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The Nutritional Status of Patients Hospitalized in the ICUs of Iranian Hospitals: A Systematic Review

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Abstract

Background: Malnutrition is so common among hospitalized patients, especially those in intensive care units (ICUs). Providing adequate nutritional support for these patients is of utmost significance.

Aim: The present study was conducted with aim to investigate the nutritional status of patients hospitalized in the ICUs of Iranian hospitals.

Method: This systematic review was performed according to recommendations from the Cochrane Handbook. A search was conducted on Medline, Web of Sciences, PubMed, Scopus, and SID databases to find the articles on nutritional support for ICU patients hospitalized in Iran until April 9, 2023, using the keywords of "intensive care unit" OR "ICU" AND "nutritional support" and "Iran".

Results: Finally, 19 original, cross-sectional, prospective cohort, and retrospective articles conducted on human samples were entered in this study. Except for one study, all articles reported that the dietary intake was significantly lower among ICU admitted patients. Nutrition Risk in Critically Ill score, Acute Physiology and Chronic Health Evaluation (APACHE II), Nutritional Risk Screening-2002 (NRS), and Subjective Global Assessment (SGA) measurement tools were used to predict the rate of malnutrition among the patients. Recorded reports indicate low calorie and nutrient intake among patients during ICU stay.

Implications for Practice: The analyzed hospitals have unsuitable and inadequate nutritional care services. In addition, the patient's intake of calories, protein, and other daily nutrients was significantly lower than the recommended amount leading to a cascade of undesirable patient outcomes.

Keywords: Enteral Nutrition, Intensive Care Unit, Iran, Nutritional Support, Parenteral Nutrition

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Introduction

Literature review indicates that the frequency of undernutrition among hospitalized patients ranges from 18.2%-40% (1). Undernutrition incidence among critically ill patients is anticipated to be considerably higher due to a sharp rise in basal metabolic rate (2,3) and the existence of several circumstances that lead to the administration of enteral diets (1). In the Intensive Care Units, patients receive continuous medical attention in an effort to reduce the risk of serious outcomes, such as malnutrition, infection, and ultimately death (4). Nutritional therapy is crucial in the medical treatment of critically ill patients since it provides the targeted supply of energy and nutrients, avoids or minimizes the development of undernutrition, and corrects nutritional changes in undernourished patients (5). In addition, nutritional therapy has lately been shown to serve a fundamental therapeutic function, directly influencing disease pathophysiology and, consequently, the clinical result (6), and play a vital role in reducing and managing patients' morbidities (7,8).

Recent evidence supports the hypothesis that nutrients and nutritional treatments affect the underlying illness process and patient outcomes (9); therefore, the focus has shifted from nutrition as support to nutrition as therapy. Without compulsory feeding, such as enteral nutrition (EN) through a tube put into the GI tract or parenteral nutrition (PN) straight into the bloodstream, ICU patients who are unable to nourish themselves orally quickly become malnourished (10). Unless a serious problem would delay the start of enteral feeding, it is preferable to use enteral nutrition rather than parenteral nutrition. Early enteral nutrition (starting 24-48 hours after admission) is the first line of recommended nutrition support since it lowers the risk of infection and mortality compared to late enteral nutrition (EN) and early parenteral nutrition (PN) (11-15). Malnutrition is linked to higher morbidity and mortality rates, nosocomial infections, lengthier hospital stays, a lower functional level upon ICU discharge, and higher hospital costs (16,17). The body's functional and metabolic abnormalities, which serve to explain the preceding events, are predicated on the idea that malnutrition affects virtually every organ and/or system in the human body. Malnourished patients exhibit poor immunological response, digestion, and absorption in theguts (18,19).

Malnutrition also exerts a negative impact on how quickly wounds heal (20). Researchers use several tools and criteria to evaluate and score healthy and adequate nutritional status. Numerous factors, including food/nutritional consumption, physical examination, disease severity, anthropometric data, and functional assessment are included in the methods used to assess nutritional risk (21). NUTRIC score, APACHE II score, and the Sequential Organ Failure Assessment (SOFA) score are some of these tools (22). The rate of hospital admissions in Iran are over two million each year, and 20%-30% of patients need intensive care (23). According to Iranian studies, the overall malnutrition rate has been reported as 20%-50% (24). Therefore, the present study was performed with aim to investigate nutritional support in ICU admitted patients in Iran by reviewing the studies conducted in this regard.

Methods

This systematic review study was conducted using the methodology described in the Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and Cochrane Handbook for Systematic Reviews. This review presents its findings by using inclusion and exclusion criteria, searching a comprehensive database, removing irrelevant studies, evaluating the quality of included studies, and interpreting the data. Adult patients over 18 years admitted to ICUs in Iranian hospitals were the key inclusion criterion. All of the included studies were written in English or Persian. This study excluded all meta-analysis review articles, narratives and systematic reviews, editorial letters, conference/poster presentations, case studies, brief studies, and animal studies.

