoring for weight change was given based on the weight lost by the subject. For patients who have gained weight or lost no weight, the score was given as 1; for a minor loss of weight less than 5%, 2 was given, for loss of weight ranging between 5%-10%, a score of 3 was given, for weight loss between 10%-15%, a score of 4 was given, and for weight loss >15%, 5 was given as the score. All these weight changes were monitored over the last 6 months. Scoring for dietary intake was based on the type of food consumed by the patients. A score of 1 indicates a regular diet, 2 indicates a sub-optimal solid diet, 3 indicates a liquid diet, 4 indicates a liquid diet with low calories, and 5 indicates starvation.

Scoring for GI symptoms was based on the type of difficulty addressed by the patients. 1 was given in case of no symptoms, 2 in case of nausea, 3, 4, and 5 in the case of vomiting, diarrhea, and severe anorexia, respectively. On assessing the functional capacity of the study subjects, scores 1 and 2 were given for normal capacity and ambulatory difficulty, respectively, and 3, 4, and 5 were given for difficulty performing routine activities, slight restriction to activities, and complete restriction or bed-ridden state, respectively. Comorbidity was assessed, and a score of 1 was assigned in case of no comorbid conditions, 2 for mild comorbidity, 3 for moderate comorbidity, 4 for severe comorbidity, and 5 for multiple comorbidities.

Correlation of Skinfold thickness to percentage body fat

The estimated skinfold thickness of the subjects was used to calculate the body fat percentage. Percentage body fat was calculated using the Durnin and Womersley equation, which uses measurements of the tricep, biceps, supra iliac, and subscapular regions along with the age and weight of the subject, and this is a gender-based calculation. Among the several equations and methods available to calculate body fat level and percentage, Durnin and Womersley equation is chosen, as it is specific to the age and gender of the subject along with the anthropometric measurements.

Durnin and Womersley equation for calculating body fat in men:

- For the age range of 20-30:

$D = 1.1631 - (0.0632 \times L)$

- For 30-40:

$D = 1.1422 - (0.0544 \times L)$

- For 40-50:

$D = 1.1620 - (0.0700 \times L)$

- For over 50:

$D = 1.1715 - (0.0779 \times L)$

Durnin and Womersley equation for calculating body fat in women:

- For the age range of 20-30:

$D = 1.1599 - (0.0717 \times L)$

- For 30-40:

$D = 1.1423 - (0.0632 \times L)$

- For 40-50:

$D = 1.1333 - (0.0612 \times L)$

- For over 50:

$D = 1.1339 - (0.0645 \times L)$

Where, D refers to the body's predicted density, measured in g/ml units, and L refers to the log of the sum of the four skinfold measurements [13, 14].

Statistical analysis

After data collection in a spreadsheet, the mean and standard deviation for all the values were calculated. Pearson's correlation coefficient was calculated to determine the correlation between the assessed parameters and the scores obtained from SGA-DMS. Student t-test was used to analyse the mean percentage of body fat observed between men and women. The values were considered statistically significant if the p-value was <0.05.

Results and Discussion

Of 152 participants, 87 (57.2%) are male with a mean age of 52.40 ± 13.03, and 65 (42.7%) are female with a mean age of 51.7 ± 14.30. Many subjects belonging to the age group of 45-60 showed slight malnourishment. The most common comorbidities found in the study population include diabetes (N=30), constituting 19.7%. Hypertension (N= 89) constituted 58.5%, and cardiac complications (N=33) constituted 21.7%. Haemodialysis duration varied between 3 to 5 years in the studied population. The mean period of dialysis was observed to be 2.9 ± 2 years.

