Assessing the Prevalence of Malnutrition in Chronic Kidney Disease Patients in Jordan

Reema F. Tayyem, PhD,* and Majd T. Mrayyan, PhD†

Objective: The study objective was to validate the use of subjective global assessment (SGA) in assessing the prevalence of malnutrition among patients on hemodialysis in Jordan by comparing SGA grades with anthropometric and biochemical measurements.

Design: This was a cross-sectional survey.

Setting: The study was performed at hospital hemodialysis units.

Patients: End-stage renal-failure outpatients (n = 178; 94 women and 84 men; mean age ± SD, 43.9 ± 14.6 years) who underwent hemodialysis were recruited from five large Jordanian hospitals. The obtained data were compared with tabulated measurements of the reference population in term of age and sex.

Main Outcome Measures: Subjective global assessment, anthropometric (dry weight, body mass index, fat percentage, fat mass, triceps skinfold thickness, mid-arm circumference, mid-arm muscle circumference, and arm muscle area), and biochemical (albumin, total protein, hemoglobin, creatinine, urea, cholesterol, phosphorus, calcium, and potassium) measurements were assessed in all patients.

Results: In this study, 56.2% of patients on hemodialysis were moderately malnourished, and 5.6% were severely malnourished. Age was inversely associated with patients’ nutritional status as well as SGA grades. The findings also suggest a significant (P < .001) decrease in some anthropometric parameters (dry weight, body mass index, fat percentage, fat mass, triceps skinfold thickness, mid-arm circumference, mid-arm muscle circumference, and arm muscle area) with advanced malnutrition.

Conclusion: A comparison of SGA grades with biochemical and anthropometric variables indicated that SGA could be used to assess nutritional status in patients on hemodialysis. Overall, about 38.2% of patients were well-nourished. Age and duration of hemodialysis appeared to be associated with nutritional status.

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Protein-energy malnutrition and wasting are common among patients with end-stage renal disease (ESRD). Treating ESRD patients with hemodialysis will not reduce the risk of developing malnutrition. Mehrotra and Kopple demonstrated that the prevalence of malnutrition in patients on hemodialysis is high (15% to 89%); the average is about 40%. It was demonstrated that 40% of hemodialysis patients were malnourished (34.7% with mild malnutrition, and 5.3% with severe malnutrition), whereas 60% of patients were classified as well-nourished.

Desbrow et al. found that about 80% of patients on hemodialysis were well-nourished, 20% were moderately malnourished, and none were assessed as severely malnourished. The estimated prevalence varies because of differences in methods used to assess a patient’s nutritional status as well as other factors that can cause malnutrition. These factors may include recurrent illness, gastrointestinal problems, depression, inflammation, inadequate diet, anorexia, medications, abnormalities of taste, and socioeconomic and cultural aspects.

Nutritional status is usually assessed by measuring anthropometric variables. These anthropometric variables can be measured by different methods including dual-energy X-ray absorptiometry or bioelectrical impedance analysis, and total body nitrogen. Total body nitrogen quantifies the body’s protein content and is considered the gold standard for assessing the nutritional status of ESRD patients. The other methods are expensive, cumbersome, rarely available, and impractical for routine use.

In addition, the assessment of malnutrition using common anthropometric and biochemical
measurements in isolation lacks specificity and reliability. Thus, using more than one type of measurement method (anthropometric and biochemical) may be more reliable and may reflect more accurately the degree of malnutrition. However, assessing nutritional status by measuring a combination of different anthropometric and biochemical parameters can be expensive, difficult, and sometimes invasive. In patients on hemodialysis, nutritional parameters that were independently correlated with malnutrition include body mass index, fat mass, lean body mass, transferrin serum prealbumin, transferrin, and C-reactive protein, and more recently, subjective global assessment (SGA). Originally, SGA was developed to recognize undernutrition in patients who underwent surgery. The use of SGA has been extended to assess the nutritional status of patients with liver transplantation, and of those with cancer. The nutritional status of patients with chronic and end-stage renal failure and patients on hemodialysis can be determined using SGA. It was reported that the use of SGA in detecting malnutrition is simple, valid, noninvasive, and practical. The reliability and ability of SGA to identify malnutrition accurately is controversial. Many studies indicated that SGA is a simple tool, and that it correlates significantly with some nutritional parameters. On the other hand, SGA was found to differentiate patients with severely abnormal nutrition from those with normal nutrition, but that it is not a reliable predictor of a moderate degree of malnutrition.

