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Effect of Normal Versus High-Protein Enteral Nutrition on Malnutrition and Anthropometric Parameters in Critically Ill Patients

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Abstract

Aim: This study investigates the effects of normal versus high-protein intake on malnutrition and anthropometric parameters in critically ill patients receiving enteral nutrition (EN) in the intensive care unit (ICU).

Study Design: Conducted between July and October 2022, this study included 42 patients aged 19-64 years who were receiving EN support. Participants were divided into two groups: 21 patients in the normal-protein group (0.8-1.2 g/kg/day) and 21 patients in the high-protein group (>1.2 g/kg/day). Anthropometric measurements, including upper mid-arm circumference, calf circumference, knee height, body weight, and height, were taken on days 1, 3, 5, and 15.

Results: The average age of participants was 47.1±13.2 years. No significant differences were found between the groups in baseline characteristics (p>0.05). Protein intake was significantly higher in the high-protein group (p<0.05); however, there were no statistically significant differences between groups in changes in upper mid-arm circumference, Body Mass Index (BMI), or Nutritional Risk Screening 2002 (NRS-2002) scores (p>0.05). Within-group comparisons showed significant improvements in both NRS-2002 and Acute Physiology and Chronic Health Evaluation II (APACHE II) scores over time (p<0.05). There were no significant differences in age, gender, marital status, weight, height, or BMI between the two groups (p>0.05). The average weight, height, and BMI across participants were 75.57±13.97 kg, 171.26±8.51 cm, and 25.72±4.26 kg/m^2, respectively. Protein intake on Day 1 (90.36±9.2 g) and Day 15 (90.36±9.2 g) in the high-protein group was significantly higher than in the normal-protein group (p<0.05). No significant differences were found between groups in terms of knee height, upper mid-arm circumference, or reference percentile values (p>0.05).

Conclusions: This study found no significant relationship between protein intake and upper mid-arm circumference, BMI, or NRS-2002 scores. Further research with a larger sample size and longer follow-up period is needed to confirm these findings.

Keywords: Anthropometric measurements; Enteral nutrition (EN); Intensive care unit (ICU); Malnutrition; Nutritional Risk Screening 2002 (NRS-2002).

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Introduction

Nutritional support in the intensive care unit (ICU) plays an important role in the treatment of critically ill patients. ICU patients are at high risk of malnutrition, and their immune systems are often compromised due to underlying medical conditions. Research shows that malnutrition further suppresses the immune system, leading to longer hospital stays and increased mortality rates.[1] Malnutrition occurs when a person does not receive adequate nutrition. It alters body cell mass and composition, causes muscle tissue loss, impairs physical and mental functions, and worsens the patient's overall condition.[2] Muscle mass plays a critical role in the survival rates of ICU patients. In the first 10 days of ICU admission, patients can lose up to 1 kg of muscle mass per day due to a catabolic state. Additionally, reports indicate a fourfold increase in nitrogen losses within the first 24 hours. Overall, reports suggest that ICU patients receive a low amount of protein (an average of 0.6 g/kg/day) during the first two weeks of admission. Malnutrition has emerged as a global issue among ICU patients. The prevalence of malnutrition among ICU patients is 80% in developing countries and 50% in developed countries.[3]