Scoring of SGA-DMS (Subjective global assessment-dialysis malnutrition score)

The subjective global assessment tool is employed to assess the nutritional status of the study subjects. In the selected subjects, over 90% were perfectly in normal nutritional status, with 53.9% being men and 42.7% being women. The scores of these subjects varied between 7 and 20, implying a normal nutritional state. 3.2% of men and 5.9% of women scored between 21 and 34 in the SGA-DMS and were found to be under moderate malnourishment. One female subject scored 35 on the scale and was observed to be severely malnourished. On comparing the overall nutrition status of the participants, the majority of the subjects were in good condition in terms of nutrition. However, no apparent relationship was found between the scores and the age or gender of the participants. Irrespective of the gender of the subject, there was equal vulnerability towards malnutrition.

Assessment of anthropometric parameters

The mean weight of the selected female subjects was 54.3 ± 11.19 kg, and that of male subjects was 58.65 ± 11.7 kg. This average weight of men and women falls close to the ranges for CKD patients given by ICMR (Male- 60 kg and Female- 55 kg) [15].

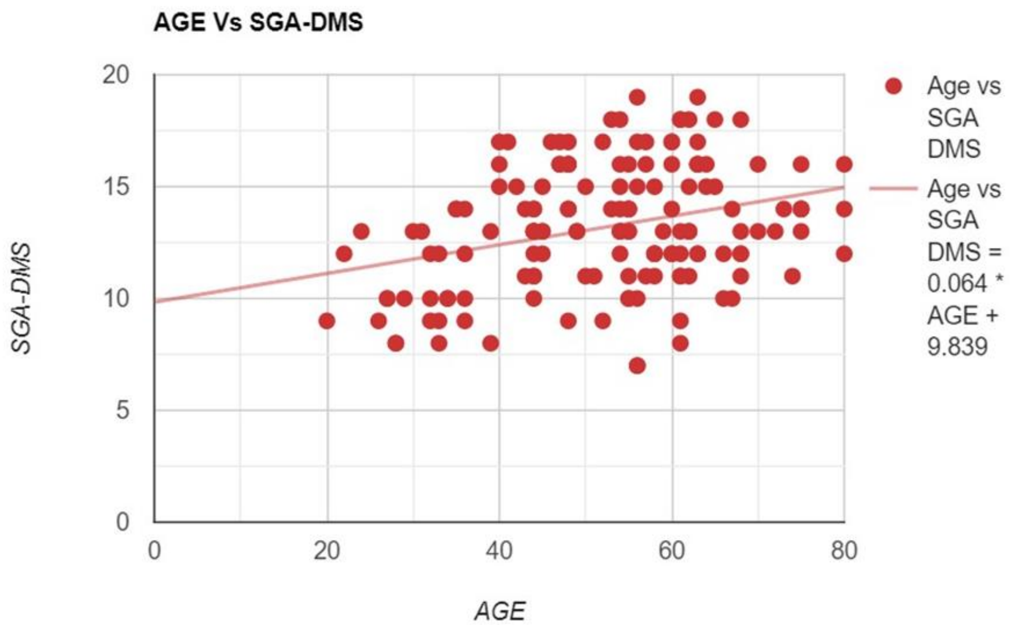

Figure 1: Pearson's coefficient of age vs. SGA-DMS

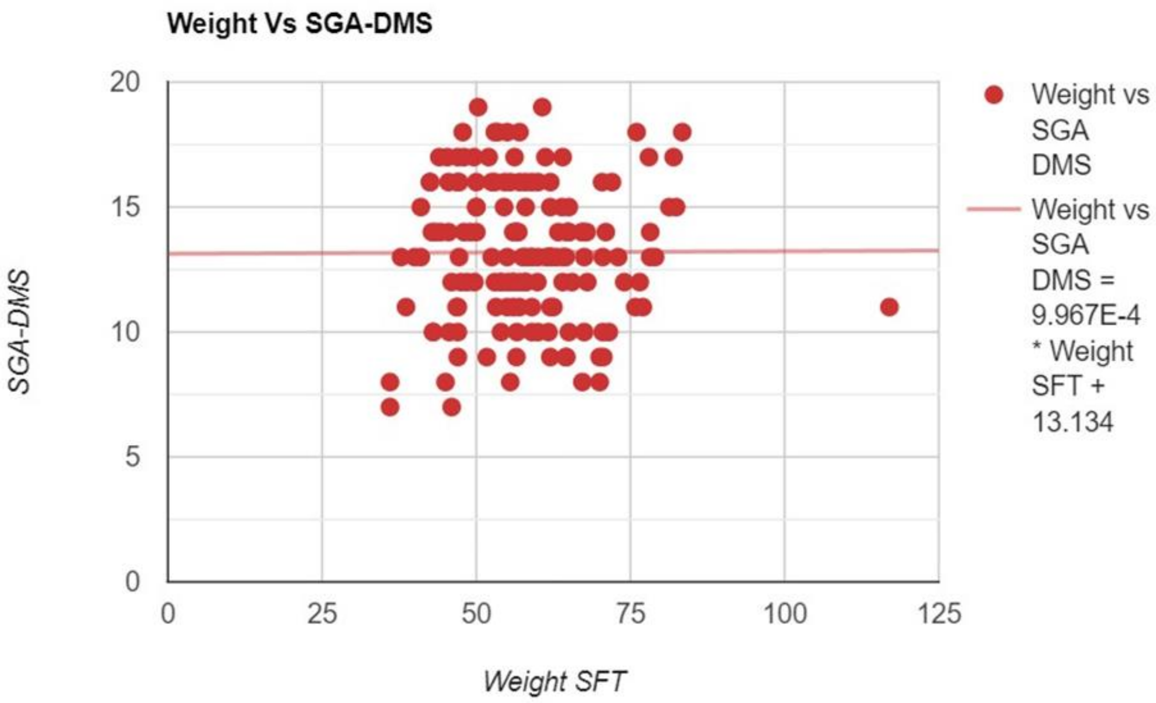

Figure 2: Pearson's coefficient of weight vs. SGA-DMS

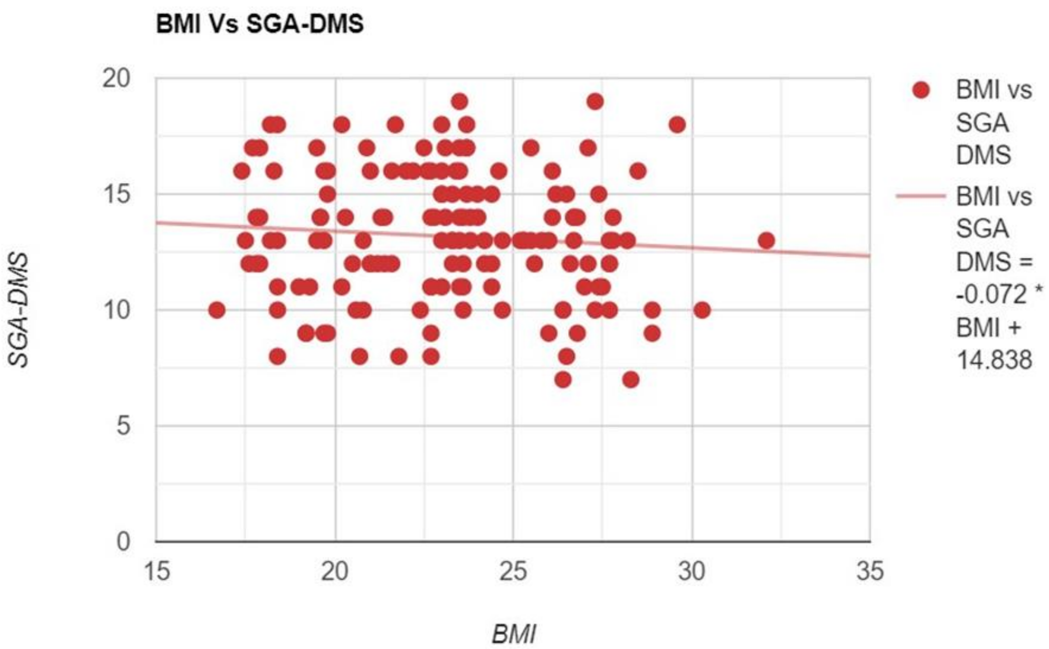

Figure 3: Pearson's coefficient of BMI vs. SGA-DMS

