ASSESSMENT OF MICRONUTRIENT ADEQUACY IN OBESE PATIENTS ON EXCLUSIVE ENTERAL NUTRITION IN THE ICU OF A HOSPITAL IN THE NORTHWEST REGION OF THE STATE OF ESPÍRITO SANTO: A RETROSPECTIVE STUDY

AVALIAÇÃO DA ADEQUAÇÃO DE MICRONUTRIENTES EM PACIENTES OBESOS SUBMETIDOS À NUTRIÇÃO ENTERAL EXCLUSIVA NA UTI DE UM HOSPITAL DA REGIÃO NOROESTE DO ESTADO DO ESPÍRITO SANTO: UM ESTUDO RETROSPECTIVO

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ABSTRACT

Critically ill obese patients are at high risk of nutritional deficiencies due to the hypermetabolic state and oxidative stress, which can compromise their recovery. This study aimed to analyze the adequacy of micronutrients in obese patients according to the Body Mass Index (BMI) admitted to an Intensive Care Unit (ICU), who were receiving exclusive enteral nutrition. Data were collected from electronic medical records and a digital database. Micronutrient intakes were assessed based on the *Dietary Reference Intakes* (DRIs). The study included 46 patients admitted to the ICU, with a median age of 67 years (interquartile range, 58-76 years), and 63% of the

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patients were male. The leading cause of hospitalization was respiratory disease (60.9%). Data analysis revealed that 12 micronutrients presented levels below the recommended levels, including sodium, calcium, potassium, chloride, magnesium, folic acid, pyridoxine, copper, vitamin A, vitamin D, pantothenic acid and chromium with percentages of 89.1%, 71.9%, 100%, 100%, 78.3%, 95.7%, 41.3%, 63%, 50%, 60.9%, 71.7 and 60.9%, respectively. No nutrient exceeded the tolerable upper intake limit. The findings of this study indicate that exclusive enteral nutrition, as administered, did not guarantee nutritional adequacy for this population, highlighting the need for adjustments in dietary prescriptions. In addition, the scarcity of specific guidelines for critically ill obese patients reinforces the importance of further research to support more precise recommendations on micronutrient administration in this population.

Keywords: Obesity, Intensive Care Unit, Micronutrient, Enteral nutrition, Nutritional deficiency.

RESUMO

Pacientes críticos obesos apresentam alto risco de deficiências nutricionais devido ao estado hipermetabólico e ao estresse oxidativo, o que pode comprometer sua recuperação. O objetivo deste estudo foi analisar a adequação dos micronutrientes em pacientes obesos de acordo com o Índice de Massa Corporal (IMC), internados em uma Unidade de Terapia Intensiva (UTI) que estavam recebendo nutrição enteral exclusiva. Os dados foram coletados a partir de prontuários eletrônicos e de um banco de dados digital. A avaliação da ingestão de micronutrientes foi feita com base nas Dietary Reference Intakes (DRIs). O estudo incluiu 46 pacientes internados na UTI, com mediana de idade de 67 anos (intervalo interquartil de 58 a 76 anos), sendo 63% do sexo masculino. A principal causa de internação foi a presença de doença respiratória (60,9%). A análise revelou que 12 micronutrientes apresentaram níveis abaixo do recomendado, incluindo sódio, cálcio, potássio, cloro, magnésio, ácido fólico, piridoxina cobre, vitamina A, vitamina D, ácido pantotênico e cromo com percentuais de 89,1%, 71,9%, 100%, 100%, 78,3%, 95,7%, 41,3%, 63%, 50%, 60,9%, 71,7 e 60,9%, respectivamente. Nenhum nutriente ultrapassou o limite superior tolerável de ingestão. Os achados deste estudo indicam que a nutrição enteral exclusiva, na forma como foi administrada, não garantiu a adequação nutricional para essa população, destacando a necessidade de ajustes na prescrição dietética. Além disso, a escassez de diretrizes específicas para pacientes obesos críticos reforça a importância de novas pesquisas para subsidiar recomendações mais precisas sobre a administração de micronutrientes nessa população.

Palavras-chave: *Obesidade, Unidade de Terapia Intensiva, Micronutrientes, Nutrição enteral, Deficiência nutricional.*

1 INTRODUCTION

Obesity is a chronic non-communicable disease characterized by the excessive accumulation of body fat resulting from multifactorial causes (Elmaleh-Sachs *et al*.,

2024; Ministério da Saúde, 2013). Its most common diagnosis is based on the Body Mass Index (BMI). According to the standard established by the World Health Organization (WHO), overweight is defined as a BMI ≥25 kilograms per square meter (kg/m²), while obesity is defined as a BMI ≥30 kg/m² for adults (Grade 1), regardless of sex or race (Haam *et al*., 2023; Araujo *et al*., 2019).