In Jordan, there are no data about the prevalence of malnutrition in patients on hemodialysis. This lack of data could be related to many factors, including the complexity of determining the level of malnutrition by using different anthropometric and biochemical parameters. Assessing the nutritional status of patients on hemodialysis is not a routine practice in Jordanian hospitals. Moreover, SGA is unfamiliar to most dietitians and physicians in Jordan. This study was conducted to validate SGA by comparing the values of different anthropometric and biochemical variables at the three grades of SGA (A, B, and C) among patients on hemodialysis. A second aim was to determine the prevalence of malnutrition among a representative sample of Jordanian ESRD patients undergoing hemodialysis by use of SGA. This is the first study in Jordan to determine the prevalence of malnutrition, and it assumes that dietary habits, cultural practices, medical resources, and psychological attitudes toward dialysis influence the nutritional status of ESRD patients receiving hemodialysis.

**Methods**

**Sample**

Using a convenience sample of 233 patients, 178 ESRD outpatients (94 women and 84 men; mean age ± SD, 43.9 ± 14.6 years) undergoing hemodialysis were recruited from the dialysis units of five large Jordanian hospitals (three governmental, and two private) in two large cities in Jordan. Of the potential participants, 55 patients refused to participate because of the anthropometric measurements and an unwillingness to answer some questions in the SGA. The main causes for renal failure in the 178 patients included primary hypertension, diabetic nephropathy, kidney stones, and chronic glomerulonephritis. The inclusion criteria of the sample involved patients undergoing hemodialysis for at least 6 months and aged 17 years or more. Patients with acute morbidity, such as those with infections, elevated body temperature, respiratory and gastrointestinal distress, and wounds, as well as patients >75 years old, were excluded. Furthermore, patients who were receiving drugs other than phosphate binders, vitamin D analogues, erythropoietin, insulin, oral hypoglycemic agents, lipid-lowering (statins) drugs, and antihypertensive drugs were excluded.

**Data Collection**

Standard socio-demographic characteristics of the patients (age, sex, educational status, marital status, and occupation) were collected. Anthropometric variables included dry weight (weight after dialysis session), body mass index (BMI; weight in kilograms/height in square meters), fat percentage, fat mass, triceps skinfold thickness (TSF), mid-arm circumference (MAC), mid-arm muscle circumference (MAMC), and arm muscle area (AMA). The TSF measurements were taken using Lange skinfold calipers (Beta Technology, Inc., Cambridge, UK), whereas MACs were measured with Sammon Preston Rolyan flexible tape (Sammon Preston, Germany). Fat percentage was determined using the body fat monitor Omron 300 (Omron, Matoukasa Co., Ltd., Japan).
Percentiles of TSF, MAC, MAMC, and AMA for every patient were calculated according to the methods of Frisancho. All measures were taken after dialysis on the right arm. Measurements were taken on the left arm in cases where the right arm was functionally impaired because of the presence of an arterio-venous (AV) shunt.

All patients were subjected to biochemical assessment as part of their routine care. The averages for albumin, total protein, hemoglobin, creatinine, urea, cholesterol, phosphorus, calcium, and potassium were determined from the 3 consecutive preceding months. Blood samples were drawn immediately before initiating the dialysis session.

The form of SGA was based on the history and physical examination of the individual patient. A patient’s history consisted of five components: weight loss (during the previous 6 months), gastrointestinal symptoms, food intake, functional capacity, and comorbidities. Each of these features was rated separately as A, B, or C to indicate the degree of malnutrition. A patient’s physical examination consisted of two components: loss of subcutaneous fat, and muscle wasting. The presence of edema or ascites could be considered a third component. These two main components were also classified as A, B, or C. Some of the required information in the SGAs was collected from the patient’s medical file (weight and weight changes, and disease state or comorbidities related to nutritional needs), whereas other data (dietary intake, gastrointestinal symptoms, and functional capacity) were recorded directly from the patient. The overall score of A (well-nourished), B (moderately malnourished), or C (severely malnourished) was based on the most predominant score (A, B, or C) in the different aspects of the SGA.

The anthropometric parameters as well as SGA grades were obtained by one renal dietitian experienced in performing SGAs, to minimize measurement errors. In addition, a pilot test for measuring the consistency of SGA was performed on 32 patients during two different occasions (2 weeks apart) by the same dietitian. Intrarater reliability was measured using Cohen’s kappa; it was reported to be 0.90, and was significantly different at \( P < .05 \).