The mean weight of men was slightly lower than the prescribed standard weight. It could be a result of malnutrition. Body weight positively correlates with SGA- DMS, r value = 0.143 and p-value = 0.078. The correlation between age and SGA-DMS is displayed in Figure 1, and the relationship between weight and SGA-DMS is depicted in Figure 2. The mean BMI in males was found to be 23.4 ± 3.2, and in females, it was found to be 22.8 ± 3.31. The r value was noted to be -0.023, in negative correlation with SGA-DMS, and the p-value was found to be 0.77, indicating it was not significant (depicted in Figure 3).

Measurements of triceps and bicep skinfold indicate the deposition of fat subcutaneously. The mean bicep skinfold values in males were noted to be 14.81 ± 2.27 (in cm), and in females, it was noted to be 14.01 ± 2.14 (in cm) with r value = 0.203 and p-value = 0.012, which is statistically significant when compared to SGA- DMS. The mean values of triceps skinfold in men were observed to be 17.79 ± 4.29 (in cm), and in women, it is observed to be 18.79 ± 4.96 (in cm) with r value = -0.060, negative significance to SGA- DMS and p-value = 0.462. The mean supra iliac skinfold measurement in men was 22.44 ± 2.10 (in cm); in women, it was 21.85 ± 2.11 (in cm) with r value = 0.026 and p-value = 0.74. The mean subscapular skinfold values were recorded to be 22.75 ± 1.89 (in cm) in men and 22.26 ± 2.12 (in cm) in women, while r value was 0.060, and p-value was found to be 0.462.

All the anthropometric parameters assessed are expressed in Table 1 and their relation to SGA-DMS. Evidence states that the severity of the condition, duration, and frequency of haemodialysis significantly impacted the nutritional status of the subjects. However, no correlation existed between SGA-DMS and the stated factors.

Body fat percentage and skinfold thickness

According to the Durnin and Womersley equation, subjects are classified based on age and body fat percentage. The results are in Table 2. Most subjects were in the over-fat category in all age groups. The detailed results are presented in Tables 3 and 4.