All research publications containing the keywords “intensive care unit”, “nutritional support”, “Iran”, “parenteral nutrition” and “enteral nutrition” were searched in five online databases (Web of Sciences, Medline, PubMed, Scopus, and SID) until April 9, 2023. Both the titles and the abstracts of were evaluated for relevance. The process of screening was carried out with the eligible criteria. Two researchers checked the inclusion and exclusion criteria, taking into account the required qualifications. The full-text editions of the publications were obtained for the final screening of the extracted papers. The papers that were duplicates, presented in languages other than English and Persian, or lacked adequate information were eliminated. The publications written in a gray literature format were also removed. Two researchers read and examined the abstracts and titles of the articles individually. In case of any ambiguity or question, they discussed together. The researchers gathered

all relevant data after deciding their goal. The collected information was utilized to create a checklist. Figure 1 depicts a PRISMA flowchart of the selected articles and procedures.

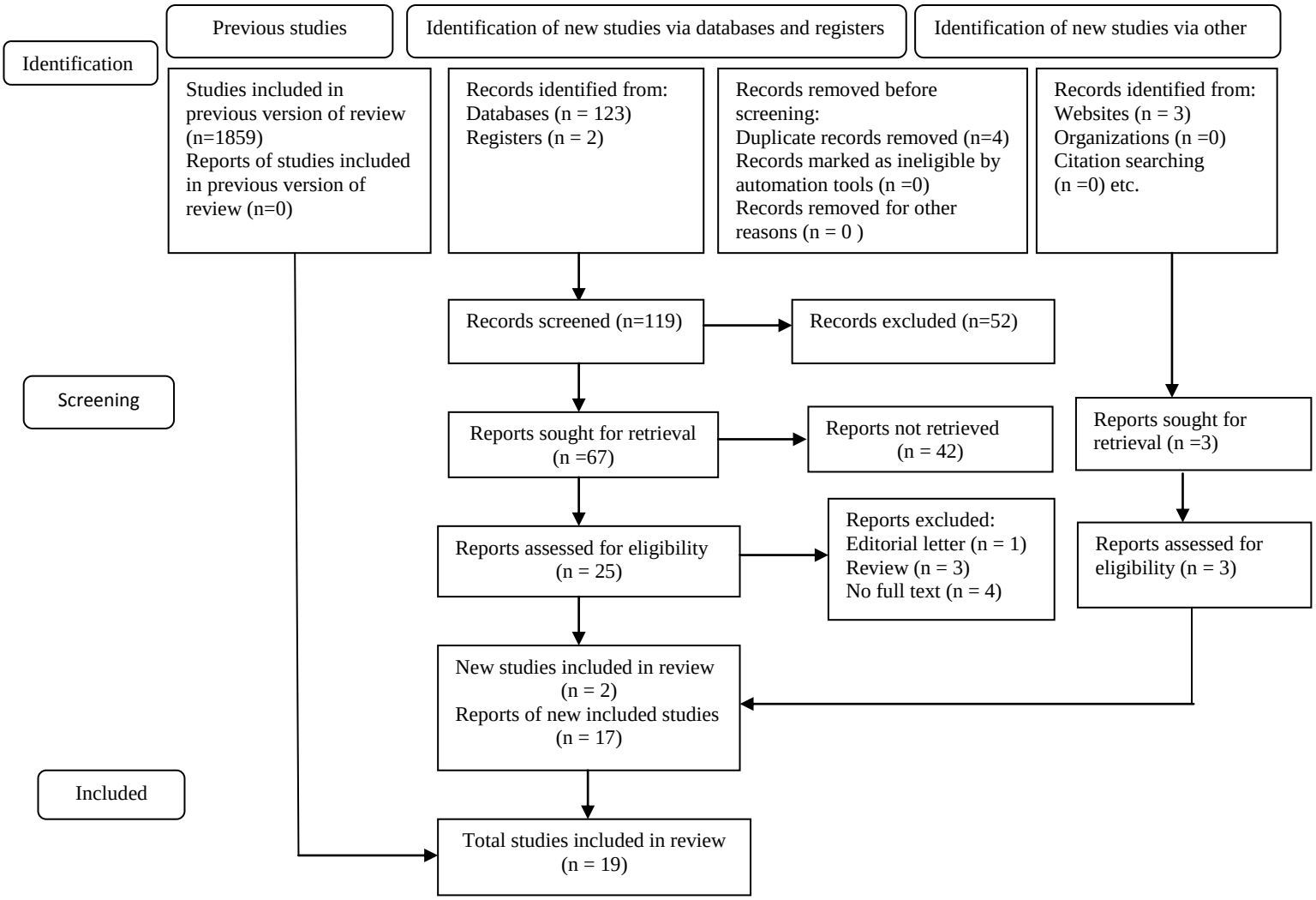

Figure 1: The PRISMA flowchart of the procedure for selecting studies

Cochrane's risk of bias tool was used to assess the potential bias in the published studies by considering eight criteria: random sequence generation, allocation concealment, blinding of participants, blinding of researchers, blinding of the evaluation process, attrition bias, adequate outcome data, selective reporting, and the absence of other biases. The level of bias risk was indicated by the responses "Yes," "No," and "Unclear", which correspond to low, high, and unclear rates of bias, respectively (25).

Ethical Consideration

Since the article was a systematic review study, no ethical consideration is applied.

Results

The search in five websites revealed a total of 1,859 documents. The initial step was to eliminate duplicate articles (n=4). After analyzing the titles and abstracts of the publications, 52 articles that were irrelevant to the research goals were deleted. Other studies included narrative and systematic articles (n=3) and letters to the editor (n=1) were excluded. The full text of four articles could not be found. Finally, there were 19 studies left.