**Ethical Considerations**

The methodology of this research was approved by the Research Committee of Hashemite University, which funded the current research. Approvals for collecting data were obtained from hospital administrators. Informed consent was obtained from each patient for documenting biochemical values, measuring anthropometric parameters, and completing the SGA.

**Data Analysis**

Statistical analyses were conducted using the Statistical Package of the Social Sciences, version 11 (SPSS, Inc., Chicago, IL). The continuous variables included age, duration of hemodialysis, and anthropometric (dry weight, BMI, fat percentage, fat mass, TSF, MAC, MAMC, and AMA) and biochemical (albumin, total protein, hemoglobin, creatinine, urea, cholesterol, phosphorus, calcium, and potassium) parameters, and are presented as means ± standard deviations. Data of continuous variables were compared among SGA grades (A, well-nourished; B, moderately malnourished; and C, severely malnourished) using one-way analysis of variance. Categorical variables using percentages and proportions were analyzed using the chi-square test. Statistical significance is reported as \( P < .05 \).

**Results**

In this study, 53.4% of the patients were female, and 46.6% were male; 30.7% were illiterate, 17.4% were literate, 12.8% were graduates of primary schools, 27.1% were graduates of high school, 12.8% were graduates of secondary school, and 7.8% were graduates of universities; 61.2% were married, 28.1% were single, 3.4% were divorced, and 7.3% were widows or widowers. In regard to occupations, 40.5% of the patients were housewives, 30.8% were public officials, 15.7% were retired, and 13.0% were unemployed.

Table 1 indicates a significant difference between percentages among SGA grades, at \( P < .05 \). The frequencies of SGA grades indicated that 38.2% (n = 68) of the selected patients were well-nourished and were classified as grade A, and 56.2% (n = 100) were classified as grade B (moderately malnourished). Only 5.6% (n = 10) of patients were severely malnourished. A higher proportion of female patients was found to be well-nourished (grade A) and severely malnourished (grade C), whereas a higher proportion of males was determined to be moderately malnourished (grade B). The average age of patients was
43.9 years. Age decreased significantly with advanced malnutrition. Table 1 shows that the mean age of patients in SGA grade A was significantly higher compared with the mean age of patients in SGA grades B and C. Duration of hemodialysis was significantly higher in SGA grade C (116.2 months) compared with SGA grade A (71.8 months).

Table 2 indicates a significant decrease in anthropometric parameters (including dry weight, BMI, fat percentage, fat mass, TSF, MAC, MAMC, and AMA) as the degree of malnutrition increased. In other words, the lowest values of the measured parameters were in SGA grade C, whereas the highest values were in SGA grade A. To exclude the effect of sex, the anthropometric variables were statistically analyzed for male and female patients separately. A significant decrease was obtained in almost all anthropometric variables as the degree of malnutrition increased in both males and females. Although the difference between TSF values was insignificant among SGA grades in male patients, there was a tendency toward a decrease with the increase in malnutrition grade.

The cross-classification of patients by SGA grade and percentile in terms of fat percentage, TSF, MAMC, and AMA is given in Table 3. Percentiles of fat percentage, TSF, MAMC, and AMA for every patient were computed according to the methods of Frisancho.17 The difference among these percentiles was found to be highly significant when these percentages were compared within the three SGA grades. Whereas about 50% to 80% of patients who were classified as moderately malnourished (SGA grade B) were in the fifth percentile or less in each of these four measurements, 100% of the severely malnourished (grade C) patients were in the same percentile.

In no case did any of the biochemical measurements significantly discriminate between the three SGA grades. However, a significant difference between grades A and B, compared with grade C, in albumin and total protein was found. In addition, there was a significant decrease in grade C when compared with grade A in regard to patients’ hemoglobin values (Table 4).