Malnutrition paired with any medical illness worsens the condition, particularly in patients diagnosed with kidney diseases; malnutrition is relatively high [16]. In CKD, when the patient is under dialysis, there are more prone to muscle and protein-energy wasting. It can be managed more with efficient diet modification and extensive nutritional intake [17, 18]. The malnutrition observed in CKD, especially in people under hemodialysis treatment, significantly influences the morbidity and mortality of the patients. It has also been found that disease-related malnutrition is on a steady hike and could result from polypharmacy, alterations in the taste and smell of food [19].

Extensively available methods, including DEXA and other assays that can determine nutrition deficiency, have yet to be proven for their efficiency. These methods can be influenced by several factors like concomitant disease conditions, diet, and lifestyle and can also be time-consuming and economically unfeasible [15]. This SGA- DMS tool used is highly efficient owing to its cost-effectiveness and consumption of less time; this also requires no particular skill and can be used easily.

Table 1: Anthropometric parameters and SGA-DMS correlation

Parameters	MEAN ± SD		Pearson Correlation with SGA-DMS	
	Male (n= 87)	Female (n= 65)	r value	P-value
Age (years)	52.40 ± 13.03	51.7 ± 14.30	0.012	0.883
Weight (kg)	58.65 ± 11.76	54.3 ± 11.29	0.143	0.078
BMI	23.4 ± 3.2	22.8 ± 3.31	-0.023	0.77
Biceps (cm)	14.81 ± 2.27	14.01 ± 2.14	0.203	0.012
Triceps (cm)	17.79 ± 4.29	18.79 ± 4.96	-0.060	0.462
Suprailiac (cm)	22.44 ± 2.10	21.85 ± 2.11	0.026	0.74
Subcapular (cm)	22.75 ± 1.89	22.26 ± 2.12	0.060	0.462

