Impact of Oral Nutritional Supplementation in Chronic Kidney Disease Patients on Maintenance Hemodialysis: An Open-label, Single-arm Study among Indian Patients

Arun Shah¹, Rachana Bhoite²*, Praneeth Immadisetti³, Wasi Shaikh⁴, Ruta Deshmukh⁵, Rahul Rathod⁶, Vinita Satyavrat⁷

Received: 10 January 2024; Revised: 20 February 2024; Accepted: 21 February 2024

Abstract

Background: Protein-energy wasting (PEW) affects about 50–75% of patients with chronic kidney disease (CKD), particularly those who are on maintenance hemodialysis (MHD). This study evaluated the efficacy and tolerability of an oral nutritional supplement in Indian patients receiving MHD.

Materials and methods: This was a 3-month, prospective, open-label, and single-centered study. Eligible participants supplemented their regular diet with one sachet (40 g) of oral nutritional supplement powder twice daily for 90 days. The study efficacy endpoints were mean change in acute phase proteins (albumin and prealbumin), anthropometric measurements [weight, body mass index (BMI), and triceps skin fold thickness], handgrip strength, hemoglobin, total iron binding capacity (TIBC), potassium, and phosphorus levels, malnutrition score (MS)—modified subjective global assessment (modified SGA), malnutrition inflammation score (MIS), and nutritional status.

Results: The study population comprised 36 (42.9%) men and 48 (57.1%) women with a mean age of 54.85 ± 15.50 years. A paired sample t-test was used to compare the baseline with end-of-study values for continuous variables. Serum albumin, prealbumin, hemoglobin, and phosphorus levels remained stable throughout the study period. The mean change in weight, BMI, triceps skin fold thickness, handgrip strength, and TIBC for the overall study population was 1.11 kg (1.82%, p < 0.0001), 0.46 kg/m² (1.98%, p < 0.0001), 3.47 mm (30.78%, p < 0.0001), 6.05 kg (44.98%, p < 0.0001) and 11.80 µg/dL (6.06%, p < 0.0001), respectively. At the end of the study period, there was a significant (p < 0.0001) improvement in the SGA and MIS scores. Further, there was a significant improvement in nutritional status as demonstrated by the overall intake of calories (p < 0.0001), proteins (p < 0.0001), carbohydrates (p = 0.003), and fats (p < 0.0001).

Conclusion: Protein–energy malnutrition is a strong predictor of morbidity, mortality, and poor outcomes in CKD patients. A scientifically designed formula in accordance with KDQI standards was able to improve the nutritional status, overall body composition, sarcopenia, and quality of life in CKD patients on MHD.

Introduction

Chronic kidney disease (CKD) is a state of progressive kidney damage with an estimated glomerular filtration rate (eGFR) of <60 mL/minute/1.73 m² for a period of 3 months or longer.¹ However, CKD is asymptomatic in the early-moderate stage, and nearly 50% of patients are diagnosed when their eGFR is <15 mL/minute/1.73 m².² The survival of patients with CKD is drastically reduced unless kidney replacement therapy (KRT) is initiated through dialysis or transplantation. Nearly 89% of all dialysis and 69% of all KRT are performed using hemodialysis,³ and maintenance hemodialysis (MHD) continues to be the primary treatment for end-stage renal disease (ESRD). ESRD has a worse prognosis than most malignancies since >20% of patients who begin dialysis die within the 1st year, and >70% of diabetic patients who begin dialysis die within 5 years.⁴ Short-term patient care is essential since mortality is highest during the first 3 months of initiation of hemodialysis.³