**Discussion**

The present study is the first to estimate the prevalence of malnutrition among Jordanian patients on hemodialysis. Moreover, a greater sample size was involved compared with other

### Table 1. Characteristics of Sample and Prevalence of Malnutrition Among SGA Grades (n = 178)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SGA Grade A (Well Nourished)</th>
<th>SGA Grade B (Moderately Malnourished)</th>
<th>SGA Grade C (Severely Malnourished)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence (%)</td>
<td>68 (38.2%)</td>
<td>100 (56.2%)</td>
<td>10 (5.6%)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Gender (M:F)</td>
<td>20:48</td>
<td>61:39</td>
<td>3:7</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age (y) (mean ± SD)</td>
<td>51 ± 14a</td>
<td>40.3 ± 13.6b</td>
<td>34.6 ± 11.3b</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Duration of hemodialysis</td>
<td>71.8 ± 59.7a</td>
<td>79.0 ± 56.2ab</td>
<td>116.2 ± 84.7bc</td>
<td>.091</td>
</tr>
</tbody>
</table>

SGA, subjective global assessment; SD, standard deviation. Different letters indicate a significant difference between SGA grades within the measured parameter.

### Table 2. Significant Differences in Anthropometric Parameters of SGA Grades (n = 178)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SGA Grade A (Mean ± SD)</th>
<th>SGA Grade B (Mean ± SD)</th>
<th>SGA Grade C (Mean ± SD)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry weight (kg)</td>
<td>70.0 ± 18.1</td>
<td>57.5 ± 13.3</td>
<td>41.2 ± 7.4</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>BMI</td>
<td>26.2 ± 5.7</td>
<td>21.4 ± 3.7</td>
<td>16.9 ± 2.1</td>
<td>.008</td>
</tr>
<tr>
<td>Fat percent</td>
<td>27.7 ± 8.9</td>
<td>17.8 ± 6.7</td>
<td>10.2 ± 5.4</td>
<td>.008</td>
</tr>
<tr>
<td>Fat mass (kg)</td>
<td>20.0 ± 9.7</td>
<td>11.4 ± 6.0</td>
<td>4.5 ± 2.5</td>
<td>.008</td>
</tr>
<tr>
<td>TSF (mm)</td>
<td>15.4 ± 7.2</td>
<td>12.0 ± 5.0</td>
<td>4.9 ± 3.0</td>
<td>.008</td>
</tr>
<tr>
<td>MAC (cm)</td>
<td>28.9 ± 3.8</td>
<td>24.1 ± 2.8</td>
<td>17.7 ± 2.6</td>
<td>.007</td>
</tr>
<tr>
<td>MAMC (cm)</td>
<td>24.0 ± 2.9</td>
<td>20.3 ± 2.7</td>
<td>16.2 ± 2.2</td>
<td>.007</td>
</tr>
<tr>
<td>AMA (cm²)</td>
<td>39.2 ± 10.6</td>
<td>24.9 ± 7.7</td>
<td>13.5 ± 5.4</td>
<td>.007</td>
</tr>
</tbody>
</table>

SGA, subjective global assessment; SD, standard deviation; TSF, triceps skinfold thickness; MAC, mid-arm circumference; MAMC, mid-arm muscle circumference; AMA, arm muscle area; BMI, body mass index.
studies and one well-trained renal dietitian was assigned to estimate all SGA grades and anthropometric measurements. According to the SGA classification, 38.2% of patients were well-nourished, 56.2% were moderately malnourished, and 5.6% were severely malnourished. The prevalence of malnutrition in the present study was as high as 61.8% in patients on hemodialysis, and this finding is supported by the results of other studies. Mehrotra and Kopple showed that estimates of prevalence vary, but that the worldwide average is approximately 40%. Those researchers reported that the majority of patients were classified as having mild to moderate malnutrition, and 6% to 8% had severe malnutrition. In a study of Swedish patients on hemodialysis, Qureshi et al. showed that 36% were well nourished, 51% were mildly malnourished, and 13% were severely malnourished. Forty-six percent of patients on hemodialysis were found to be well-nourished, whereas 34% were moderately nourished, and 20% were poorly nourished, according to SGA, in New York, NY. On the other hand, several studies demonstrated that the percentage of well-nourished patients was higher than those with either moderate or severe malnutrition. Moderate to severe malnutrition was found in 34% to 36% of patients on hemodialysis in Australia, Amsterdam, and Germany.

Many factors play a role in causing variations in the prevalence of malnutrition in different studies. These factors include variations between the countries that conducted those studies, sample heterogeneity, and diversity in dietary patterns, socioeconomic status, comorbidities, and medical care at hospitals from one country to another, or even within the same country. In addition, the dose and conditions of dialysis may influence the rate of developing malnutrition. The experience of the caregiver who administers the SGA may also influence the classification process. Although the prevalence of malnutrition among Jordanian patients on hemodialysis is high, it is still within the average of other countries.

