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Plate waste and malnutrition in intensive care patients

Kevser Karlı[1], Mehtap Sarıaslan[2], Güzin Tümer[3]

[1]Department of Nutrition and Dietetics, Faculty of Health Sciences, Kastamonu University, Kastamonu, Türkiye
[2]The Intensive Care Unit, On Dokuz Mayıs University, Samsun, Türkiye
[3]Department of Dietetics, Health Practice and Research Hospital , Ondokuz Mayıs University, Samsun, Türkiye

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ABSTRACT

Objective: This study aimed to determine food waste rates in intensive care patients.

Methods: In this cross-sectional study, 45 patients in the intensive care unit were assessed for malnutrition risk using NRS 2002. Food waste rates were calculated by weighing the weight of the food served and left on the plate. Energy density of foods was calculated. The patients' energy and nutrient intakes were calculated. Evaluated according to the recommendations of the Türkiye Dietary Guidelines.

Results: 55.55% of the patients had severe malnutrition. Patients cannot consume 38.17% of the food served. The highest waste rate is in vegetables and salads (75.35%). The energy density of patients' food consumption is low. The patients' energy and protein intake was 828.56 kcal/day and 32.13 g/day. Energy and nutrient intake are below recommended, except for sodium and vitamin B12. A moderate positive correlation was found between hand grip strength and energy (r=413, p=0.001) and protein (r=453, p=0.001) intake.

Conclusion: Patients cannot consume approximately 40% of the food. Improved protein and energy intake increased muscle strength and performance. Since a decrease in food intake will cause malnutrition to worsen, there is a need to develop strategies to increase energy and protein intake in these patients.

Keywords: intensive care, malnutrition, plate waste, food intake

INTRODUCTION

Many Intensive care unit (ICU) patients struggle to maintain sufficient energy and nutrient intake. This insufficiency leads to increased catabolism, decreased fat tissue, and muscle mass loss, often resulting in severe malnutrition. The prevalence of malnutrition in ICU patients ranges between 38-78%[1], with a specific study in Turkey reporting a risk prevalence of 44.2%.[2]

Despite oral nutrition availability, ICU patients' nutritional needs are not fully met, making it challenging to reach target energy and protein levels promptly. Encouraging oral feeding and utilizing oral nutritional products can help improve daily intake, emphasizing the importance of considering food service quality in hospital settings.[3]

Several factors contribute to decreased food intake in ICU patients, including loss of appetite, the quality and appearance of hospital food differing from patients' usual diet, and delays in food service. Studies indicate that inpatients leave about half of the food served uneaten.[4,5] Simzari et al. highlighted the connection between plate waste and hospital malnutrition[6], underscoring the importance of addressing food waste in medical settings.

Although the optimal energy and protein intake for ICU patients remains uncertain, guidelines generally recommend an intake of 24-30 kcal/kg/day and 1.2-1.5 g/kg/day of protein.[7,8] Hospital diets designed for patients at risk of malnutrition typically provide approximately 30 kcal/kg of energy and 1.2-2.0 g/kg/day of protein.[9] Meals in hospitals in Türkiye are planned according to healthy