In addition to being expensive, MHD alters the nutritional state of 20–70% of patients, resulting in cachexia and malnutrition.⁵ Severe and mild malnutrition is seen in 6–8% and 30–65% of MHD patients, respectively.⁶ Protein-energy wasting (PEW), also known as uremic malnutrition, is linked to low protein intake, inflammation, catabolic state, oxidative stress, decreased albumin and prealbumin levels, sarcopenia, weight loss, and comorbidities in these individuals. As a result, PEW is by far the best predictive indicator for poor outcomes and mortality in CKD patients.⁷ As little as a 1 gm/L change in serum albumin concentration over the course of a few months might result in an increase or decrease in survival.⁸ The serum prealbumin is also gaining attention as a reliable marker of PEW status.⁹ Consequently, the clinical practice guidelines of KDOQI recommend serum albumin and prealbumin levels along with adjusted potassium–phosphorus levels and handgrip strength as nutritional indicators to predict the survival of MHD patients. Furthermore, the guidelines also support the use of a nutritional screening tool, a subjective global assessment-dialysis malnutrition score (MS), that determines the nutritional status of MHD patients.

Studies have shown the importance of nutritional supplements in avoiding PEW and reducing treatment expenses in individuals who are severely malnourished.¹⁰ As opposed to conventional interventions like angiotensin-converting enzyme inhibitors or angiotensin-receptor blockers that do not induce remission and sodium/glucose cotransporter 2 inhibitors that are contraindicated in advanced renal patients, the risk of short-term mortality in MHD patients can be decreased by preventing PEW through an improvement in nutritional intake.⁴ Even while the number of CKD-related mortality in India is still greater than in low-income nations, there is a paucity of data on Indian patients receiving MHD.¹¹ Given this information, the current study’s objective was to assess the effects of an oral nutritional supplement in Indian CKD patients receiving MHD.

[Received: 10 January 2024; Revised: 20 February 2024; Accepted: 21 February 2024]

**Materials and Methods**

**Study Design and Eligibility Criteria**
This was a 3-month, prospective, single-center, open-label, and single-arm study. Male and female patients on MHD who were diagnosed as malnourished (serum albumin concentration <4 gm/dL with or without a loss of ≥ 5% dry weight over the past 3 months), older than 18 years, with a record of body weight for the previous 6 months, and who were willing to take the oral nutritional supplement met the eligibility requirements. Exclusion criteria were any of the following: unable or unwilling to provide informed consent and comply with the protocol procedures, had a history of dialysis noncompliance, malabsorption syndromes, chronic inflammatory diseases of unknown origin, malignancy, nephrotic syndrome, or chronic liver disease, the presence of recurrent acute illnesses, body weight <40 kg, or if they were pregnant or lactating females. Patients were also disqualified if they had recently undergone surgery or were using any other dietary supplements. The study was carried out in accordance with the ethical principles outlined in the latest version of the Declaration of Helsinki and the applicable guidelines for good clinical practice. Ethics committee approval was obtained for this study, and the study was registered at the Clinical Trials Registry of India.

**Study Intervention**
Patients who met the eligibility criteria were included in the study and underwent baseline assessments, anthropometric measurements, and laboratory testing both before and after the study. Patients received an oral nutritional supplement in addition to their regular diet during the study period. The oral nutritional supplement was scientifically designed with high protein (whey protein isolate as a primary source), low glycemic index, and energy-dense formula with added medium chain triglycerides and low potassium and phosphorous levels. Patients were instructed to consume one sachet (40 gm) of oral nutritional supplement powder twice a day for 90 days. One serving (40 gm) was reconstituted in 180 mL of plain water.