Table 1. Demographic characteristics of patients and information of hospitals and ICUs

Author (year) Reference	Type of Study	Number of patients	Male/female ratio	Age	Admission disease type	ICU type	Data gathering (month)	Number of Hospitals (city)	Nutrition administration route
Yousefzadeh et al. (2007)[37]	Cross-sectional	115	97/18	41.22 ± 5.7	Trauma	NNICU	6	Poursina Hospital, Rasht	EN
Nematy et al. (2012)[10]	Prospective cohort	29	13/16	46.44	Myasthenia, Thrombosis and sinusoidal thrombosis, CVA, Convulsion, Subarachnoid hemorrhage	NNICU	—	1 Mashhad	Oral N & EN
Daneshzad et al. (2015)[28]	Descriptive	100	56/44	49.99±21.54	Surgery, Inflammation, Brain and nervous disease, CVD, Cancers, Kidney disease, Respiratory disease	—	15	Al-Zahra Hospital, Isfahan	—
Hejazi et al. (2016)[32]	Descriptive	125	84/41	49±21.2	Neurological, gastrointestinal, orthopedic, renal, and respiratory diseases, Trauma, Sepsis, CVD Cancer	Emergency ICU, GICU, Central ICU, Internal ICU, Trauma Center	18	Nemazee and Rajaei teaching hospitals, Shiraz	EN & PN
Kimiaei-Asadi et al. (2017)[11]	Descriptive cross-sectional	123	98/25	<20 - >50	Trauma	—	6	Mobasher Kashani Hospital (Hamadan)	—
Edrisi et al, (2017)[31]	Prospective observational	128	107/21	24 - 45	Trauma, Sepsis, Internal bleeding, Cancer, Cord injury, Respiratory arrest	—	6	two hospitals, Shiraz	EN
Nachvak et al. (2017)[36]	Descriptive	85	29/56	62.44±17.54	Stroke, Organ failure and injuries, Open abdominal surgery, Cancer, CVA, Sepsis, Alzheimer, Cerebral palsy, MS, Parkinson Trauma	—	3	two hospitals, Amol	EN
Shabanpur et al. (2018)[12]	Cross-sectional study	150	90/60	62.83 ± 21.16	TBI, Open abdomen, Burns, CVAs, LOC, Respiratory failure/pneumonia, Renal failure, Sepsis, CVD, Cancer	—	12	12 (Kermanshah and Mazandaran)	EN): 160 EN&PN: 20
Nachvak et al. (2018)[35]	Descriptive	124	74/50	61.53 ± 19.2	Renal problems, Hypertensive, Pulmonary disease, Cardiac disease, Malignancy, Trauma, Open wound of the abdomen, CVD, MS, Parkinson, Alzheimer, CVA	General Hospital, Trauma Center	10	2 hospitals in Amol	EN & PN
Valizade Hasanloei et al. (2018)[33]	Prospective cross-sectional	1183	631/552	61.32 ± 18.85	Trauma, Respiratory dysfunctions, Cancer, CVA	GICU, NICU, SICU, MICU, Post-surgery ICU	21	six different ICUs, Imam Khomeini Hospital, Urmia	EN, PN, ORAL, MIX

Table 1. Demographic characteristics of patients and information of hospitals and ICUs (continued)

Author (year) Reference	Type of Study	Number of patients	Male/female ratio	Age	Admission disease type	ICU type	Data gathering (month)	Number of Hospitals (city)	Nutrition administration route
Mishamandani et al. (2019)[23]	Comparative study	1311	771/540	16- >76	Blood pressure, Heart disease, Brain disorders, Hyperlipidemia, Thyroid problems, Metastatic cancer, Metabolic disorder, Cirrhosis, Leukemia, Tuberculosis, AIDS	General Internal Surgery, NNICU, Neurology, Trauma, Cancer, Thorax, Stroke	—	32 hospitals	—
Ramezani Kapourchali et al. (2019)[27]	Retrospective	48	48/0	38.79±7.35	TBI	NNICU	—	Poursina Hospital, Rasht	EN
Osooli et al. (2019)[24]	Prospective	150	87/63	57.42 ± 17.20	Medical Surgical or trauma	—	—	ICUs at AlZahra hospital in Isfahan	EN & PN
Hosseinzadeh Zoroufchi et al, (2020)[29]	Cross-sectional descriptive	45	25/15	49.35±23.5	Trauma	SICU	6	Kowsar Hospital in Semnan	EN & PN
Afshari et al. (2020)[30]	Cross-sectional	50	28/22	63.5	Internal problems surgery or trauma	—	6	Baqiyatallah Hospital-Tehran	EN & PN
Rafiee et al. (2020)[32]	Cross-sectional	55	35/20	49 (18-77)	Medical Surgical or trauma	—	2	Isfahan	EN & PN
Mishamandani et al. (2021)[73]	Cross-sectional	1321	780/541	54.8 ± 19.97	Neurologic diseases, Cancer, Trauma, Hypertension, Diabetes	—	12	25 hospital	EN, PN, Oral N
Majari et al. (2021)[26]	Prospective cohort	440	255/185	≥18 (60.0 ± 19.2)	Neurologic, gastrointestinal liver disease, Cardiovascular malignant	MICU, NNICU, SICU, GICU	5	2 (Shohadaye-Tajrish, and Taleghani hospitals)	PN& EN
Ahmadi et al. (2022)[74]	Cross-sectional	100	61/39	55.36±18.86	COVID-19	ICU	12	Shahid Faghihi Hospital, Shiraz	—