Table 2: % Body fat calculated from SFT using Student t- test

S no.	Parameter	Male (Mean±SD)	Female (Mean±SD)	p value
1	% Body fat	31.34 ± 2.9	37.35 ± 2.5	0.0001
2	Min % BF	23.5	30.6	NA
3	Max % BF	36.7	41.1	NA

Table 3: Body fat levels by Durnin and Womersley equation for men

Age (years)	% Body fat	No of participants	Inference
20-30	<9%	0	Very low
	9-12%	2	Low
	13-16%	0	Average
	17-19%	0	Very high
	20%+	3	Over- fat
30-40	< 11%	7	Very low
	11-13%	0	Low
	14-17%	7	Average
	18-22%	0	Very high
	23%+	7	Over- fat
40-50	< 12%	0	Very low
	12-15%	5	Low
	16-20%	0	Average
	21-25%	0	Very high
	26%+	20	Over- fat
Over 50	< 13%	0	Very low
	13-16%	8	Low
	17-21%	0	Average
	22-27%	0	Very high
	28%+	28	Over- fat

Table 4: Body fat levels by Durnin and Womersley equation for women

Age (years)	% Body fat	No of participants	Inference
20-30	< 17%	2	Very low
	17- 20%	0	Low
	21-23%	1	Average
	24-27%	0	Very high
	28%+	4	Over- fat
30-40	< 18%	0	Very low
	18-21%	4	Low
	22-24%	0	Average
	25-29%	0	Very high
	30%+	3	Over- fat
40-50	< 20%	3	Very low
	20-23%	0	Low
	24-27%	1	Average
	28-31%	0	Very high
	32%+	8	Over- fat
Over 50	< 21%	0	Very low
	21-24%	0	Low
	24-31%	8	Average
	32-35%	0	Very high
	36%+	31	Over- fat

The only limitation of the method is that it only includes some of the protein sources found in the body. However, it is mainly based on dietary intake and body composition [20-24]. In this study, the bicep skinfold thickness (as demonstrated in Figure 4) was positively correlated with the SGA- DMS tool in assessing the anthropometric parameters. In contrast, tricep skinfold thickness (Figure 5) was negatively correlated, indicating that it is indirectly proportional to the SGA-DMS score. On the other hand, both supra iliac skinfold thickness (Figure 6) and subscapular skinfold thickness (Figure 7) were in positive correlation with the SGA- DMS tool, which indicates that with increasing supra iliac skinfold thickness and subscapular skinfold thickness, higher is the SGA-DMS value. Other studies reported that parameters like MAMC (Mid Arm Muscle Circumference), MAC (Mid Arm Circumference), etc. were significantly correlated with SGA-DMS [23].

Lawson *et al.* [25] conducted a study that stated that SGA-DMS assessment was highly reliable and useful in estimating CKD patients' nutritional status. It also identifies patients at high risk of developing complications and those at high morbidity and mortality. Although several studies have found significance in correlating SGA-DMS and factors like age, weight, and so on, our study did not find any correlation significance on assessment [26, 27].