### Table 3. Cross-Classification of Patients by SGA Grades and Reference Percentiles of Fat Percentages, TSF, MAMC, and AMA (n = 178)

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Fat Percentile A (%)</th>
<th>SGA Grade A</th>
<th>Fat Percentile B (%)</th>
<th>SGA Grade B</th>
<th>Fat Percentile C (%)</th>
<th>SGA Grade C</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤5</td>
<td>8.6</td>
<td>48.6</td>
<td>100</td>
<td>11.7</td>
<td>50.5</td>
<td>100</td>
</tr>
<tr>
<td>10–25</td>
<td>27.0</td>
<td>39.2</td>
<td>100</td>
<td>35.0</td>
<td>38.6</td>
<td>100</td>
</tr>
<tr>
<td>50–75</td>
<td>42.1</td>
<td>12.2</td>
<td>100</td>
<td>45.0</td>
<td>10.9</td>
<td>100</td>
</tr>
<tr>
<td>85–90</td>
<td>13.0</td>
<td>8.3</td>
<td>100</td>
<td>4.9</td>
<td>78.5</td>
<td>100</td>
</tr>
<tr>
<td>&gt;95</td>
<td>9.3</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Source of percentiles is Frisancho. SGA, subjective global assessment; TSF, triceps skinfold thickness; MAMC, mid-arm muscle circumference; AMA, arm muscle area.

*Difference between the three SGA grades in the same percentile is highly significant at $P < .001$.

### Table 4. Significant Differences in Biochemical Parameters of SGA Grades (n = 178)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SGA Grade A (Mean ± SD)</th>
<th>SGA Grade B (Mean ± SD)</th>
<th>SGA Grade C (Mean ± SD)</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin (g/L)</td>
<td>39.0 ± 4.5$^a$</td>
<td>39.0 ± 4.0$^a$</td>
<td>36.2 ± 7.0$^b$</td>
<td>.049</td>
</tr>
<tr>
<td>Total protein (g/L)</td>
<td>71.7 ± 7.1$^a$</td>
<td>70.1 ± 8.6$^b$</td>
<td>64.4 ± 7.6$^b$</td>
<td>.042</td>
</tr>
<tr>
<td>Hemoglobin (g/dL)</td>
<td>10.5 ± 1.3$^b$</td>
<td>9.4 ± 1.5$^{b, c}$</td>
<td>8.3 ± 1.2$^b$</td>
<td>.045</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>10.1 ± 2.7$^a$</td>
<td>11.2 ± 2.6$^b$</td>
<td>8.2 ± 2.0$^b$</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Urea (mg/dL)</td>
<td>53.6 ± 14.7</td>
<td>59.0 ± 14.8</td>
<td>55.2 ± 14.4</td>
<td>.069</td>
</tr>
<tr>
<td>Cholesterol (mg/dL)</td>
<td>183.3 ± 60.6</td>
<td>165.6 ± 40.7</td>
<td>143.9 ± 73.7</td>
<td>.219</td>
</tr>
<tr>
<td>Phosphorus (mg/dL)</td>
<td>4.9 ± 1.9</td>
<td>4.7 ± 1.5</td>
<td>4.4 ± 1.6</td>
<td>.518</td>
</tr>
<tr>
<td>Calcium (mg/dL)</td>
<td>9.3 ± 0.9</td>
<td>9.2 ± 1.0</td>
<td>9.3 ± 1.3</td>
<td>.507</td>
</tr>
<tr>
<td>Potassium (mg/dL)</td>
<td>19.9 ± 2.7</td>
<td>20.3 ± 2.7</td>
<td>18.3 ± 3.2</td>
<td>.157</td>
</tr>
</tbody>
</table>

SGA, subjective global assessment; SD, standard deviation.