AIDS: Acquired Immune Deficiency Syndrome CVAs: Cerebrovascular accidents, LOS: Loss of consciousness, CVA: cerebrovascular accidents, TBI: Traumatic brain injury, MS: Multiple sclerosis, CVD: cardiovascular disease, MICU: Medical intensive care unit, NNICU: Neurosurgery intensive care unit, SICU: Surgery intensive care unit, GICU: General intensive care unit, Oral N: oral nutrition, PN: parenteral nutrition, EN: enteral nutrition, PEG: percutaneous endoscopic gastrostomy,

Table 2. Nutritional information and scores of patients hospitalized in ICU

Ref	BMI (kg/m^2)	NUTRIC Score	NRS Score	APACHE Score	SOFA Score	Other scores	Intake volume	Energy and macronutrient received	Outcome
(37)	—	—	—	—	—	—	27.83 ± 52.78 ml to 50-100 ml	1850±345.8 (kcal/d) Pr: 52.2±66.3 (g/d)	The process of nutritional support in head injury patients was unfavorable. Energy, macronutrient intake of carbohydrates, as well as the fat and protein was lower than required.
(70)	AD: 26± 3.9	—	AD: 47.6% D: 38.1%	—	—	—	AD: 1732.3 ± 662 (kcal/day), D: 1767.1 ± 537.1 (kcal/day)	—	After admission to the ICU until discharge: Reduced weight, BMI, and triceps skinfold thickness. Over the length of the hospital stay, high-sensitivity C-reactive protein declined. Throughout their stay in the ICU, the proportion of patients at risk for malnutrition reduced (not significant). On admission, the prevalence of malnutrition was as high as 47.6%. Using the NRS-2002, the nutritional condition of patients considerably improved during their hospital stay.
(28)	—	—	—	—	—	—	—	Received energy: 1298.26 Required energy: 2060.22 Difference of above values: -761.96	ICU patients were given less energy than they needed to consume, and after staying in the hospital for a week, their mid-arm circumference drastically decreased. They need specialized nutritional attention. Based on the measurements taken on the first day of their stay in the ICU, the patient's serum albumin levels dropped below the normal range.
(35)	AD: 25.7 D: 22.8	—	—	70±25	AD: 8.4±2.9	—	—	534.9, 361.4 (kcal/d) Pr: 20.6, 16 (4.4-36.5) (g/d)	The energy and protein consumption was far lower than the recommended amount. According to SGA, there was a rise in malnutrition among ICU patients on the day of discharge. Anthropometric assessments outperformed biochemical testing to predict the nutritional status. There was a significant reduction in the patient's weight, calf circumference, mid-upper-arm circumference, mid-arm muscle circumference, and triceps skinfold thickness. BMS and lean mass weight both fell sharply. Except for magnesium, which dramatically dropped, biochemical indicators did not indicate any significant alterations
(71)	AD: 18.5 D:15.98	—	—	—	—	—	—	—	Patients' weight of decreased by 6.98 (kg) from admission to discharge. Moreover, BMI reduced by 2.57 (kg/m^2).
(31)	—	—	—	—	—	—	ECR: 2293 ± 361 ACI: 668±333 FCI:42.3% ± 28.4	The participants were placed into one of the following groups: Ensure formula, Entrameal standard formula, Nutricomp standard formula, and Enterameal high fiber formula. All formulations had an energy density of 1 kcal/ml.	The patients' average calculated daily energy need was 2293 kcal; nonetheless, their average daily energy intakes over the seven days and on the final day were 668 and 977 kcal, respectively. The energy intake of four different types of formulations did not differ significantly. In the ICUs, enteral feeding is unsuccessful when performed with the most popular formulas. The insufficient administration of the recommended enteral nutrition in ICU patients should be more focused.

Table 2. Nutritional information and scores of patients hospitalized in ICU (continued)