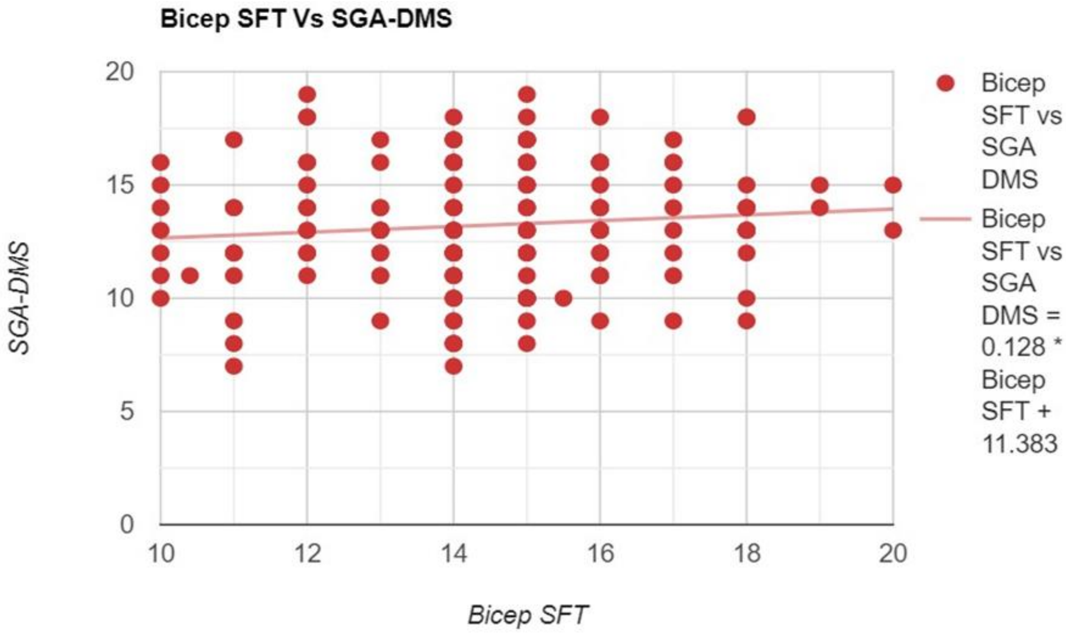

Figure 4: Pearson's coefficient of BSF vs. SGA-DMS

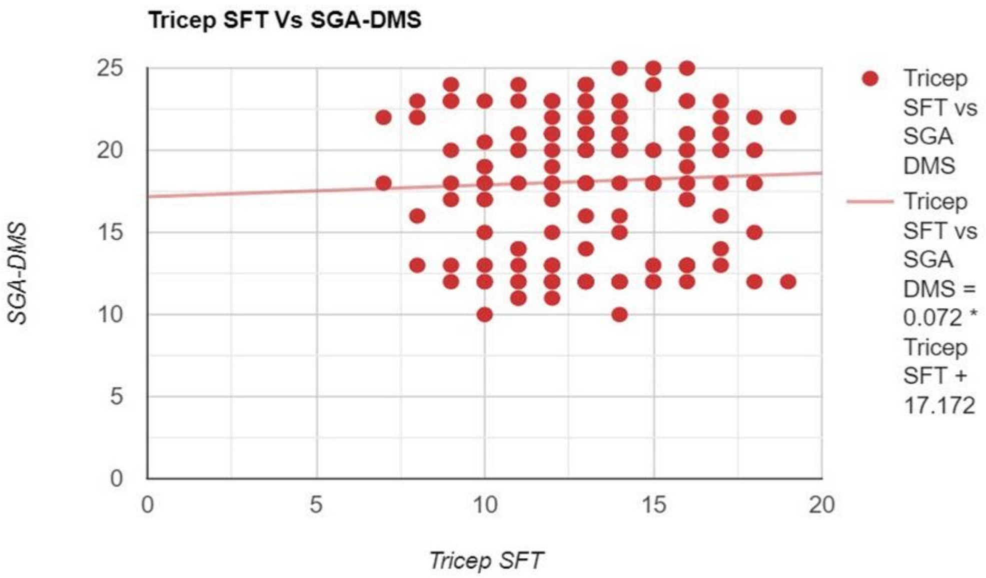

Figure 5: Pearson's coefficient of TSF vs. SGA-DMS

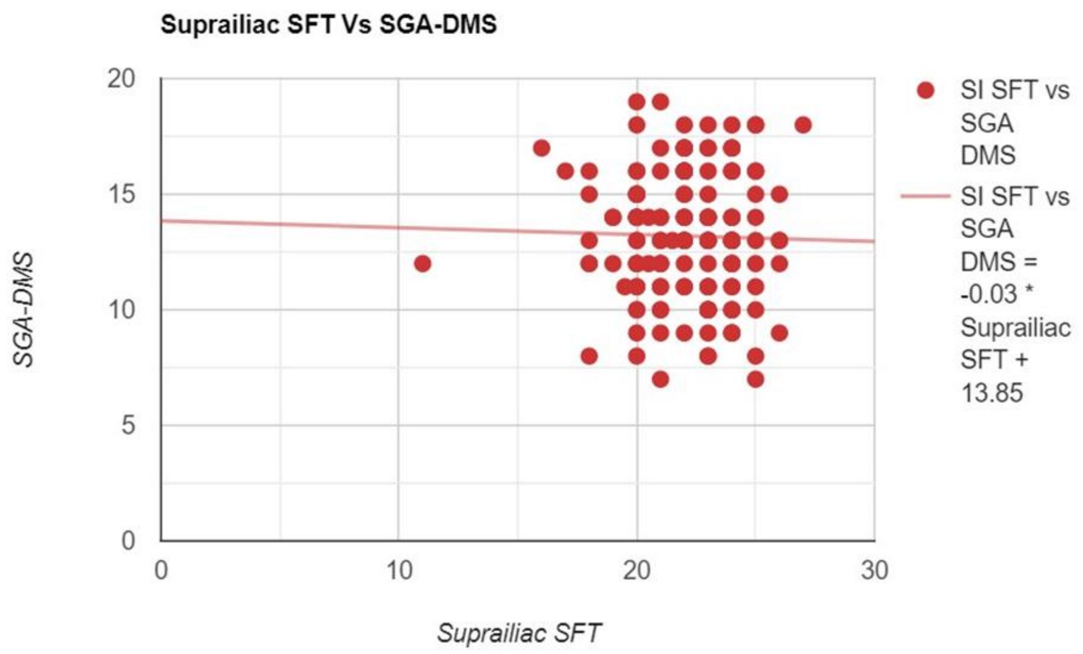

Figure 6: Pearson's coefficient of SST vs. SGA-DMS

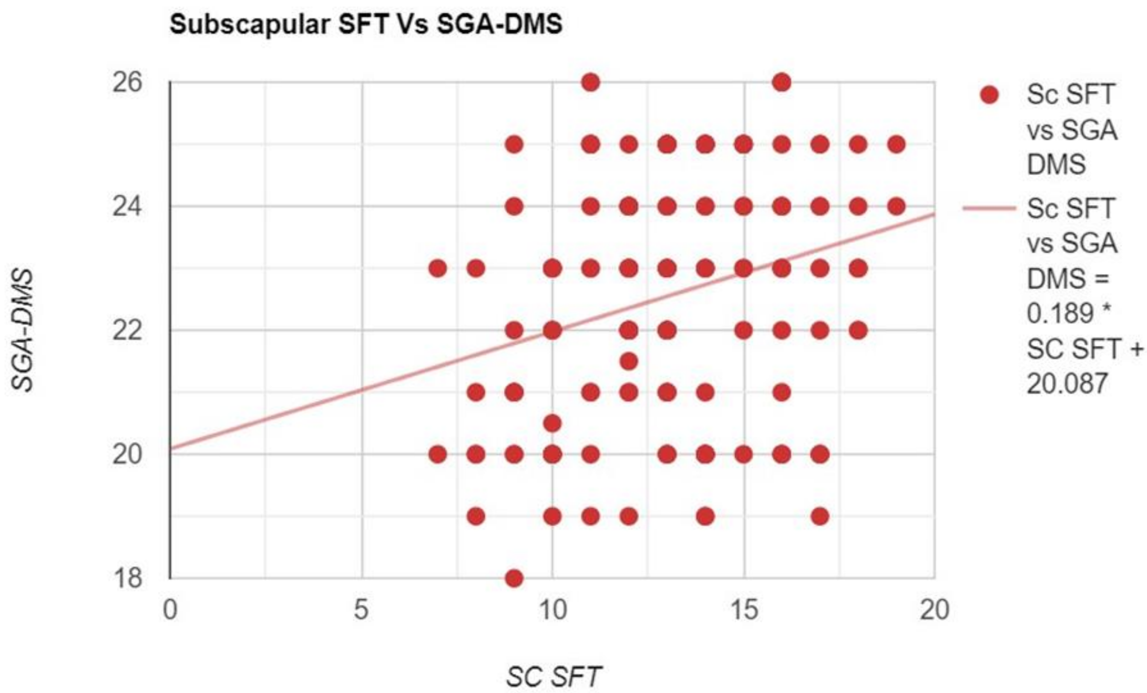

Figure 7: Pearson's coefficient of SST vs. SGA-DMS

Table 5: Results of patients malnourished (in%) based on SGA-DMS

S. No	Range of scores	Subjects		Total
		Male (N=87)	Female (N=65)	
1	7-20	82 (53.9%)	55 (42.7%)	137 (90.1%)
2	21-34	5 (3.2%)	9 (5.9%)	14 (9.2%)
3	35	0	1 (0.6%)	1 (0.6%)

Assessment derived from a measure of dietary intake cannot be included for comparison with SGA-DMS because it mainly involves the history that the patient gives and, therefore, may not be feasible and may not be accurate. A study conducted by Heys SD *et al.* [26] concluded that dietary supplementation and external nutritional support primarily led to the prevention and progression of the illness. Therefore, nutrition was an essential key factor to be considered. However, from our study, we infer that the history regarding nutrition given by the patient may need to be more reliable and it should not be considered for making comparison with the scores derived.