**Efficacy Endpoints**
The study efficacy endpoints were mean change in acute phase proteins (albumin and prealbumin), anthropometric measurements [weight, body mass index (BMI), triceps skin fold thickness], handgrip strength, hemoglobin, total iron binding capacity (TIBC), potassium, and phosphorus levels, MS (modified subjective global assessment (modified SGA)), malnutrition inflammation score (MIS), and nutritional status (proteins, carbohydrates, and fats) at the end of the study period. The primary endpoint was a mean change in acute phase proteins used to assess the effectiveness of PEW prevention at the end of the study period. The other endpoint was to evaluate the impact of the study intervention on sarcopenia, nutritional status, and quality of life among CKD patients. BMI was computed using the height and weight calculation and classified according to World Health Organization guidelines. The triceps skinfold was measured at the back of the left arm, midway between the acromial process of the scapula and the olecranon process of the ulna, with a Harpenden caliper. The Durnin and Womersley equation was used to calculate the percentage of body fat. Handgrip strength was measured using a handgrip dynamometer. The measurements were taken three times at 5-second intervals before and after the dialysis session, with the highest value chosen for analysis. The photometric approach was used to test hemoglobin in the DXH 800 equipment. Serum albumin was measured using the albumin bromocresol green technique, whereas serum prealbumin was measured using immunoturbidimetry. TIBC was estimated as the sum of serum iron and serum unsaturated iron-binding capacity. The indirect ion-selective electrodes technique was used to assess potassium, whereas the molybdate ultraviolet method was used to assess phosphorus. A 24-hour dietary recall was used to collect thorough information on all the foods and beverages taken by the patients in the previous 24 hours, and a mean of macronutrients was determined based on the previous 3 days’ dietary intake during site visits. Modified SGA was used as a reliable and valid tool for the nutritional assessment of hemodialyzed patients. It has two components—patient-related medical history on five items (weight change, dietary intake, gastrointestinal symptoms, functional capacity, and comorbidity) and physical examination on two items (decreased fat stores or loss of subcutaneous fat and signs of muscle wasting). Each component has a score between 1 and 5, a total ranging between 7 (normal) and 35 (very severe). Thus, an MS between 7 and 10 represents a well-nourished individual, whereas an MS score between 11 and 22 represents mild to moderate malnutrition. MIS was used to examine PEW (malnutrition) and inflammation. The MIS has 10 components across four sections, namely the patient’s medical history (change in end dialysis dry weight, dietary intake, gastrointestinal symptoms, functional capacity, and comorbidity), physical examination (decreased fat stores or loss of subcutaneous fat and signs of muscle wasting), BMI, and laboratory parameters (serum albumin and serum TIBC). Each component has four levels of severity, ranging from 0 (normal) to 3 (severely abnormal). The sum of all 10 components ranges between 0 (normal) and 30 (severe degree of malnutrition and inflammation). The patient’s diary entries were used to monitor their compliance with the study intervention.

**Statistical Analysis**
Continuous data was tested for normal distribution using the Shapiro–Wilk test, and a p-value of <0.05 indicated that the normal distribution had failed. Continuous data are summarized as arithmetic means with standard deviation (SD). Changes from baseline to day 90 were computed for all continuous variables and presented as mean change with 95% confidence intervals (CI). Since all continuous data were normally distributed, a paired sample t-test was used to compare the baseline with day 90 (end of study) values for continuous variables. Categorical and nominal data are presented as numbers with percentages. All testing was done using two-sided tests at a 0.05 (95% confidence level). Statistical analysis was performed using Stata IC 13.1 (StataCorp LLC, Texas, United States of America).

**Results**

**Baseline Characteristics of Participants**
A total of 100 eligible patients were included in the study, and 84 completed it. Therefore, the results were analyzed for these 84 patients. There were 48 (57.1%) women and 36 (42.9%) men with a mean age of 54.85 ± 15.50 years. The demographic and vital parameters of the study participants at baseline are presented in Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>N = 84</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean ± SD, year</td>
<td>54.85 ± 15.50</td>
<td></td>
</tr>
<tr>
<td>Gender, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>36 (42.9)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>48 (57.1)</td>
<td></td>
</tr>
<tr>
<td>SBP, mean ± SD, mm Hg</td>
<td>137.50 ± 18.16</td>
<td></td>
</tr>
<tr>
<td>DBP, mean ± SD, mm Hg</td>
<td>81.10 ± 8.99</td>
<td></td>
</tr>
<tr>
<td>SpO2, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>98.29 ± 0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight, mean ± SD, kg</td>
<td>60.74 ± 14.25</td>
<td></td>
</tr>
<tr>
<td>BMI, mean ± SD, kg/m²</td>
<td>23.20 ± 4.12</td>
<td></td>
</tr>
</tbody>
</table>
Oral Nutritional Supplementation for CKD Patients

Frequent hospitalization, financial burden, and unacceptably high mortality. In 2014, a 2-year prospective study at an Indian tertiary care hospital observed 63.12% deaths within the first 6 months of hemodialysis initiation. Therefore, measures to improve the longevity of MHD patients should focus especially on the first few months of the treatment. A consensus statement suggests oral, enteral, or parenteral nutritional supplements to fulfil the protein and energy demands when oral dietary intake from regular meals is insufficient.