Ref	BMI (kg/m^2)	NUTRIC Score	NRS Score	APACHE Score	SOFA Score	Other scores	Intake volume	Energy and macronutrient received	Outcome
(36)	—	—	—	administration 72.29±18/49	—	SGA: number of patients on day1 and discharge was 36 and 71	—	For feeding the patients, mainly hospital-made solutions were used, enriched with energetic commercial formulas and supplements, including carbons 2, protein, and standard enteral.	There was a significant increase in the prevalence of malnutrition during hospitalization and at the time of discharge. Anthropometric indicators related to nutritional status (creatinine level and whole blood lymphocytes) significantly decreased at the time of discharge compared to the time of hospitalization. The energy and protein intake was significantly less than needed. A significant negative correlation was observed between anthropometric measurements, some biochemical indices, and malnutrition at the time of discharge. The malnutrition prevalence improved during hospitalization.
(72)	—	—	—	—	—	—	Most bolus feeding: 200 and 250 mL. 1-day feeding solution: 200-500 mL (70.6%)500–1000 mL (20%), 1000– 1500 mL (6%), 1500–2000 mL (3.33%)		Only 30% of patients received diet counseling, and none of the dietitians worked predominately in ICUs. None of the participating ICUs kept regular records of daily energy intake, protein intake, or nutritional status. Anthropometric measurements, such as MAC and electrolyte status, were not recorded for patients. Nutritional care services in ICUs needed improvement since they were of inadequate quality.
(38)	—	—	—	—	1 DAY: 6.61 ± 2.3 D: 5.54 ± 3.4	SGA: A: 21 B: 91 C: 12	188.95 ± 58.013cc	The energy needs were 1567.24 205.68 calories; they only consumed 1041.09 337.15 calories. Their protein intake was 47.38 19.21; their protein requirement was 72.47 10.19. The intake was substantially lower than protein and energy requirements	Patients in ICUS consumed much less protein and energy than they needed. Based on the SGA and mean SOFA score, the rate of malnutrition was 39.6% on admission and 83.1% on discharge, and it considerably decreased over the patient's ICU stay. During ICU hospitalization, their anthropometric measurements reduced considerably. Inappropriate nutrition support was provided to Iranian ICU patients. Anthropometric measurements, such as the calf circumference, MUAC, TSF, and MAMC, drastically decreased throughout their ICU stay. The macronutrient and energy content of the in-house- tube-feeding formula was much lower than that of the commercial formula.
(33)	<18.5	—	—	—	—	—	—	Energy intake: 1052.75 ± 561.25 Kcal/day requirement: 1804.61 ± 201.76 Kcal/da Protein intake: 35.38 ± 23.19 gr/day, requirement: 77.9 ± 12.72 gr/day	The findings demonstrated that critically ill patients' protein and calorie intakes are insufficient. Consequently, it is important to take into account real dietary intake records, individual dietary requirement calculations, and personalized dietary planning in light of the disease and stress experienced by the patient.

Table 2. Nutritional information and scores of patients hospitalized in ICU (continued)

Ref	BMI (kg/m^2)	NUTRIC Score	NRS Score	APACHE Score	SOFA Score	Other scores	Intake volume	Energy and macronutrient received	Outcome
(23)	—	HR: Cancer LR: Neurologic problem	HR: neurologic problem LR: Trauma	—	—	SGA: Most patients had well or moderate nutrition status.	—	—	Patients with cancer and those who had suffered trauma had the highest and lowest nutritional scores, respectively. The number of patients with high NUTRIC scores rises with age. Patients in Iran's ICUs had a slightly better nutritional status than patients in other countries, which may be attributable to careful attention to patient care guidelines in Iran.
(27)	27.13±6.04	—	—	C: 18.58±3.8 DI: 21.20±5.4	—	—	A mixture of natural foods with vitamins and Nutrition Powder: 645 kcal/L (35g protein/L) + glutamine (10 g/L) + protein (1.5-2 g/kg) + energy (25-30 kcal/K).	—	To evaluate the dietary needs of patients, nutritionists must regularly participate in multidisciplinary rounds ICU rather than only once or twice for special situations. We discovered that patients with a dietitian present in the ICU consumed more protein and energy on average and were fed less frequently.
(34)	≤18.49-40≥	≥5: 79 <5: 71	—	20.16	8.06	—	—	Delivered nutrition: Energy (kcal/kg/d)= 11.02, Protein (g/kg/d)= 0.64//Prescribed nutrition: Energy (kcal/kg/d)=17.72,Protein (g/kg/d)= 0.99	During follow-up, malnutrition developed in 84% of the study population, and 87.4% and 83.3% of patients failed to receive at least 80% of the protein and calorie target, respectively. Underfeeding was more common in surgical and medical patients compared to trauma patients. Malnutrition development could only be predicted by the NUTRIC score, which measures nutrition risk in critically sick patients. Underfeeding dramatically increased both ICU and hospital mortality rates. The majority of nutritionally at-risk patients didn't receive enough calories and therefore developed malnutrition.
(29)	25.77	—	—	—	—	—	—	Determined calories: 904.91 Required calories: 1529.55Determined protein: 51.35, Required protein: 107.01	For trauma patients in the ICU for less than 24 hours, the amount of calories and protein assessed by the ICU was less than the necessary level; consequently, dietary alteration is suggested.

Table 2. Nutritional information and scores of patients hospitalized in ICU (continued)

Ref	BMI (kg/m^2)	NUTRIC Score	NRS Score	APACHE Score	SOFA Score	Other scores	Intake volume	Energy and macronutrient received	Outcome
(30)	—	—	—	—	—	—	EN group: 1162 ml/ PN group: 28 g of lipid	Powdered Entera Meal® formulae (54.6% carbohydrate, 14% protein, 31.6% fat, and maltodextrin) are dissolved in 150 ml of water to make EN solutions.	Just 7% of patients in the enteral group take the necessary protein, whereas 70% of them did not take adequate calories. No patient in the parenteral group obtained enough protein or calories. Hospitalized ICU patients appear to receive minimal nutritional support, and more care should be taken to avoid any potential consequences associated with malnutrition. Patients in the EN group got only about 60% of the calories they needed each day, while those in the TPN group got less than 40%. The patients' daily protein requirements had not even been supplied in half by hospital nutrition (EN and TPN).
(73)	—	3.4 ± 2.14	—	18.2± 7.33	4.4 ± 3.70	—	EN: 100-300 ml, 59.2 ± 37.78 percent of required calories and 55.5 ± 30.04 percent of required protein.	—	The ICU patients' dietary intake was extremely low, and they received much less protein and calories than needed. In fact, the patient's needs were not met by nutritional care support. In order to bridge the gap between patient intakes and nutritional demands, it is suggested that a comprehensive nutritional assessment be carried out on the first day of hospitalization. Physicians and nutritionists must also follow the current recommendations. The NUTRIC score and APACHE II had an odds ratio of 0.85 and 0.92, respectively for the prediction of energy deficiency.
(26)	—	4.0 (2.0–6.0)	3.0 (3.0–4.0)	—	6.0 (5.0–8.0)	MUST: Patients with a score ≥2 were exposed to high nutrition risk.	—	—	Higher energy intake is associated with a lower mortality rate in patients with higher NUTRIC scores.
(74)	D: 24.2±3	—	LR: 30% MR: 29% HR: 41%	—	—	—	—	—	The majority of patients (70.5%) in the diet group were at high risk of malnutrition, and there was a substantial difference between the two groups in NRS 2002 scores. Probability of death due to COVID-19 increases for each unit above the NRS-2002 score.