Corresponding author: Kevser Karlı
Email: kevserkarli@kastamonu.edu.tr

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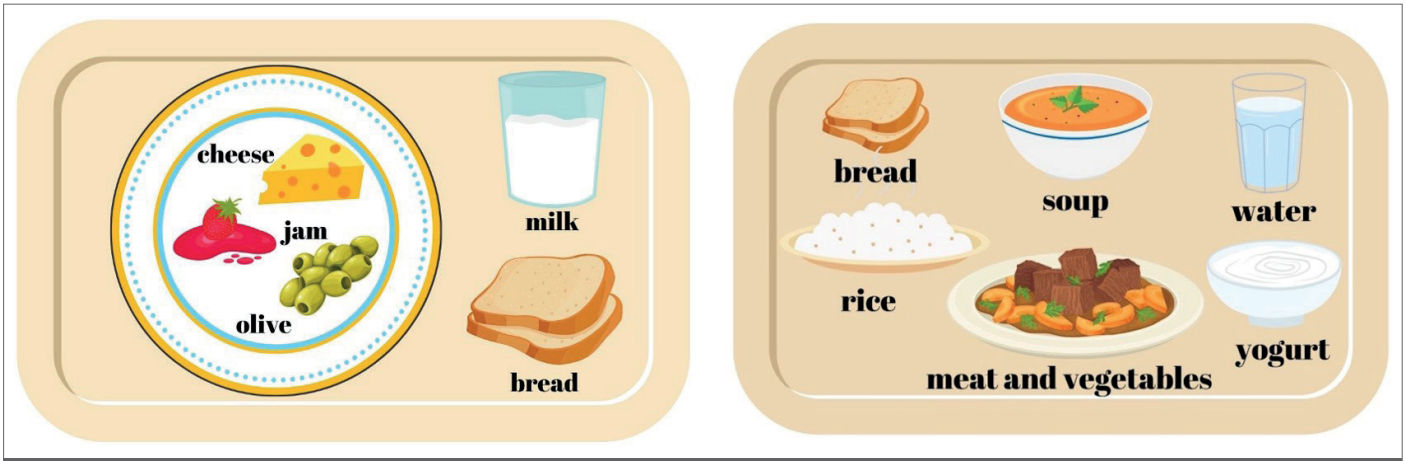

Figure 1. The typical structure of meals served in hospitals in Türkiye

nutrition principles, including foods from the dairy, meat, cereal, vegetable, and fruit groups, as illustrated in Figure 1.

Despite these efforts, the desire and capacity of ICU patients to consume food often diminish due to their deteriorating health status, making malnutrition inevitable. Thus, offering appetizing and appropriately textured foods that patients are more likely to consume can significantly increase food intake and reduce waste, serving as a crucial strategy in combating malnutrition.[10,11]

This study explores the relationship between food waste and malnutrition in ICU patients who can receive an oral diet.

Main Points

- The prevalence of malnutrition is high in intensive care unit patients.
- Intensive care patients leave approximately two-fifths of the meals served on their plates.
- In these patients, energy and nutrient intake remain below the daily recommended amounts.
- Oral enteral nutrition products are of vital importance for intensive care patients.
- Catering services and content should be improved in hospitals.
- A moderate positive significance was found between the rate of meeting the daily recommended amount of protein and hand grip strength.

METHODS

Study Desing

This cross-sectional study was conducted between November 2023 and March 2024 in the Intensive Care Unit of On Dokuz Mayıs University Adult Hospital Internal Medicine Clinic.

Ethical Approval

Ethical approval for the study was received from Ondokuz Mayıs University Clinical Research Ethics Committee (26.10.2023, No: 2023/206). Patients were informed about participation in the study, and written consent was obtained from the volunteers.

Participants

Patients aged 18 and over who were newly extubated and could achieve oral feeding, had no limb loss and could use a hand dynamometer were included in the study. To ensure patient compliance, two days after extubation, that is, on the third day of extubation, The study follow-up period started when the patient had a safe swallowing function and the ability to use his upper extremities in bed.

The patients were followed for 72 hours. During data collection, patients who were intubated, sedated, or died within 72 hours, patients whose treatment was stopped, patients who went hungry due to examination, patients whose food intake was stopped for any reason, patients who were transferred to another service, and patients who refused treatment were excluded from the study. All patients (N=124) who met the study criteria in the ward during the study period were included. Forty-five patients completed the study.

Data Collection Tools

Questionnaire: The questionnaire consists of general and health status information, hand grip strength data, and three-day food consumption records.

Data on general and health status: Information on the general and health status of the patients was obtained from hospital records. Patients with an NRS 2002 score of 3 and 4 were considered risky, and a score of 5 and above was considered high risk.[11]

Data related to hand grip strength: Hand grip strength was measured with a Camry Electronic Hand Dynamometer on the left hand, and it was repeated three times on the first and third days of the study. The patients were asked to squeeze the hand dynamometer with maximum isometric effort for five seconds in the measurements. The kg value on the LCD screen was recorded, and the measurements were averaged. The evaluation was made according to gender.