Considering this, we gave MHD patients an oral nutritional supplement for 3 months to address their dietary issues and test the effectiveness and tolerance of our product.

The nutritional status and outcomes of CKD may be reliably predicted by serum albumin and prealbumin levels. A systematic review and meta-analysis revealed that oral nutritional supplements can increase 1071.09 ± 196.72 kcal, mean difference = 272.96, \( p < 0.001 \), proteins (34.14 ± 10.86 vs 68.18 ± 7.18 gm, mean difference = 34.04, \( p < 0.001 \)), carbohydrates (127.97 ± 35.71 vs 139.92 ± 28.04 gm, mean difference = 11.95, \( p = 0.003 \)) and fats (17.16 ± 9.59 vs 27.96 ± 4.52 gm, mean difference = 10.80, \( p < 0.001 \)) at the end of the study period (Table 3 and Fig. 3).

**Discussion**

Chronic kidney disease (CKD) is a global healthcare burden with mortality higher than many cancers. Nearly a third of the 697.5 million cases of CKD reported in 2017 originated in China (332.3 million) and India (115.1 million). Despite years of progress in the clinical results of hemodialysis, MHD patients continue to have a poor quality of life due to comorbidities, recurring infections, frequent hospitalization, financial burden, and unacceptably high mortality. In 2014, a 2-year prospective study at an Indian tertiary care hospital observed 63.12% deaths within the first 6 months of hemodialysis initiation. Therefore, measures to improve the longevity of MHD patients should focus especially on the first few months of the treatment. A consensus statement suggests oral, enteral, or parenteral nutritional supplements to fulfil the protein and energy demands when oral dietary intake from regular meals is insufficient. Considering this, we gave MHD patients an oral nutritional supplement for 3 months to address their dietary issues and test the effectiveness and tolerance of our product.

The nutritional status and outcomes of CKD may be reliably predicted by serum albumin and prealbumin levels. A systematic review and meta-analysis revealed that oral nutritional supplements can increase 1071.09 ± 196.72 kcal, mean difference = 272.96, \( p < 0.001 \), proteins (34.14 ± 10.86 vs 68.18 ± 7.18 gm, mean difference = 34.04, \( p < 0.001 \)), carbohydrates (127.97 ± 35.71 vs 139.92 ± 28.04 gm, mean difference = 11.95, \( p = 0.003 \)) and fats (17.16 ± 9.59 vs 27.96 ± 4.52 gm, mean difference = 10.80, \( p < 0.001 \)) at the end of the study period (Table 3 and Fig. 3).

**Change in Acute Phase Proteins, Handgrip Strength, PEW, MS, MIS, and Laboratory Parameters**

Compared to baseline levels, there was no significant drop in albumin (mean difference = −0.01 gm/dL, 95% CI, −0.09–0.12; \( p = 0.822 \)) and prealbumin (mean difference = −0.02 gm/L, 95% CI, −0.03–0.00; \( p = 0.068 \)) levels and the same were kept close to the baseline values at the end of the study period (Table 2 and Fig. 1). However, a significant improvement was observed in handgrip strength (\( p < 0.0001 \)), PEW (\( p < 0.0001 \)), MS (\( p < 0.0001 \)), MIS (\( p < 0.0001 \)), and TIBC (\( p = 0.027 \)) levels (Table 2 and Figs 1 and 2).