AD: Admission, D: Discharge, C: Control, DI: Dietitian Intervention, LR: High score, MR: moderate risk, HR: high risk, SGA: Subjective Global Assessment, ECR: Estimated Calorie Requirement, ACI: Average calorie intake, FCI: Final calorie intake, ICU: Intensive Care Unit, BMI: Body Mass Index, NRS-2002: Nutrition Risk Screening 2002, BMS: Body Cell Mass, MAC: Mid-Arm Circumference, MUAC: Mid-Arm Muscle Circumference, NUTRIC: Nutrition Risk in Critically Ill.

Table 3. Cochrane's risk of bias methodologies is used to assess the quality of research

Author (year)	Bias due to confounders	Bias due to selection of participants	Bias due to measurement of variables	Bias due to missing data	Incomplete outcome data	Free of selective reporting	Other sources	Other sources	Risk of bias
Mishamandani (2019)	No	No	No	No	No	No	No	No	Low
Shabanpur (2018)	No	No	No	No	No	No	No	No	Low
Majari (2021)	No	No	No	No	No	No	No	Yes	Low
Nachvak (2018)	No	No	No	No	No	No	No	No	Low
Kimiaei-Asadi (2017)	No	No	No	No	No	No	No	No	Low
Mishamandani (2021)	No	No	No	No	No	No	No	No	Low
Nematy (2012)	No	No	No	No	No	No	No	No	Low
Ahmadi (2022)	No	No	No	No	No	No	No	No	Low
Ramezani Kapourchal (2019)	No	No	No	No	No	No	No	No	Low
Daneshzad (2015)	No	No	No	No	No	No	Yes	No	Intermediate
Hosseinzadeh Zoroufchi (2020)	No	No	No	No	No	No	No	No	Low
Afshari (2020)	No	No	No	No	No	No	Yes	Yes	Intermediate
Edrisi (2017)	No	No	No	No	No	No	Yes	Yes	Intermediate
Nachvak (2017)	No	No	No	No	No	No	No	No	Low
Rafiee (2020)	No	No	No	No	No	No	No	No	Low
Valizade Hasanloei (2018)	No	No	No	No	No	No	No	No	Low
Osooli (2019)	No	No	No	No	No	No	No	No	Low
Hejazi (2016)	No	No	No	No	No	No	Yes	Yes	Intermediate
Yousefzadeh (2007)	No	No	No	No	No	No	Yes	Yes	Intermediate

These studies (n=19) observed a total of 5,672 patients. Women comprised 40.67% (n=2,307) of the total sample. The patients were admitted to ICUs in the hospitals throughout Iran, including Mazandaran, Amol, Kermanshah, Mashhad, Tehran, Hamedan, Isfahan, Shiraz, Semnan, Rasht, and Urmia. The patients in medical intensive care units (MICU), neurosurgery intensive care units (NICU), surgery intensive care units (SICU), and general intensive care units (GICU) were monitored. Various tools were used to check the nutritional status of ICU patients in these 19 studies. NUTRIC and APACHE II used in five studies (25%), NRS (20%), SOFA (20%), and SGA (15%) scoring systems were placed in the next levels. BMI were recorded in 35% of the studied articles. Moreover, in 14 articles, the level of calorie and protein intake was significantly lower than the daily needs of the patients (23,26-37). Three studies (28,32,38) reported that the level of blood factors, such as albumin, significantly decreased among patients during hospitalization. In all studies, except for one (23), the results pointed to poor nutritional status among patients hospitalized in ICUs. Data extracted from the studies were presented in Tables 1 and 2.

Quality assessment of methodological approaches

Five of the submitted studies had an intermediate risk of bias, while others (14) had a low risk. An assessment of the quality of articles was displayed in Table 3 and Figure 2.