Food consumption records: Food consumption was recorded for three days (72 hours). To determine food consumption and waste amounts, the food served at meals, and the waste on the plate was measured using a Beurer KS 59 Kitchen Scale by recording the plate in grams.

The energy and nutrient intakes of the patients were analyzed with the Beslenme Bilgi Sistemi (BeBiS, İstanbul, TÜRKİYE) program and evaluated according to the rate of meeting the daily recommended intake of the Turkish Dietary Guidelines by gender. Daily recommended intake ≤66% was considered inadequate, 67-133% adequate, and >133% excessive.[12]

The energy density of the food consumed is calculated by dividing the energy (kcal) of the food by its quantity (g). The energy of the food was calculated using the BeBIS program and divided by quantity. The calculation excluded foods that have weight but do not contribute to energy intake, such as water and sugar-free drinks. The classification is very low <0.6 kcal/g, low 0.6-1.5 kcal/g, medium 1.6-3.9 kcal/g, and high 4.0-9.0 kcal/g.[13]

Statistical Analyses

The research data were analyzed with SPSS 23.0 (IBM SPSS Corp., Armonk, NY, USA) package program. General and health information of the patients, hand grip strength data, data on food consumption, and energy density values were evaluated by descriptive statistical methods. Box Plot graphs were used to evaluate the suitability of the data for normal distribution. A Paired Samples T-test was used to compare the first and third days' hand grip strength measurements. Patients' food consumption and waste rates on the plate were expressed graphically. Repeated measures ANOVA was used to compare the energy density of meals and days. A Paired Samples T-test was used to compare the food consumption of the patients with the daily recommended consumption amounts. The Pearson correlation coefficient was used to determine the relationship between energy, protein intake, and hand grip strength. The results were evaluated at a 95% confidence interval and $p<0.05$ significance level.

RESULTS

57.78% of the patients participating in the study were male. The mean age of the patients was 59.27±16.70 years. In addition to oral nutrition, 60.00% of the patients received enteral or parenteral nutrition. The daily target calorie intake was not reached in 92.60% of those receiving enteral or parenteral nutrition support. 37.78% of the patients did not consume their meals because of loss of appetite, 28.89% because the food's taste, odor, texture, and temperature were unsuitable, and 20.00% because of nausea. The distribution of information regarding the patients' general health status and anthropometric measurements is shown in Table 1.

The patients' mean NRS 2002 score was 5.38±1.28. Hand grip strength was 15.69±5.89 kg in males, 7.05±3.81 kg in females on the first day, 14.68±6.04 kg in males, and 6.30±4.06 kg in females on the third day. There was a statistically significant difference between the hand grip strength measurements on the first and third days in men ($p=0.228$).

According to the three-day food consumption records, the most common foods left on the plate by the patients were vegetables and salads (75.35%), rice-pasta-pastry-potato (57.84%), and syrup desserts (57.53%). The distribution of food left on patients' plates is shown in Figure 2. No statistically significant relationship was found between plate waste and hand grip strength ($p>0.005$).

The energy density of the foods consumed by the patients is given in Table 2. The highest energy density in meals was in breakfast ($P<0.005$). The energy density of all meals or days was low (less than 1 kcal/g/day). There was no statistically significant relationship between energy density and hand grip strength ($p>0.005$).

The average energy and nutrient intakes of the patients calculated from the three-day food consumption records and the rates of meeting the daily intake recommendations are given in Table 3. Except for sodium and vitamin B12, energy and nutrient intakes did not meet the daily recommended intake, and the results were statistically significant ($p<0.005$). A moderate positive correlation