Malnutrition in critically ill ICU patients is a widespread issue that adversely affects prognosis, immune function, and the duration of hospital stay. Early and adequate nutritional support, particularly protein intake, plays a crucial role in patient outcomes. However, the literature is inconclusive about the optimal amount and timing of protein intake, especially during the acute phase of illness. Although various guidelines from the European Society for Clinical Nutrition and Metabolism (ESPEN) and the American Society for Parenteral and Enteral Nutrition (ASPEN) recommend 1.2-2.0 g/kg/day of protein for ICU patients, clinical practice often falls short of these targets. The literature contains inconsistencies regarding how different protein levels affect malnutrition and anthropometric outcomes. The present study addresses this gap by evaluating the effects of normal versus high-protein enteral nutrition (EN) on malnutrition and selected anthropometric measures. It is emphasized that initiating a high-protein diet for ICU patients shortens the recovery process and reduces the prevalence of malnutrition.[4] A recent retrospective cohort study found that patients receiving more than 0.7 g/kg/day of protein during the first three days of ICU admission had higher 60-day survival rates compared to those receiving lower amounts. Researchers have reported that providing early protein support to critically ill patients improves their chances of survival in the ICU. In another study involving 455 adult ICU patients, low-protein intake (<0.8 g/kg/day) before the third day and high-protein intake (>0.8 g/kg/day) after the third day were associated with reduced 6-month mortality. Additionally, the study recommends that protein intake in ICU patients should be gradually increased to 0.8-1.2 g/kg/day on days 3 to 5, and to more than 1.2 g/kg/day from day 6 onwards.[5] Based on clinical trials, ESPEN recommends that ICU patients receive 1.3 g/kg/day of protein. The American Society for Parenteral and Enteral Nutrition recommends 1.2 to 2 g/kg/day of protein.[6] The timing of protein intake is one of the most debated topics regarding protein targets in ICU patients. Studies have shown that an intake of 1.0 g/kg/day during the early stages of illness is associated with reduced mortality.[7, 8] However, various studies have also reported adverse outcomes due to early high-protein intake. This may be because the patient's ability to utilize nutrients during the acute stress phase is significantly impaired; therefore, early high-protein intake is not beneficial.[9] Providing critically ill patients with high amounts of protein after injury reduces endogenous proteolysis, which is believed to help minimize muscle loss in these patients.[2] Our prospective cohort study aimed to investigate the effects of high-protein enteral nutrition therapy on the nutritional status and selected blood parameters of ICU patients.

Materials and Methods

The study was conducted with 42 patients aged 19-64 who met the inclusion criteria and were hospitalized between July and October 2022. The manuscript now includes a clarification that the sample size was determined based on Cohen's effect size recommendations for a small-to-moderate effect, with a power of 0.8 and an alpha of 0.05.

The study was conducted in accordance with the Declaration of Helsinki.

The inclusion criteria for the study were individuals aged 19-64 years who were receiving enteral nutrition support in the ICU. The exclusion criteria were as follows: patients receiving renal replacement therapy (including those with acute or chronic kidney failure, acute kidney injury (AKI), or end-stage kidney failure); patients with hepatic encephalopathy (advanced stage); abdominal distension; diarrhea; gastric regurgitation; patients who developed sepsis during the nutrition period; patients with a blood urea nitrogen (BUN) value >60; patients with a history of kidney or other organ transplants; patients with organ failure; those who died within seven days of starting enteral feeding; and patients receiving parenteral nutrition. Individuals who did not meet the study criteria were excluded. A BUN value >60 mg/dL was used as an exclusion criterion to minimize the inclusion of patients with undiagnosed or developing renal dysfunction. While we acknowledge that AKI staging is a more sophisticated approach, BUN was selected due to its immediate availability in routine ICU evaluations. The questionnaire consists of four main sections: (1) general information about the participants (gender, age, marital status, reason for ICU admission, weight, and height); (2) biochemical blood findings (albumin, C-reactive protein (CRP), alanine aminotransferase (ALT), aspartate aminotransferase (AST), blood urea nitrogen, insulin, and glomerular filtration rate (GFR)); (3) anthropometric measurements (mid-upper arm circumference, calf circumference, and knee height); and (4) enteral nutrition information (the patient's energy and protein requirements, the enteral product administered, and the actual energy and protein intake). Additionally, the Nutritional Risk Screening 2002 (NRS-2002) and the Acute Physiology and Chronic Health Evaluation II (APACHE II) scoring systems were used.