**Change in Nutritional Status**

There was a significant improvement in nutritional status demonstrated by the overall intake of calories (798.12 ± 188.7 vs 1071.09 ± 196.72 kcal, mean difference = 272.96, \( p < 0.001 \)), proteins (34.14 ± 10.86 vs 68.18 ± 7.18 gm, mean difference = 34.04, \( p < 0.001 \)), carbohydrates (127.97 ± 35.71 vs 139.92 ± 28.04 gm, mean difference = 11.95, \( p = 0.003 \)) and fats (17.16 ± 9.59 vs 27.96 ± 4.52 gm, mean difference = 10.80, \( p < 0.001 \)) at the end of the study period (Table 3 and Fig. 3).

**Discussion**

Chronic kidney disease (CKD) is a global healthcare burden with mortality higher than many cancers. Nearly a third of the 697.5 million cases of CKD reported in 2017 originated in China (332.3 million) and India (115.1 million). Despite years of progress in the clinical results of hemodialysis, MHD patients continue to have a poor quality of life due to comorbidities, recurring infections, frequent hospitalization, financial burden, and unacceptably high mortality. In 2014, a 2-year prospective study at an Indian tertiary care hospital observed 63.12% deaths within the first 6 months of hemodialysis initiation. Therefore, measures to improve the longevity of MHD patients should focus especially on the first few months of the treatment. A consensus statement suggests oral, enteral, or parenteral nutritional supplements to fulfil the protein and energy demands when oral dietary intake from regular meals is insufficient. Considering this, we gave MHD patients an oral nutritional supplement for 3 months to address their dietary issues and test the effectiveness and tolerance of our product.

The nutritional status and outcomes of CKD may be reliably predicted by serum albumin and prealbumin levels. A systematic review and meta-analysis revealed that oral nutritional supplements can increase 1071.09 ± 196.72 kcal, mean difference = 272.96, \( p < 0.001 \), proteins (34.14 ± 10.86 vs 68.18 ± 7.18 gm, mean difference = 34.04, \( p < 0.001 \)), carbohydrates (127.97 ± 35.71 vs 139.92 ± 28.04 gm, mean difference = 11.95, \( p = 0.003 \)) and fats (17.16 ± 9.59 vs 27.96 ± 4.52 gm, mean difference = 10.80, \( p < 0.001 \)) at the end of the study period (Table 3 and Fig. 3).

**Discussion**

Chronic kidney disease (CKD) is a global healthcare burden with mortality higher than many cancers. Nearly a third of the 697.5 million cases of CKD reported in 2017 originated in China (332.3 million) and India (115.1 million). Despite years of progress in the clinical results of hemodialysis, MHD patients continue to have a poor quality of life due to comorbidities, recurring infections, frequent hospitalization, financial burden, and unacceptably high mortality. In 2014, a 2-year prospective study at an Indian tertiary care hospital observed 63.12% deaths within the first 6 months of hemodialysis initiation. Therefore, measures to improve the longevity of MHD patients should focus especially on the first few months of the treatment. A consensus statement suggests oral, enteral, or parenteral nutritional supplements to fulfil the protein and energy demands when oral dietary intake from regular meals is insufficient. Considering this, we gave MHD patients an oral nutritional supplement for 3 months to address their dietary issues and test the effectiveness and tolerance of our product.