Table 1. Distribution of information on the general, health status and anthropometric measures of patients			
General and health status		**n**	**%**
Gender	Male	26	57.78
	Female	19	42.22
Marital status	Single	10	22.22
	Married	35	77.78
Number of regular drug use	1-3	31	68.89
	4 and over	14	31.11
Reason for hospitalizations*	Oncological diseases	19	25.00
	Diseases of respiratory system	16	21.05
	Diseases of the cardiovascular system	13	17.10
	Gastroenterological diseases	8	10.52
	Diseases of the endocrine system	5	6.57
	Infection	5	6.57
	Sepsis/septic shock	3	3.94
	Diseases of the genitourinary system	2	2.63
	Hematological diseases	2	2.63
	Post-operative follow-up	2	2.63
	Diseases of the nervous system	1	1.31
Edema on the first day	Yes	19	42.22
	No	26	57.77
Nutritional routes	Oral	17	37.78
	Oral+enteral	5	11.11
	Oral+parenteral	23	51.11
Diet type	Liquid and soft diet	19	42.22
	Standart diet	26	57.78
Reason for enteral or parenteral nutiriton	Failure to reach target calories	25	92.60
	Aspiration risk	1	3.70
	Breathing problems	1	3.70
Reasons for not consuming meal	Loss of appetite	17	37.78
	Inappropriate taste, smell, texture and temperature of the food	12	28.89
	Nausea	9	20.00
	Difficulty chewing	6	13.33
	Breathing difficulties	1	2.22
Anthropometric measures		**X±SD**	
Hand grip strength	First day	12.05±6,65	
	Third day	11.15±6.70	
*More than one option is marked, the number n exceeds the sample size.			