Janardhan *et al.* [28] conducted a study from which we infer that the DMS score negatively correlated to the anthropometric measurements. While in our study, we see that all other anthropometric measurements were positively correlated with the SGA-DMS score except triceps skinfold thickness. Most subjects were healthy and in normal nutritional status, while a meager percentage were found to be severely malnourished. However, on assessing the body fat percentage of the subjects, we observe that they are all under the over-fat category, which implies that they are at high risk of obesity which could also put them at risk of developing various cardiac and metabolic complications. The brief categorisation of the subject nutritional status as per SGA-DMS is presented in Table 5. However, the assessment of biological markers is necessary to determine malnourishment efficiently.

Kobylińska M *et al.* [29] state in their study that most CKD patients though malnourished, tend to contain over-fat and are most likely to develop several complications. It could be due to the reason that with lack of nutrition, especially protein, CKD patients tend to lose lean muscle over time, but at the same time can accumulate fat and develop fatty mass.

Several other studies also imply that obesity, the primary condition in CKD patients, can severely affect the absorption of other nutrients causing malnutrition.

Therefore, efficient monitoring and diet planning are required to maintain a healthy nutritional status [29, 30]. Anderson CA *et al.* [31] conducted a study stating that nutritional status of the CKD patients should be maintained and monitored throughout the entire time. It also signifies the importance of a healthy diet in preventing the accumulation of toxic metabolites and also prevents the progress and complications associated with the disease.

Conclusion

This study emphasizes on elaborating the link between malnutrition and CKD in patients undergoing hemodialysis. It has been found that malnutrition tends to be a common result in hemodialysis and needs to be properly addressed. By employing the other methods along with SGA-DMS, better assessment of malnutrition could be made possible, and efficient nutritional advice from healthcare and adherence to the diet patterns and periodic evaluation might prevent malnutrition. Dietary recommendations should be made, considering the plan's feasibility and sustainability for the patient. They should ensure that timely changes are made to keep in line with the condition prognosis. This study elaborates its main focus and helps to prevent malnutrition and also avoid progression in a futuristic view. This data can be used to develop methods that can efficiently manage the stated consequences. Further studies will potentially aid in better management of the condition.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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