In this study, patients who had not received any individual intervention by the researcher were classified as ICU patients receiving enteral nutrition support with either high-protein or normal-protein content, based on the protein content of the products they received. As a cross-sectional comparative study, this research included 21 ICU patients receiving high-protein enteral nutrition (≥1.2 g/kg/day) and 21 patients receiving normal-protein enteral nutrition (0.8-1.2 g/kg/day) (Fig. 1).

Approval for the study was obtained from the Scientific Research and Publication Ethics Committee of Eastern Mediterranean University, Health Sub-Ethics Committee, with decision number ETK-00-2022-06, dated 10.05.2022. To conduct the study and access patient files, permission was also granted by the İzmir Provincial Directorate of Public Hospitals Services of the Ministry of Health of the Republic of Türkiye, with approval number 77597247/354, dated 30.0.2022.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics 22. The Kolmogorov-Smirnov and Shapiro-Wilk tests, the Student's t-test, and Mann-Whitney U test were used for group comparison. The sample size was calculated based on Cohen's recommendations, and random sampling was employed. The paired sample t-test was used for normally distributed parameters, while the Wilcoxon signed-rank test was applied for non-normally

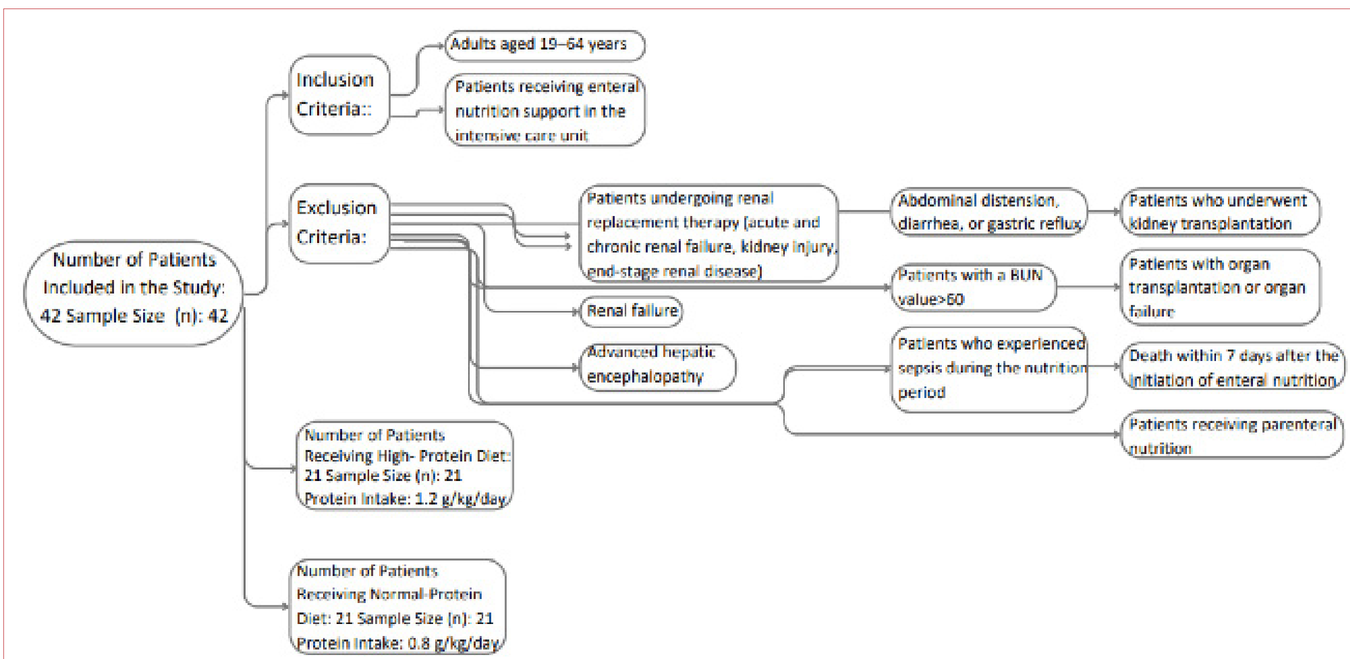

Figure 1. Flow Chart.

distributed parameters. Qualitative data comparisons were conducted using Fisher's Exact Chi-Square test, the Fisher-Freeman-Halton Exact Chi-square test, the Continuity Correction, and the McNemar test.