Different letters indicate significant difference ($P < .05$) between SGA grades within the measured parameter.
Age was inversely associated with SGA grades, which runs counter to the findings of Morais et al., who demonstrated that older patients were most affected by malnutrition because of the increase in comorbidities with age and the aging process. On the one hand, in the present study, there was an indirect relationship between age and SGA grade, which could be related to the increase in duration of hemodialysis in young patients (grade C) compared with older ones (grades A and B). These results are similar to those of Chazot et al., who found that despite adequate dialysis dose and protein intake, patients treated with hemodialysis for a long period of time became malnourished. This may be attributable to protein catabolism, muscle-protein breakdown, and loss of body fat, which are usually stimulated by the dialysis procedure. On the other hand, young patients require more energy and nutrients compared with older ones. The potential causes leading to malnutrition in hemodialysis patients include inadequate energy intake and micronutrient deficiencies. Unhealthy dietary habits and loss of appetite were other factors in the development of malnutrition, and they were more prevalent in young patients. A concomitant study on those same patients was conducted to estimate patients’ dietary patterns, and it demonstrated that young patients did not comply with dietary restrictions that are generally required to decrease the complications of dialysis. In addition, that study demonstrated that young patients had a lower appetite and food intake that was below the recommended amounts. All these factors may help explain the inverse relationship between age and malnutrition in patients on hemodialysis. However, this issue calls for more investigation of the underlying causes of severe malnutrition in young patients.

The significant differences between the three grades of SGA in the measured anthropometric parameters and the calculated percentiles indicate that SGA can differentiate between well-nourished patients and malnourished patients. However, Cooper et al. pointed out that SGA may differentiate severely malnourished patients from those with normal nutrition, but is not a reliable predictor of a moderate degree of malnutrition. Moreover, Jones et al. demonstrated that SGA might not reliably identify those patients on hemodialysis with abnormal nutrition. The present findings are consistent with many other studies that demonstrated a significant decrease in some anthropometric parameters (BMI, TSF, MAC, MAMC, and AMA) with worsening malnutrition. Furthermore, the proportions of patients with different fat percentages and TSF, MAMC, and AMA percentiles indicated that all patients in the present study in grade C were at the fifth percentile or less. On the other hand, about half of the grade B patients were at the fifth percentile or less. However, for SGA grade A patients, >90% of the patients were above the 50th percentile.

In regard to biochemical parameters, the current research shows that serum albumin can be used as an indicator of malnutrition in severe cases such as those classified as SGA grade C. The measurements of total protein revealed significant decreases when SGA grades A and B were compared with grade C. Therefore, these two biochemical parameters could not be used as sensitive indicators for malnutrition. This study further supports the evidence indicating that the reduction in serum albumin in patients on hemodialysis is not related to malnutrition. Inflammation is considered the major contributor in the decreased serum albumin of patients on hemodialysis. However, Desbrow et al. found a significant inverse correlation between degrees of SGA and serum albumin ($r = -0.28$, $P < .038$). Tirmintajn-Jankovic and Dimkovic demonstrated the presence of a significant reduction in total protein and serum albumin as SGA grades increased. Measurements of hemoglobin revealed the presence of anemia in all study populations, including patients in SGA grade A. Anees et al. demonstrated that 41 of 51 patients on hemodialysis were anemic. That study also pointed out that a significant reduction in hemoglobin could be detected in SGA grade C compared with grades A and B. These findings are in agreement with those of Jones et al., who found that the decrease in hemoglobin was insignificant when SGA grade A compared with grade B. In ESRD, a low level of hemoglobin may result from many causes; hence, it is unreasonable to measure hemoglobin when assessing nutritional status.

**Study Limitations**

The sample was not random. Because of the inclusion criteria, patients were selected conveniently.
Conclusion

Although the prevalence of malnutrition among Jordanian patients on hemodialysis is high, it still within the average range of other countries. The prevalence of malnutrition was found to be 61.8%; 56.2% of the patients were malnourished, and 5.6% were severely malnourished. An inverse relationship between age and grade of malnutrition was detected. The role of age requires in-depth research to assess the influence of this variable on the nutritional status of patients on hemodialysis.

As expected, as the degree of malnutrition increased, there was a significant decrease in the measured anthropometric parameters, including postdialysis weight, BMI, fat percentage, fat mass, TSE, MAC, MAMC, and AMA. The lowest values occurred in SGA grade C, whereas the highest values were reported in grade A. On the other hand, in no case did any of the biochemical measurements significantly discriminate between the three SGA grades except for albumin and total protein, which decreased significantly when SGA grades A and B were compared with C.

Acknowledgments

Special thanks go to all the patients who participated in this study in spite of their poor health, and to Dr. Karen Messer and Dr. Cheryl Rock (University of California at San Diego, San Diego, California) for valuable input and suggestions to improve this paper. We also acknowledge Hanan Othman (renal dietitian) for her help in collecting data, and Zahra’ Al-Alamy and Maha Salamh for entering and analyzing data.

References