The nutritional status and outcomes of CKD may be reliably predicted by serum albumin and prealbumin levels. A systematic review and meta-analysis revealed that oral nutritional supplements can increase
albumin levels by 2.17 gm/L (95% CI, 0.89–3.45, \( p < 0.001; I^2 = 90\%\)) in MHD patients. \( p \) After receiving short-term enteral nutritional supplementation for 1 month, serum albumin levels were found to be higher in MHD patients (3.4 ± 0.4 vs 3.9 ± 0.3, \( p = 0.000\)) in another study. \( p \) Similar outcomes were observed by other authors, where serum albumin levels increased from 3.01 ± 0.44 to 3.85 ± 0.32 (\( p < 0.0001\)) and from 3.0 ± 0.05 to 3.5 ± 0.06 (\( p < 0.0001\)) following 3 months of predialytic and intradialytic oral nutritional supplements, respectively. \( p \) Oral nutrition supplements are useful for maintaining albumin and prealbumin levels and preventing further decline in these levels. As a result, they have helped CKD patients on MHD improve their nutritional status and quality of life. The findings of our study also revealed that serum albumin levels could be maintained from baseline to 3 months of intervention without any further depletion (3.85 ± 0.52 vs 3.84 ± 0.36, \( p = 0.822\)). In keeping with our findings, Fouque et al. found no differences in serum albumin levels across groups with energy-dense, renal-specific oral supplements between groups after 3 months. \( p \) Patients undergoing hemodialysis have a 2.47 times increased risk of complications when their serum albumin level is below 3.8 gm/dL (hazard ratio higher in females). As a result of our intervention, the serum albumin levels were effectively kept above this limit. Similarly, for each 1 mg/dL increase in the serum prealbumin, a 9% decrease in the risk of death is seen. \( p \) Studies have shown both significant and nonsignificant rises in serum prealbumin levels after oral supplementation. \( p \) In contrast, our result showed a nonsignificant decline in serum prealbumin levels (0.26 ± 0.08 vs 0.24 ± 0.07, \( p = 0.068\)).

Generally, with each dialysis cycle, 6–12 gm amino acids and 7–8 gm protein are lost along with loss of water-soluble vitamins and trace elements such as zinc, carotene, folate, calcium, and dietary fiber leading to PEW, a complex syndrome of muscle wasting, malnutrition, and inflammation. \( p \) We used a range of indicators to accurately assess distinct nutritional status/PEW in the MHD population. Our study found a significant improvement in weight (60.74 ± 14.25 vs 61.85 ± 13.45 kg, \( p < 0.0001\) and BMI (23.20 ± 4.12 vs 23.66 ± 3.87 kg/m², \( p < 0.0001\)) at the end of the study period. In line with our results, two previous studies have shown a similar increase in weight (58.78 ± 11.20 vs 59.41 ± 10.60 kg, \( p < 0.0001\) and (59.9 ± 1.55 vs 60.4 ± 1.49 kg, \( p = 0.022\)) following 3 months of nutritional supplementation. \( p \) Also, a similar result was observed for the BMI (21.1 ± 0.50 vs 21.3 ± 0.47 kg/m², \( p = 0.019\)) in one of these studies. \( p \) Furthermore, two systemic reviews and meta-analyses have also shown an increase in BMI by 0.40 kg/m² (95% CI, 0.10–0.71, \( p = 0.01\); \( I^2 = 49\%) \) and 0.30 kg/m² (95% CI, 0.09–0.52, \( p = 0.005\); \( I^2 = 41\%\)), respectively with oral nutritional supplements. \( p \) Additionally, there are reports of stable BMI with nutritional intervention and a decline in BMI in the control group during the study period of 3 and 6 months, respectively. \( p \) Our study showed a significant increase in the triceps skin fold thickness at the end of the study period (11.27 ± 4.16 vs 14.74 ± 3.81 mm, \( p < 0.0001\)). A similar result was observed in a previous study where triceps skin fold thickness increased (10.5 ± 5.0–11.9 ± 5.0 cm, \( p < 0.001\)) after 6 months of oral nutrition supplementation and decreased (12.6 ± 5.4–11.3 ± 5.5 cm, \( p < 0.001\)) in the control group. \( p \) Another study found that using oral fat-based high-energy supplements daily for 80 days did not significantly enhance the thickness of the triceps skin folds (20.40 ± 6.17 vs 21.55 ± 5.37 mm, \( p = 0.538\)). Furthermore, our study demonstrated a significant improvement in the handgrip strength (13.45 ± 5.72 vs 19.50 ± 5.03 kg, \( p < 0.0001\)). In a prior study, a similar increase in handgrip strength was seen after 3 months (17.79 ± 7.9 vs 20.9 ± 6.4 kg) and 6 months (17.79 ± 7.9 vs 23.7 ± 6.5 kg, \( p < 0.05\)) of oral nutritional supplementation. \( p \) Our findings were also in agreement with a systematic review and meta-analysis of 22 randomized controlled trials that showed a significant improvement in handgrip strength following oral nutritional supplementation (0.96 kg (95% CI, 0.07–1.84, \( p = 0.034\); \( I^2 = 41\%\))) when compared to placebo or routine care. \( p \)