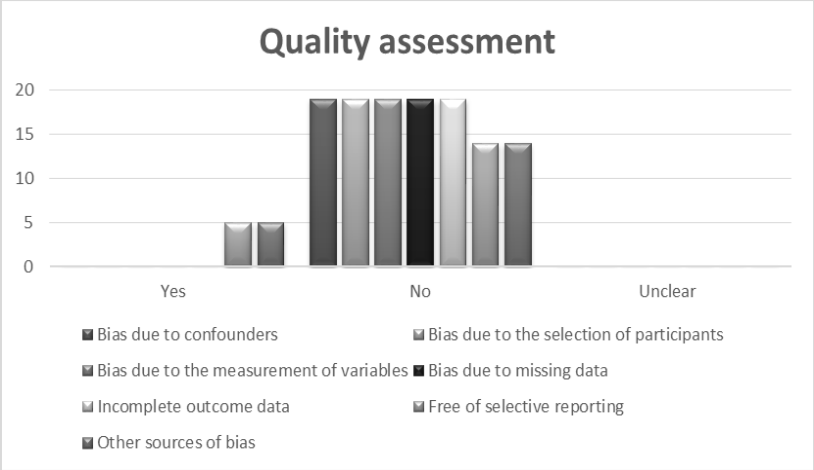

Figure 2. Quality of the articles to determine their bias

Discussion

The purpose of the present study was to assess the nutritional health of adult patients hospitalized in ICUs of Iranian hospitals. According to the findings of this systematic review, the risk of malnutrition in ICU patients is very high. In most cases, patients hospitalized in these units were at high risk of malnutrition, which can generate a myriad of problems for the patient and ultimately, the healthcare system.

Types of feeding methods in critically ill patients

Nutrition support therapy administers EN and/or PN (39). In ICUs, nutritional support is recognized as an important aspect for management of critically ill patients (40,41). Enteral nutrition utilizing nasogastric tubes (NGTs) is typically used to address the nutritional demands of the majority of critically ill patients who have a functional gastrointestinal system but are unable to do this orally (42,43). Even though EN has shown promising clinical results and lowers the mortality of malnourished critically ill patients. The majority of patients receiving tube feedings have an intolerance to feeding tubes, including vomiting, diarrhea, constipation, abdominal distention, regurgitation, and high gastric residual volume (GRV) (44,45). In fact, a drawback of EN is a possible reduction in nutritional sufficiency, especially during the acute illness phase and in the presence of gastrointestinal dysfunction (6,46). On the other hand, the PN has repeatedly been demonstrated in previous reviews to be associated with more serious infectious problems, although potentially better securing the intended nutritional intake (47-51).

Factors influencing the measurement and diagnosis of nutritional risk

Various criteria, including food/nutritional intake, physical examination, disease severity, anthropometric data, and functional assessment, are applied to identify nutritional risk. Some tools to evaluate nutritional risk have been confirmed in the hospital setting. Since almost all critically ill patients require mechanical ventilation and sedation, achieve many of these requirements are challenging (52). The articles examined in this study include several methods for measuring and estimating the risk of malnutrition, such as measuring calories, protein, carbohydrates, and fat taken daily, recording changes in weight and BMI, or the amount of arm circumference or thickness of skin folds. Considering the enormous quantities required to maintain hemodynamic stability, changes in weight might be impacted by fluid status, making it more challenging to evaluate muscle and fat loss. Numerous conventional techniques lack information on inflammatory status, which is essential in an ICU patient since it is one of the causes of hypermetabolic status and consequently, muscle wasting (21). Hospital malnutrition should be identified early, and effective nutritional intervention procedures must be determined through appropriate instruments (53). For instance, Valizade (33) and Ramezani (27) suggested that the presence of nutritionists in the ICU is very necessary, and the patients who were under the supervision of nutritionists had a higher protein and energy intake compared to other patients, while the frequency of their nutrition was less.

Malnutrition assessment tools

Researchers use several tools to measure nutritional status, such as the Nutrition Risk Screening 2002 (NRS e2002) (54) and the NUTRIC score (22) for identifying critically ill patients who would benefit from nutritional therapy (NT). The NUTRIC score, a tool developed by Heyland et al., is the first nutritional risk assessment tool developed especially for the ICU patients, linking starvation, inflammation, and outcomes. It can identify patients who need more aggressive nutritional treatment and extensive nutritional support depending on their nutritional risk (22).

Among the advantages of this privilege, we can refer to the fact that this score improves the death rates and ventilation times of critically ill patients who benefit from intensive protein-energy provision during ICU stay. In order to stratify effects according to baseline risk, the effects of nutritional therapies for ICU patients with particular baseline characteristics were assessed by the NUTRIC score (55). Mishamandani et al. reported that patients' NUTRIC scores increased significantly with age (23). The NUTRIC score assess nutritional risk and associated outcomes (mortality and length of ventilation) through combining pre-hospitalization parameters, such as chronic BMI and acute starvation (pre-hospital admission duration) with acute Interleukin-6 and chronic inflammatory parameters (number of comorbidities), as well as the severity of illness based on APACHE-II classification system and SOFA-scores, on ICU admission.

The NUTRIC score has been validated and a high score is linked to a longer time spent on mechanical ventilation and a greater 28-day death rate. On the other hand, although the NUTRIC score was validated within the same database, limiting its applicability outside of that database (22). Moreover, this method lacks basic nutrition risk indicators, including BMI, weight status, oral intake, or physical examination, and its lack of nutrition history data may restrict its clinical applicability (56). Furthermore, PANDORA (57), recently introduced the Patient and Nutrition Derived Outcome Risk Assessment Score. Nonetheless, this score has not yet been validated in an ICU context.