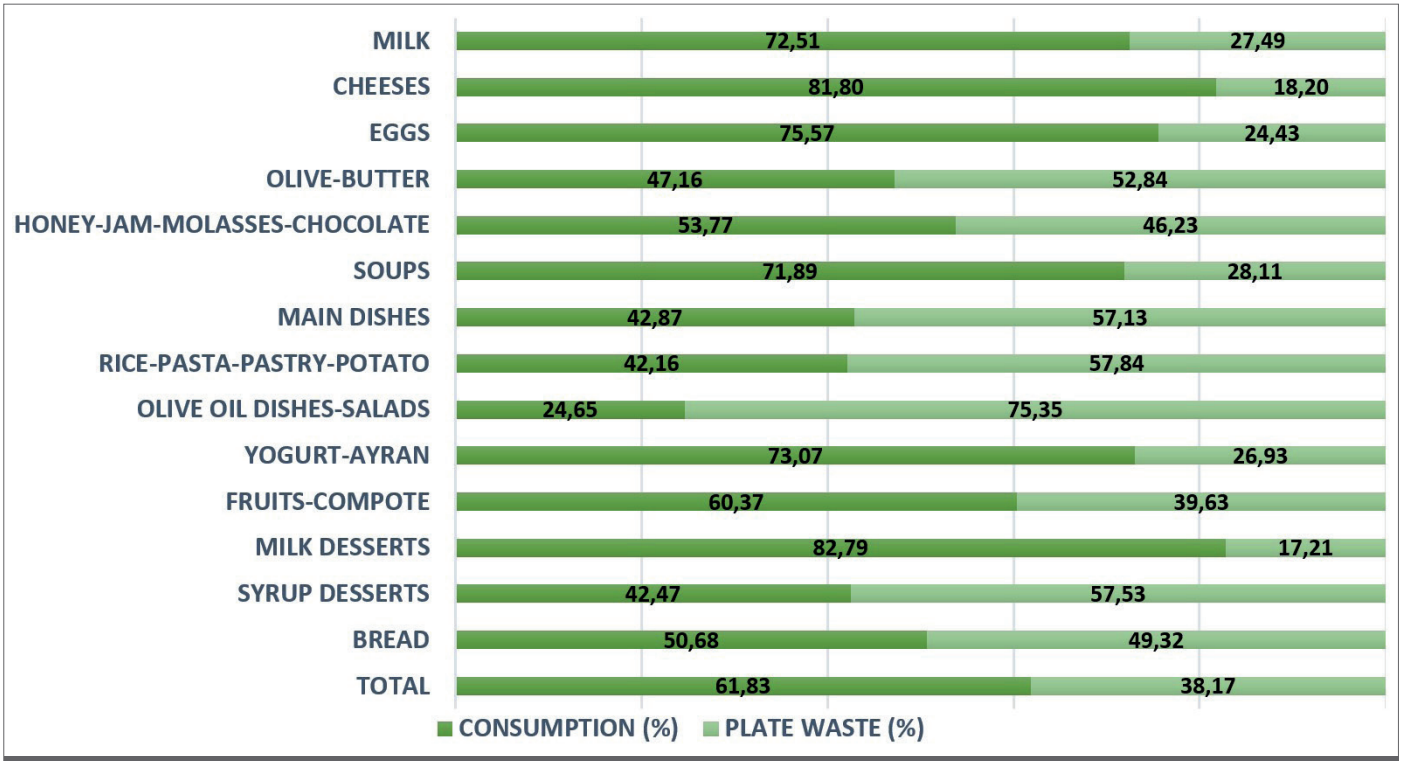

Figure 2. The distribution of food left on patients' plates

was found between hand grip strength and energy (r=413, p=0.001) and protein (r=453, p=0.001) intake, respectively.

DISCUSSION

In large-sample studies conducted in internal medicine wards and intensive care units, it has been reported that the prevalence of malnutrition is high, and one in every five patients has severe malnutrition.[14,15] In intensive care unit patients, the clinical general condition may worsen with the effect of malnutrition due to factors such as increased energy and nutrient requirements due to hypermetabolism, inflammation, trauma, and organ dysfunction.[3] In these patients, an individualized nutritional approach is required to meet the increased metabolic needs, reduce the negative effects of malnutrition, and support the healing process. Nutritional support in intensive care patients has been associated with favorable clinical outcomes, reduced complications, and improved overall prognosis.[3,10]

Table 2. The energy density of the foods consumed by the patients

		X±SD	P
Energy Density (kcal/g)	**Meals**		
	Breakfast	1.42±0.98	
	Lunch	0.71±0.27	0.001
	Dinner	0.79±0.35	
	Days		
	First day	0.98±0.40	
	Second day	0.93±0.33	0.752
	Third day	0.95±0.38	
	Total (Three days)	0.97±0.30	

Repeated Measures ANOVA

Table 3. Energy and nutrient intake calculated from a three-day diet record

Content	Total (n=45)	Male (n=26)			Female (n=19)		
	Food Consumption	Food Consumption	RDA (%)	P[1]	Food Consumption	RDA (%)	P[2]
	Mean	Mean	%		Mean	%	
Energy (kcal)	828.56	869.60	44.99	0.001	772.40	39.95	0.001
Carbohydrate (g)	84.68	90.67	32.88	0.001	76.48	27.74	0.001
Protein (g)	32.13	33.09	57.90	0.001	30.82	53.88	0.001
Fat (g)	39.56	40.97	62.42	0.001	37.64	57.37	0.001
Cholesterol (mg)	128.28	134.62	44.90	0.001	119.61	39.93	0.001
Fiber (g)	7.58	7.55	23.12	0.001	7.62	34.21	0.001
Vitamin A (µg)	520.26	520.25	58.13	0.001	520.27	73.83	0.019
Vitamin D (µg)	0.42	0.44	5.89	0.002	0.40	4.35	0.001
Vitamin E (mg)	8.71	8.52	66.46	0.001	8.97	59.79	0.001
Vitamin B1 (mg)	0.31	0.32	27.01	0.001	0.30	27.12	0.001
Vitamin B2 (mg)	0.71	0.75	58.15	0.001	0.65	59.28	0.001
Vitamin B3 (mg)	9.11	9.38	58.78	0.001	8.74	61.97	0.001
Vitamin B5(mg)	2.00	2.10	42.00	0.001	1.86	37.19	0.001
Vitamin B6 (mg)	0.48	0.50	32.81	0.001	0.46	32.09	0.001
Vitamin B7 (mg)	97.31	97.41	29.51	0.001	97.16	29.03	0.001
Vitamin B9 (µg)	14.03	14.57	48.60	0.001	13.29	44.26	0.001
Vitamin B12 (µg)	2.11	2.19	61.05	0.464	2.01	53.74	0.214
Vitamin C (mg)	20.27	20.00	22.26	0.001	20.63	27.33	0.001
Sodium (mg)	2167.81	2148.92	107.45	0.573	2193.65	109.68	0.593
Potassium (mg)	934.60	971.57	27.75	0.001	884.01	25.25	0.001
Calcium (mg)	433.40	460.72	40.31	0.001	396.02	34.21	0.001
Magnesium (mg)	107.35	111.44	27.01	0.001	101.76	31.67	0.001
Phosphorus (mg)	551.46	577.87	52.54	0.023	515.32	63.61	0.023
Iron (mg)	4.21	4.16	51.94	0.001	4.28	46.86	0.001
Copper (mg)	0.54	0.54	60.98	0.001	0.54	59.63	0.001
Zinc (mg)	5.03	5.15	47.09	0.001	4.87	60.25	0.001
Fluorine (µg)	178.27	182.22	4.56	0.001	172.86	5.70	0.001
Iodine (µg)	92.42	92.31	61.53	0.001	92.58	61.75	0.001