Results

The average age of the patients included in the study was 47.12±13.21 years. A total of 42 ICU patients participated, of whom 20 (47.6%) were women and 22 (52.4%) were men.

The distribution of gender, marital status, and age according to the type of enteral nutrition, along with the evaluation results, is presented in Table 1. No statistically significant differences were found between the enteral nutrition groups in terms of age, gender, or marital status (p=1.00), indicating a generally homogeneous distribution. Among individuals receiving both high-protein and normal-protein diets, 52.3% were male and 47.6% were female. The majority of individuals consuming a high--protein diet (33.3%) were in the 50-59 age group, and similarly, the majority of those on a normal-protein diet (42.9%) were also in the 50-59 age group (Table 1).

The distribution of diagnoses according to the type of enteral nutrition is also presented in Table 1. No statistically significant difference was observed between the groups regarding the distribution of underlying diseases (p=0.281). In the high-protein group, the most common reason for ICU admission was orthopedic trauma (33.3%), while in the normal-protein group, it was also orthopedic trauma (52.4%) (Table 1).

Table 1 also presents the distributions and evaluation results of anthropometric measurements based on the type of enteral nutrition. No statistically significant differences were found between the groups in terms of average weight, height, or Body Mass Index (BMI) (p=0.828, p=0.202, and p=0.526, respectively).

The average weight, height, and BMI of all participants were 75.57±13.97 kg, 171.26±8.51 cm, and 25.72±4.26 kg/m^2, respectively.

As shown in Table 2, no statistically significant difference was observed between the enteral nutrition groups in terms of NRS-2002 scores on Day 1 and Day 15 (p>0.05).

In the high-protein group, the change in NRS-2002 scores from Day 1 to Day 15 was statistically significant (p+0.001). On Day 1, the rate of severe malnutrition was 90.5%, which decreased to 4.8% by Day 15.

Similarly, in the normal-protein group, the change in NRS-2002 scores from Day 1 to Day 15 was also statistically significant (p+0.001). The severe malnutrition rate was 90.5% on Day 1 and dropped to 0% on Day 15.

Table 1. Clinical and demographic characteristics of participants

	All Patients	High Protein	Normal Protein	p
Gender, n (%)				
Female	20 (47.6)	10 (47.6)	10 (47.6)	1.000
Male	22 (52.4)	11 (52.4)	11 (52.4)	
APACHE II score, (mean±SD)	22±2	22±2	21±3	0.131
Age (years), (mean±SD)	47±13	46±15	48±11	0.558
Weight (kg), (mean±SD)	75.57±13.97	70.05±15.85	75.09±12.19	0.828
Height (cm)	171.26±8.51	172.95±8.61	169.57±8.27	0.202
BMI (kg/m^2)	25.72±4.26	24.30±4.47	26.14±4.09	0.526
Reason for ICU admission, n (%)				
Oncology	6 (14.3)	5 (23.8)	1 (4.8)	
Infection	10 (23.8)	6 (28.6)	4 (19)	
Cerebrovascular disease	5 (11.9)	3 (14.3)	2 (9.5)	
Mesenteric ischemia	1 (2.4)	0 (0)	1 (4.8)	0.281
Internal medicine	1 (2.4)	0 (0)	1 (4.8)	
Orthopedics and trauma	18 (42.9)	7 (33.3)	11 (52.4)	
Cardiovascular disease	1 (2.4)	0 (0)	1 (4.8)	

APACHE II: Acute Physiology and Chronic Health Evaluation II.