The Malnutrition Universal Screening Tool (MUST) is another nutritional risk assessment tool frequently used for hospitalized patients; however, it has limited efficacy in critically ill patients (56,58,59). Nevertheless, the Netherlands, for example, has been used MUST score as a quality measure for measuring hospitals for years. In Iran, Majari et al. (2021), in addition to the NUTRIC score, also used the MUST score to diagnose the risk of malnutrition among patients (26). It should also be highlighted that the MUST score was commonly utilized for critically ill patients until recently, when no other tool was available to assess nutritional risk in ICU patients (60). However, studies illustrated that the MUST score is less effective at predicting the future than the NUTRIC score. Furthermore, since it has not been validated in the ICU patients, the researchers suggest that the MUST score should not be used to assess nutritional risk in the ICU (55). The study by Majari also found that more energy intake was associated with a lower 28-day mortality rate in patients with a higher NUTRIC score (26). In the same context, Coltman et al. demonstrated that despite some restrictions, the SGA was thought to be the most useful instrument for evaluating nutrition status in

the ICU population. It is worth noting that there was a considerable amount of overlap between various patient groups; moreover, the SGA and the NUTRIC score were able to identify nutritional risk or malnutrition despite their differences (56). In addition, Rosa et al. stated that in terms of patients requiring additional rehabilitation after discharge and ICU length of hospital stay, NUTRIC Score as a tool for identifying nutritional risk or malnutrition demonstrated similar outcomes to SGA; nonetheless, it was associated with high rate of mortality when compared to SGA (53).

The APACHE diagnostic scoring system was developed in 1981 to measure the severity of a condition. The tool used 34 physiologic variables to assess the level of illness. The APACHE scoring system has been the gold standard in intensive therapy. The APACHE score is directly correlated with hospital mortality. From time to time, new versions have been released (61). The 1985 release of APACHE II was a simplified improvement over APACHE (62). Three factors can be used to estimate the probability of death: patient's age, 12 acute physiological features (acute physiology score [APS]), chronic illnesses, and surgical interventions. Some applications of APACHE II are risk stratification, comparing the quality of care, and prognosis (63). Today, other versions of this tool have been introduced with some modifications. The studies conducted in Iran that were evaluated in this review also used different versions of the APACHE score (II and IV) (23,27,32,34,36). Researchers believe that these scoring systems have limitations in evaluating critically ill patients. For example, ICU mortality appeared to be the best outcome to discriminate between ICUs with good quality treatment (low risk-adjusted mortality) and ICUs with poor quality treatment (high risk-adjusted mortality). Prognostic indicators were established to compare the quality of health care provided by various ICUs. On the other hand, some authors have underlined that the prognostic significance of the grading systems that are currently available is heavily dependent on the treatment. Two patients who have a similar severity of disease may have significantly different scores based on whether or not they received adequate resuscitation (64). Another reason is that the prognosis assessment based on scores is only applicable to a research population, not to a specific patient. Furthermore, some parts of the scores are difficult to determine. A perfect diagnostic index should be based on factors identified in common regular examinations, applicable to a variety of patient populations, easily and broadly measured, and unrelated to treatment or individual opinions (65). Finally, the severity scores used nowadays are typically based on a prediction of death. Recent studies have demonstrated a new method for evaluating organ failure that emphasizes on morbidity than mortality (66).

Organ dysfunction/failure in critically ill patients can be described using the SOFA score, as demonstrated by Vincent et al., patients' conditions and disease progression can be observed and clarified with the help of regularly repeated scoring. The SOFA score could facilitate patient comparison, which would be useful for clinical trials (67). Respiratory, cardiovascular, renal, hematological, hepatic, and central nervous systems function are used to calculate the SOFA score, which evaluates organ dysfunction, morbidity, and mortality in the ICU patients (68). Some studies demonstrated that an increasing score of the SOFA(within the range of 0-4) indicates growing organ dysfunction (69). The mean score of SOFA was 6 in the studies evaluated in this paper, indicating that patients admitted to ICUs across the country have poor health status and receive inadequate and poor-quality nutrition (23,26,34,38).

One of the advantages of this systematic review study was the large number of cross-sectional longitudinal studies conducted in various cities around Iran that considered various hospitals and patients with severe diseases. On the other hand, the number of various assessment systems utilized in the studies can present problems with clarity of the results, considering that approved and recognized procedures were used in all of the studies around the world. However, the limitation of this study is the lack of a standardized measurement scale. The articles reviewed in this study utilized various methods for assessing and quantifying the risk of malnutrition, as well as measuring changes in weight, BMI, and other validated criteria. Furthermore, an additional crucial issue to consider is the varying lengths of stay for patients in the intensive care unit.

Implications for practice

The nutritional care services were in poor and inadequate condition in the hospitals included in this study. Furthermore, the patient's daily intake of calories, protein, and other nutrients was drastically less than the recommended amount, exerting adverse effects on patients and causing negative

consequences. Researchers concluded that the presence of nutritionists is vital and necessary for each patient hospitalized in the ICU of Iranian hospitals. Nutritionists can contribute greatly to accelerated patient recovery and improving treatment progress by monitoring their health conditions and assessing their energy and nutritional requirements.

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Authors' Contributions
Zahra Feyzabadi: Conception and design, Saeid Jamalie: Data collection, Benyamin Fazli: Data collection, Seyyed Saeed Shams: Data analysis, Mohaddeseh Badpeyma: Data collection, Alireza Sedaghat: Conception and design. All authors contributed to the writing of the manuscript and discussed on the manuscript**.**

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