RDA (%): percentage of meeting the daily recommended consumption
P[1]: Comparison of male energy and nutrient intake with recommended amounts
P[2]: Comparison of female energy and nutrient intake with recommended amounts
Paired Simple T Test

The main aim of nutrition in intensive care units is to provide appropriate energy and nutrient needs according to the condition of the disease. Although meals prepared according to the patient's energy and nutrient needs are served from the hospital kitchen, the rate of leaving food on the plate is high for these patients due to loss of appetite, not liking the food, and being hungry due to the examinations performed. Gomes et al. reported that hospital food waste is 2-3 times higher than in other catering areas.[16] Kontogianni et al. reported that only 41.6% of inpatients consumed the entire meal served.[4] Schiavone et al. stated that 41.6% of the food served

to the patients was wasted, 30.4% were not hungry, and 13.6% left food on their plates because they did not like the taste of the food.[6] In this study, the main reasons why patients left food on the plate were loss of appetite (37.78%), inappropriate taste, smell, texture, and temperature of the food (28.89%), and nausea (20.00%) (Table 1).

Simzari et al. reported that the average plate waste rate for lunch and dinner during hospital stay was 37.7±29.88 and 30.4±23.61, respectively, and there was a link between plate waste and malnutrition.[6] In a study conducted in the USA, researchers reported that 32.1 percent of patients in intensive care units ate one-quarter or less of their meals. The authors found that the risk of hospital mortality was 3.24 times higher for patients who ate a quarter meal or less compared to those who ate all their meals and 5.99 times higher for patients who were allowed to eat but did not eat anything.[17] A study conducted in 2021 reported that 2 out of every five hospitalized patients were at risk of malnutrition. More than 50% of patients ate half or less of the hospital meals, and the risk of hospital mortality was up to 6 times higher in patients who ate very little or nothing.[18] In this study determined that 38.17% of the meals served to intensive care patients remained on the plate, and the most unconsumed meals were vegetable dishes and salads, with 75.35%. Regardless of the reason, consuming less or not consuming the food served in intensive care patients leads to deficiencies in energy and nutrient intake, exacerbating the disease and increasing mortality rates.[19]

Considering the tendency to eat small amounts of food in intensive care patients, serving foods with high energy density at meals is a good strategic nutrition approach. Foods with high energy density include cheeses, olives, butter, cream, hazelnut and peanut spreads, honey, jam and molasses. Enriching the meals served with these foods will increase energy intake.[13,20] In this study, the average energy density of the foods consumed daily by the patients was below 1 kcal/g. This means that the energy density is low. (Table 2). Practices such as adding cream to soup at lunch and dinner, serving pasta with cheese and olives, and dressing vegetable dishes and salads with healthy oils such as olive oil increase the energy density of the meal. The aromatic components in these foods add flavor and reduce plate waste.[12] However, if nutritional intake is less than necessary, trying to increase the energy density of the diet with meals may not be sufficient. Therefore, adding oral enteral nutrition products containing 1-1.5 g/kcal energy to the diet is vital in intensive care patients.