In two previous studies, three months of supplementation resulted in significant increases (9.23 ± 1.88 vs 10.16 ± 1.82, \( p = 0.0001\) and 9.3 ± 0.28 vs 9.8 ± 0.16, \( p = 0.048\)) in the hemoglobin levels. \( p \) We did note a nonsignificant decrease in the hemoglobin levels, though. Our findings were consistent with a previous study that found no changes in hemoglobin concentration. \( p \) Although there were no differences between the control and supplement groups in another trial, the control group required considerably more erythropoietin doses to maintain constant hemoglobin levels (\( p = 0.012\)) than the supplement group. \( p \) Our study had more females than males, which may have contributed to the nonsignificant reduction in hemoglobin levels.

Increased mortality is linked to a significant change in the levels of serum potassium and phosphorus. The serum phosphorus levels at 3 months in our study did not differ significantly from two prior studies (6.65 ± 1.86 vs 6.66 ± 1.25 mg/dL and 6.05 ± 0.26 vs 6.09 ± 0.25 mg/dL, \( p = 0.895\); \( p \) Another research that supports our findings found an increase in serum potassium levels (3.8 ± 0.8 vs 4.8 ± 0.7 mEq/L, \( p = 0.02\)). Likewise, few studies have reported no significant changes in serum potassium levels after 3 months. \( p \) The oral nutritional supplement used in the study was designed to provide low potassium and phosphorus levels according to KDOQI guidelines. Renin–angiotensin–aldosterone system inhibitors, which are known to increase the risk of hyperkalemia in individuals with impaired kidney function, may be the cause of the rise in serum potassium levels. \( p \)

Our SGA and MIS scores correlate favorably with the positive findings. At the end of the study period, the nutritional status of our patients had improved, going from mild–moderate malnutrition (score 11-22)
to well-nourished (score 7–10), as shown by the modified SGA score. No patient had significant malnutrition, either. Our results corroborated with another study in which the supplement group showed improved SGA scores (p < 0.05) and quality of life, whereas the control group continued to have a mild-to-moderate risk of malnutrition at 3 months. Intradialytic amino acid supplementation was also shown to improve the SGA score at 3 months (16 vs 11, p = 0.01) and at 6 months (16 vs 11, p = 0.01).29 Patients with PEW had considerably higher MIS scores, with scores greater than 5 indicating malnourishment. After the patients received the oral nutritional supplement, our intervention successfully reduced their MIS scores to below 5, showing that they were well-nourished. The whey protein and vitamin E in our supplement may have contributed to this impact, as shown in a previous randomized control trial.30 Additionally, one research found that while MIS scores in the intervention group remained stable (8.3 ± 2.8 vs 8.2 ± 3.0), the same significantly increased (p = 0.006) in the control group after 6 months.25 Serum TIBC in MIS scoring is an indirect measurement of serum transferrin concentration. It is a helpful indicator of inflammation and nutritional status. It is known that a decrease in TIBC > 20 mg/dL during the first 6 months increases the risk of mortality to 57% when compared to those with stable TIBC levels.31 In agreement with a previous study,21 our investigation found considerably higher levels of TIBC (194.66 ± 36.97 vs 206.46 ± 48.98, p = 0.027).