Table 2. Within-group changes in Nutritional Risk Screening 2002 (NRS-2002) and Acute Physiology and Chronic Health Evaluation II (APACHE II) scores

Parameter	Day 1 (Mean±SD)	Day 15 (Mean±SD)	p (within-group)
NRS-2002 (Normal)	High risk: 90.5%	High risk: 0%	0.001
NRS-2002 (High)	High risk: 90.5%	High risk: 4.8%	0.001
APACHE II (Normal)	21.05±2.54	20.48±2.54	0.036
APACHE II (High)	22.14±2.03	20.95±1.94	0.001

In Table 2, no statistically significant difference was found between the groups in APACHE II scores on Day 1 and Day 15 (p>0.05).

However, in the high-protein group, the decrease in APACHE II score from Day 1 to Day 15 was statistically significant (p=0.001).

In the normal-protein group, a statistically significant reduction in APACHE II score was also observed from Day 1 to Day 15 (p=0.036).

Table 3 shows that there was no statistically significant difference between the enteral nutrition groups in upper mid-arm circumference percentile values on either Day 1 or Day 15 (p>0.05).

In the high-protein group, there was no statistically significant change in upper mid-arm circumference percentile values on Day 15 compared to Day 1 (p>0.05).

Similarly, in the normal-protein group, no statistically significant change was observed in upper mid-arm circumference percentile values between Day 1 and Day 15 (p>0.05).

Table 3. Comparison of anthropometric measurements between groups

Measurement	Normal Protein	High Protein	p
Upper Mid-Arm Circumference	NS	NS	>0.05
Calf Circumference (Day 1)	44.62±14.58	33.95±3.51	0.001
Calf Circumference (Day 15)	42.62±8.95	33.95±3.51	0.001
Knee Height	NS	NS	>0.05

NS: Not Significant. All values rounded for clarity.

Table 4. Selected laboratory findings

Parameter	Group	Day 1 (Mean±SD)	Day 15 (Mean±SD)/ p
Albumin (g/dL)	Normal Protein	26.24±5.23	24.57±4.26/0.045
Albumin (g/dL)	High Protein	24.38±3.72	23.57±4.61/>0.05
CRP (mg/dL)	Both Groups	>normal range	>normal range/>0.05

As shown in Table 4, albumin levels on both Day 1 and Day 15 in all cases from both the high-protein and normal-protein groups were above the reference range. Therefore, a comparison could not be performed.

In the high-protein group, the CRP level was within the normal range in one case (4.8%) on both Day 1 and Day 15, while in 95.2% of cases, CRP levels remained above the reference range. In the normal-protein group, all patients had CRP values above the normal range on both days. No statistically significant difference was found between the two groups (p>0.05).

According to Table 5, intra-group comparisons revealed no statistically significant changes in upper mid-arm circumference, calf circumference, or knee height averages between Day 1 and Day 15 in either the high-protein or normal-protein group (p=0.692).

In Table 5, no statistically significant changes were observed in mid-upper arm circumference and mid-thigh circumference averages between the enteral feeding groups on Days 1 and 15 (p=0.165).

However, the average calf circumference on both Day 1 and Day 15 was statistically significantly lower in the high-protein group compared to the normal-protein group (Day 1: 44.62±14.58 vs. 33.95±3.51, p=0.001; Day 15: 42.62±8.95 vs. 33.95±3.51, p=001).

Discussion

Although several previous studies have reported that high-protein intake improves muscle mass and nutritional status in critically ill patients, our findings did not show significant differences in anthropometric parameters, such as mid-upper arm and calf circumference, between the high-protein and normal-protein groups over the 15-day period. This contrasts with the prior literature, where prolonged high-protein intake has been associated with better preservation of lean mass.[7]

Table 5. Comparison of mid-upper arm circumference, calf circumference, and knee height values by enteral feeding method