Authorities recommend that intensive care patients' energy intake be up to 70% of their nutritional requirement in the first week unless assessed by indirect calorimetry.[19] Wang et al. suggest that high energy intake is associated with lower mortality in patients with high nutritional risk and that at least 800 kcal/day energy intake is required to reduce mortality rates in the intensive care unit.[21] In a multicentre study by Alberda et al., the data of 2772 intensive care patients were analyzed. Although the average energy of the prescribed diets was 1794 kcal/day, it was determined that the patients received only 1034 kcal/day. The authors concluded that an energy increase of 1000 kcal daily was associated with reduced mortality.[22] A similar study by Nicolo et al. reported that the average energy consumption of 2828 patients who stayed in intensive care for four days or more was 1100 kcal, 64.1% of the prescribed amount.[23] In this study, the patient's three-day average energy consumption was 828.56 kcal/day. The percentage of meeting the daily recommended energy intake is 44.99% for men and 39.95% for women (Table 3). All of these results are below the authorities' recommendations. Additionally, this study found a moderate positive correlation between energy intake and hand grip strength.

Available data from studies conducted in intensive care units indicate that patients have low protein intake during the first two weeks of hospitalization. In their study, Alberda et al. reported that the average amount of protein in the prescribed diets was 87.5 g, and the patients consumed only 47.1 g/day.[22] In their study, Nicolo et al. reported that the average protein intake of intensive care patients was 51 g, meeting 60.5% of the prescribed amount. Researchers indicate that achieving ≥80% of prescribed protein intake reduces mortality.[23] In this study, patients' three-day average protein consumption was 32.13 g/day. The rate of meeting the daily recommended intake is 57.90% for men and 53.88% for women (Table 3). Inevitably, the protein needs of these patients cannot be met because approximately 20-30% of foods with high protein content and quality, such as milk, yogurt, cheese, eggs, and milk desserts served at meals, are left on the plate (Figure 2). In addition, one of the results showed moderate positive significance between protein intake and hand grip strength. This means that as protein intake increases, hand grip strength increases.

Micronutrient deficiencies may occur in intensive care patients due to decreased nutritional intake upon hospitalization, if not before.[24] Antioxidant micronutrients, particularly β-carotene, vitamin D, vitamin E, vitamin C, copper, iron, manganese, selenium, and zinc, tend to be lower in intensive care patients than healthy controls.[19] Similarly, in this study, there was a statistical difference between the micronutrient intakes of the patients and the recommended amounts, except for sodium and vitamin B12 (Table 3). However, essential minerals such as sodium, potassium, and magnesium are added, and fluid therapy

is applied in intensive care. This reduces micronutrient loss and meets the requirements. In addition, in patients with reduced nutritional intake, oral enteral products are an essential component of nutritional therapy to ensure daily intake of micronutrients. In standard enteral formulas, healthy individuals' recommended amount of vitamins and minerals is met when the daily enteral product intake is above 750 ml (2 kcal/g) or 1000-1500 ml (1 kcal/g). Therefore, additional enteral or parenteral vitamins and minerals should be provided if the patient cannot tolerate the enteral formulas given.[24]

Limitations

This research is one of the few studies determining food waste rates in intensive care patients. However, the amount of energy obtained from enteral and parenteral products has been neglected. In addition, there is a small number of samples, the inability to obtain biochemical findings of the individuals, and the failure to obtain anthropometric measurements of the patients due to their condition.

Malnutrition is common in intensive care patients. This study found that intensive care patients consumed only about two-fifths of the food served at meals. Plate waste increases the negative effects of malnutrition. Energy and protein intake are correlated with hand grip strength. Enriching the foods offered to these patients with cheese, olives, butter, cream, honey, and molasses, which have a high energy density, increase taste and reduce waste and malnutrition. Considering the link between plate wastage and malnutrition, there is a need to develop various strategies to reduce plate wastage rates in hospitals.

Ethical approval: The study was approved by the Ondokuz Mayıs University Clinical Research Ethics Committee (2023/206 / 26.10.2023).

Informed consent: Patients were informed about participation in the study, and written consent was obtained from the volunteers.

Author contributions: Concept – K.K., M.S.; Design – K.K., M.S.; Supervision – G.T.; Resources - K.K., M.S.; Materials - K.K., M.S., G.T.; Data Collection and/or Processing – M.S., G.T.; Analysis and/or Interpretation – K.K., G.T.; Literature Search - K.K., M.S., G.T.; Writing Manuscript - K.K., M.S., G.T.; Critical Review - K.K., M.S., G.T.; Other – K.K., M.S., G.T.

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