Lastly, there was a significant improvement in the nutritional status of our study population in terms of daily intake of proteins, carbohydrates, fats, and total calories. The nutritional status of hemodialysis patients can be improved by oral nutritional supplements that can supply an additional 7–10 kcal/kg per day of energy and 0.3–0.4 gm/kg per day of protein to fulfill daily energy and protein consumption.7 In a previous study, an increasing trend (p = 0.08) in relative protein intake was observed in the supplement group after 6 months.32 Another study found that supplement groups consumed more total calories (approximately 250 kcal mean), energy, fat, protein (12 mg on average), and fiber at 3 and 6 months.27 Therefore, in our investigation, improved dietary intake was associated with an overall improvement in the nutritional status of MHD patients, as shown by SGA and MIS scores (indicating a well-nourished condition). Additionally, our oral supplement showed improved body composition following supplementation, probably converting the catabolic effect of the dialysis therapy to an anabolic condition.

Beyond protein and calories, our supplement included a range of micronutrients (vitamins, trace elements, and fiber) that MHD patients ordinarily insufficiently consume/absorb, which may be the reason we saw the desired benefits in our study population. None of the patients reported any adverse effects related to our nutritional supplement, and it was very well tolerated.

**Conclusion**

Malnutrition is a key contributor to the risk of complications in MHD patients; hence, its prevention is essential for extending life. Giving nutritional supplements for at least three months (as advised by KDOQI standards) may make it simple and affordable to reverse PEW and, consequently, the risk of short-term death. The positive findings of our study support the ardent recommendation of oral nutritional supplements for CKD patients undergoing MHD.

**Practical Application**

Although hemodialysis successfully delays otherwise impending death, the morbidity and mortality risk in MHD patients remains unacceptably high. The prevention of malnutrition is critical since it contributes significantly to the high rates of hospitalization, infection, comorbidities, and poor quality of life experienced by MHD patients. Our study’s positive findings support the use of oral nutritional supplements for CKD patients undergoing MHD.

**Limitations of the Study**

It was a short-duration study. A study on the impact of long-term oral nutrition supplementation (6–12 months) in CKD patients who are on MHD suffering from PEW can be explored further to improve malnutrition and PEW status.

**Funding**

This work was supported by Dr Reddy’s Laboratories Limited, Ameerpet, Hyderabad, Telangana, India.

**Consent for Publication**

The author consents to Editorial Board to publish the paper. The author(s) accept responsibility for publishing this material in his own name, if any.

**Availability of Data and Materials**

The data analyzed is available from the corresponding author and could be available at a reasonable request.

**Ethics Approval and Consent to Participate**

Ethics approval for the study was obtained from the Institutional Ethics Committees of BAN Hospital, Mumbai, Maharashtra, India.

**Authors’ Contributions**

All the authors were responsible for the conception and design of the study, acquisition of data, analysis and interpretation of data, drafting of the article, and final approval of the version to be published. Dr Rachana M Bhoite and Praneeth Immadiseti helped conceptualize and design the study. Dr Arun Shah and Dr Rachana M Bhoite supervised and approved the final draft of the study. Praneeth Immadiseti monitored and supervised the study. Dr Wasil Shaikh and Dr Ruta Deshmukh helped with data collection during the study. Dr Rahul Rathod and Dr Vinita Satyavrat provided input and scientific support during the study period. All authors critically reviewed all manuscript drafts and provided comments. All authors gave their approval for the final version to be published. Dr Rachana M Bhoite is the guarantor of this work and, as such, takes full responsibility for the integrity and accuracy of the data analysis.

**CTRI Registration Number**

CTRI/2022/04/041763.

**Conflicts of Interest**

The study investigators received a research grant from Dr Reddy’s Laboratory, India, and as such, they report no conflict of interest for the study product used. Dr Rachana Bhoite, Praneeth Immadiseti, Dr Rahul Rathod, and Dr Vinita Satyavrat are all Dr Reddy’s Laboratory, India employees.

**Acknowledgments**

The authors would like to thank Dr Deepak Langade, Professor and Head, Pharmacology, D Y Patil University School of Medicine, Navi Mumbai, and Catalyst Clinical Services Pvt. Ltd. for their support with statistical analysis, data interpretation, writing assistance, and paper submission.

**References**

Oral Nutritional Supplementation for CKD Patients