	All Patients		High Protein		Normal Protein		p
Arm Circumference							
Day 1	27.81±4.59 (27.5)	16-38	27.52±4.25 (28)	18-38	28.1±5 (27)	16-36	[1]0.692
Day 15	27.55±4.62 (27.5)	16-37	27.43±4.07 (28)	18-37	27.67±5.22 (27)	16-36	[1]0.870
[a]p			0.162		0.165		
Calf Circumference							
Day 1	39.28±11.78 (37)	28-64	[2]0.001*	30-43	44.62±14.58 (41)	28-64	
Day 15	38.28±8.02 (37)	28-64	[2]0.001*	30-43	42.62±8.95 (41)	28-64	
[b]p			1.000		0.102		
Knee Height							
Day 1	40.43±5.31 (41)	32-54	42.9±6.05 (43)	31-54	41.67±5.76 (41)	31-54	[1]0.166
Day 15	40.43±5.31 (41)	32-54	42.9±6.05 (43)	31-54	41.67±5.76 (41)	31-54	[1]0.166
[a]p	1.000				1.000		

[1]Student's t-test; [2]Mann-Whitney U Test; [a]Paired samples t-test; [b]Wilcoxon signed-rank test. *p<0.05.

This study did not find a statistically significant advantage of high-protein intake over normal-protein intake in terms of anthropometric or most biochemical outcomes. However, both groups demonstrated within-group improvements in nutritional risk and disease severity scores, suggesting that enteral nutrition (EN) in general may offer benefits. The study included 42 patients aged 18-64 years, with an average age of 47.12±13.21 years. Participants were divided into two groups receiving either high-protein or normal-protein enteral products, with a gender distribution of 52.3% male and 47.7% female in both groups.

The short follow-up period (15 days) and reliance on basic anthropometric measurements may have limited the ability to detect significant differences. Future studies could incorporate CT imaging, BIA, or functional assessments such as handgrip strength to provide more sensitive evaluations of nutritional status. A longer study duration would also better reflect changes in body composition.

This study also included patients in the 50-59 age range. In a separate study involving 757 ICU patients, 55.5% were male and 44.5% were female.[10] Various studies have shown that the majority of ICU patients are of advanced age, and this factor affects mortality. In a study conducted by Machado et al.,[11] 348 ICU patients were included, with an average age of 59.6±16.7 years. Similarly, in other study by Ishtiaq et al.[12] in 2018, the average age was 55.8 years. Fetterplace et al.[13] in 2018 included 60 ICU patients in their study; the average age of those receiving low-protein nutrition was 65±15 years, while the average age of those receiving high-protein nutrition was 66±16 years.

Regarding the distribution of diagnoses among patients receiving enteral nutrition, a significant proportion of both high-protein and normal-protein recipients belonged to the orthopedic and trauma group, accounting for 52.4% of the sample.

Singer et al.[14] compared patients receiving high-protein (>1.2 g/kg/day) and normal-protein (0.8-1.2 g/kg/day) enteral nutrition. To assess malnutrition, they measured mid-upper arm circumference, calf circumference, and knee height. The mid-upper arm circumference is a key indicator of muscle, fat, and bone mass loss. Changes in this measurement can reflect a variety of conditions. The purpose of measuring mid-upper arm circumference is to detect changes in body weight and, consequently, to assess the level of malnutrition and the energy/protein balance. In a study mid-upper arm circumference of less than 26 cm in men was identified as an indicator of increased mortality risk. The study also suggested that mid-upper arm circumference is an effective marker for identifying malnutrition in elderly individuals over 60 years of age with prolonged ICU stays.[15] According to recent research, there is a negative correlation between the presence of sarcopenia and mid-upper arm circumference (MUAC), with individuals diagnosed with sarcopenia exhibiting lower MUAC values. A similar association has been observed with calf circumference measurements (cm) as well.[16] In the present study, no statistically significant differences were found between the high-protein and normal-protein groups in terms of albumin, creatinine, CRP, ALT, AST, GFR, fasting blood sugar, lymphocyte count, or hemoglobin levels. However, a significant difference in BUN levels was observed between Day 1 and Day 15 within the high-protein group. In ICU patients, blood albumin levels typically decrease during periods of malnutrition. Due to an increase in extracellular fluid, albumin levels in the blood may decrease. In ICU patients, reduced albumin levels are commonly observed in conditions such as septic shock, trauma, sepsis, and post-surgical interventions. A serum albumin level below 3 g/dL is known to be associated with increased mortality and morbidity in ICU patients.[17] In the present study, no significant difference in albumin levels was found between the high- and normal-protein intake groups. However, in a study significant decrease in albumin levels was observed on Days 5 and 10 in enterally fed ICU patients.[18] To effectively observe the impact of high-protein intake in enterally fed individuals, monitoring serum albumin levels in the blood over a longer period, such as three to four weeks, may be necessary. In another study involving ICU patients, 30-day and 90-day mortality rates were evaluated, and it was found that patients receiving high protein showed a significant increase in albumin levels.[19] Unlike serum albumin, CRP is an acute-phase reactant and a marker of immune system activity. CRP levels rise in response to infection and metabolic stress and are affected by various pathological conditions.[20] In the current study, no difference in CRP levels was observed between the high- and normal-protein intake groups. However, a separate study reported that CRP levels were lower in patients receiving high-protein nutrition.[19] In other study compared high- and low-protein support groups in their study on enteral nutrition in ICU patients. Their findings showed significant differences in ALT, AST, CRP, and creatinine levels, results that differ from those of the present study.[21] The average energy requirement for individuals in the high-protein group was 2879.18±519.2 kcal/day, while it was 2769.5±571.93 kcal/day for the low-protein group. The energy fulfillment rates were 58.3% for the high-protein group and 60.6% for the low-protein group. These findings indicate that the patients in this study did not meet their calculated energy requirements. Daily energy needs for patients in critical care can be estimated using indirect formulae such as Schofield or Harris-Benedict equations. In this study, patients' energy requirements were determined using the Harris-Benedict equation. According to the guidelines from ESPEN and other studies, it is recommended that patients initially receive 20-25 kcal/kg/day to reduce the risk of complications. If no complications occur, patients should progress from the catabolic phase to the anabolic phase, with an intake of 25-30 kcal/kg/day.[22] At the International Protein Summit, the impact of high-protein intake on ICU patients was discussed. It was recommended to administer 1.2 g/kg/day of protein to reduce the prevalence of malnutrition and mortality in ICU patients. Achieving the target protein intake within the first week of ICU admission should be a primary goal. According to research, high-protein enteral nutrition plays a crucial role in preventing refeeding syndrome, establishing protein balance in the body, and increasing insulin sensitivity in ICU patients.[23] As is known, the primary component of protein is nitrogen. Urea nitrogen is excreted in the urine, typically ranging from 8 to 35 g. Total nitrogen loss occurs through both feces and urine and constitutes daily nitrogen loss. It is known that 1 g of nitrogen corresponds to 2 g of urea, 30 g of muscle, or 6.25 g of protein.[8] According to ESPEN guidelines, ICU patients should receive at least 1.3 g/kg of protein. Studies have shown that high-protein enteral nutrition in ICU patients reduces malnutrition, mortality, and length of hospital stay.[24] However, the effectiveness of high-protein enteral nutrition on malnutrition and mortality varies depending on the type of disease. For example, when sarcopenic patients received 1.2 g/kg/day of protein, there was a noticeable improvement in blood parameters and nutritional status compared to those receiving 0.8 g/kg/day. In contrast, the same effect was not observed in septic patients, likely due to resistance to protein supplementation.[7] In the ICU, protein administration should be introduced gradually. In one study, ICU patients were given 1.2 g/kg/day of protein starting from the first day, and improvements in muscle development and malnutrition were observed. Koekkoek et al.[25] began with 0.8 g/kg/day of protein and increased the amount to 1.2 g/kg/day by the fifth day, resulting in improvements in both blood values and nutritional status. In the present study, high protein intake was defined as >1.2 g/kg/day, and normal protein intake was defined as 0.8-1.2 g/kg/day. Patients were monitored for a period of 15 days.

To assess nutritional status, the NRS-2002 screening tool was used. No statistically significant difference was found between the enteral nutrition groups in NRS-2002 scores on Day 1 and Day 15 (p>0.05). In a study by Zhang et al.[26] in 2020, ICU patients with an NRS-2002 score of ≥3 were considered at nutritional risk, and this applied to 87.1% of their study population.

The discrepancy may be attributed to the relatively short follow-up duration, patient fluid variability, or the limited precision of bedside anthropometric tools.[26, 27] Additionally, the actual difference in protein intake between the two groups may have been too modest to produce measurable changes within this timeframe.

Importantly, both groups exhibited significant within-group improvements in NRS-2002 and APACHE II scores, indicating a potential clinical benefit from nutritional support itself, regardless of protein level. These results align with evidence suggesting that enteral nutrition can stabilize critically ill patients even in the absence of visible anthropometric changes. Future research employing more sensitive tools, such as bioelectrical impedance analysis (BIA), computed tomography (CT) imaging, or functional assessments, over longer follow-up periods is needed to detect more subtle changes in nutritional status.[27, 28]

The study revealed that the average APACHE II score in the high-protein group decreased from 20.71±2.24 to 21.59±2.34, indicating an improvement in disease severity. The research emphasized the importance of assessing both CRP and albumin levels, as no single blood parameter alone can reliably indicate malnutrition risk. CRP levels in the high-protein group exceeded the standard reference range.

No significant changes in CRP levels were observed between the high- and normal-protein groups on either the first or fifteenth day of enteral feeding in the ICU. This lack of variation may be due to the relatively short 15-day observation period. Additionally, there was no difference in mid-upper arm circumference percentiles between the high- and low-protein groups.

In this study, no statistically significant relationship was found between protein intake on the first day and BMI, mid-upper arm circumference, APACHE II, NRS-2002, or CRP levels ($p>0.05$).

However, there was a moderate, inverse (43.4%), and statistically significant correlation between protein intake on the fifteenth day and the NRS-2002 score ($p=0.049$; $p<0.05$). No statistically significant relationships were found between protein intake on the fifteenth day and BMI, mid-upper arm circumference, APACHE II, CRP, or albumin levels ($p>0.05$). In other study onducted a similar study and reported comparable results, suggesting that BMI and mid-upper arm circumference are not associated with protein intake.[27] The absence of a significant relationship between CRP and protein levels in this study may be attributed to the rapid, time-dependent variability of metabolic functions in ICU patients. This variability may prevent the suppression of protein catabolism, even with increased protein intake, when compared to healthy individuals. In this study, it is suggested that the short follow-up period may have influenced the results.[28] Additionally, the administration of high-protein enteral nutrition to ICU patients during the acute phase may impair absorption in intestinal cells due to an excess of amino acids. This may have increased mucosal inflammation, leading to elevated CRP levels. Therefore, the lack of a significant relationship between protein intake and CRP in this study could be attributed to this factor.[29] Tian et al.[30] in 2015 conducted a study on ICU patients and, in contrast to the present findings, reported a positive relationship between APACHE II and CRP levels in patients receiving high-protein enteral nutrition.

Limitations

This study has certain limitations:

- ICU patients may have had altered anthropometric measurements due to fluid shifts.
- Short duration of follow-up.
- Small sample size.
- Use of basic anthropometric measurements, which are prone to inaccuracies from fluid imbalance.
- No randomization, introducing potential confounding variables.

Conclusion

In critically ill ICU patients, higher protein intake (>1.2 g/kg/day) did not result in statistically significant differences in anthropometric parameters or key laboratory values compared to normal protein intake. However, both groups demonstrated internal improvements in nutritional status and severity scores over the 15-day period. Larger, longer-term studies utilizing more advanced assessment methods are needed.

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Informed Consent: Consent form was obtained from the patients included in the study or from their relatives.

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