For the elderly (>60 years), however, the WHO standard of BMI ≥30 kg/m² is considered inappropriate due to its low sensitivity, failing to identify those with excess weight/body fat. In other words, diagnostic criteria are adapted to account for age-related physiological changes and, consequently, changes in body composition. Thus, the literature highlights the need for more accurate and specific cutoff points for this population. It is important to note that there is no consensus in the international literature or established guidelines for an ideal definition of obesity in this age group. According to studies on the diagnosis of excess fat/obesity in the elderly, the most accurate cutoff points with the best sensitivity and specificity are a BMI ≥25 kg/m² for men and a BMI ≥26.6 kg/m² for women (Silveira *et al*., 2020; Malandrino *et al*., 2023; Nowak *et al*., 2025).

In intensive care settings, the number of obese patients admitted has been steadily increasing (Costa-Borba *et al*., 2021; Dickerson *et al*., 2022; Marik; Varon, 1998; Aragão Neto *et al*., 2022). Hospitalized obese patients present factors such as metabolic and inflammatory alterations influenced by their critical condition, nutritional status, and associated comorbidities, which may lead to impaired dietary status and challenges in nutritional therapy management (Coppini *et al*., 2011).

Furthermore, in addition to their nutritional status in critical clinical conditions, these patients experience a catabolic state, in which the body begins breaking down muscle proteins and other structures to obtain energy, resulting in muscle loss, weakness, and impaired immune function. Adequate nutrition is crucial for critically ill patients in a catabolic state, as proper nutrient and caloric intake may help minimize muscle loss and promote recovery (Gouveia-Castro *et al*., 2023; Silva *et al*., 2024).

Thus, critically ill obese patients are at high nutritional risk and are more susceptible to complications associated with overfeeding (hyperglycemia, hepatic steatosis, and insulin resistance). In this context, current nutritional therapy guidelines recommend hypocaloric and high-protein dietary goals (Gouveia-Castro *et al*., 2023).

For this patient population, where oral intake is not feasible but who have a functional gastrointestinal (GI) tract, the alternative feeding route of choice is enteral

nutrition through formulated enteral diets. The American Society for Parenteral and Enteral Nutrition (ASPEN) recommends nutritional targets for critically ill obese patients with BMI >30 kg/m² of 11-14 kilocalories (kcal) per kilograms (kg) of actual body weight or 22-25 kcal per kg of ideal body weight, with a protein provision of 2.0 g/kg of ideal body weight (Compher *et al*., 2022).

In this context, these patients are particularly susceptible to nutrient deficiencies. Beyond nutritional factors, their hypercatabolic state and oxidative stress increase micronutrient requirements, which are often not met due to the reduced volume of prescribed and administered formula. Lower caloric targets further compound this compared to recommendations for eutrophic patients (Al-Dorzi; Stapleton; Arabi, 2022; Gouveia-Castro *et al*., 2023).

Enteral formulas provide patients with both macronutrients (lipids, carbohydrates, and protein) and micronutrients (vitamins and minerals), including sodium, calcium, potassium, chloride, magnesium, copper, phosphorus, manganese, zinc, iodine, molybdenum, selenium, fat-soluble vitamins (A, D, E, K), and water-soluble vitamins (C and B complex). These nutrients are essential for maintaining or restoring nutritional status, supporting patients in combating disease, and reducing hypermetabolism and catabolism associated with inflammatory responses (Lemos *et al*., 2022).

To date, no specific guidelines exist in the literature providing general recommendations for vitamins and minerals in critically ill patients. However, the *Dietary Reference Intakes* (DRIs) outline the most widely used reference values, initially published in 1997 and remaining current (Institute of Medicine, 1997). These values include: Recommended Dietary Allowance (RDA), Adequate Intake (AI), Tolerable Upper Intake Level (UL), and Estimated Average Requirement (EAR) (Padovani *et al*., 2006; Paternez; Braga, 2023; Vieira; Lima; Cruz, 2021).

Enteral formulas are designed to ensure their energy values meet recommended dietary intakes and upper intake levels for healthy populations. Their micronutrient composition aims to fulfill daily recommendations for eutrophic adult patients (Breik *et al*., 2022; Iacone *et al*., 2016). Additionally, the literature indicates that the delivery of enteral nutrition often fails to meet prescribed targets in clinical practice. The main causes identified for this shortfall include recurrent feeding interruptions, due to fasting for extubation, diagnostic procedures, and surgical

interventions, and the metabolic impact of the acute inflammatory response (Viana *et al*., 2025; Ritter *et al*., 2019; Ribeiro *et al*., 2014; Kim *et al*., 2012).

However, the actual volumes of enteral formula delivered to patients are determined by calculations of nutritional requirements (energy and protein) as well as the percentage of the formula infused. These variables may compromise micronutrient delivery during enteral nutrition therapy, potentially leading to clinically significant deficits (Assis *et al*., 2010; Sousa-Gomes; Cabral; Oliveira, 2017; Mendonça; Guedes, 2018; Sousa; Andrade, 2022).

In critically ill obese patients, given substantially lower energy requirements, administered volumes frequently remain below one liter of enteral formula, potentially impairing vitamin and mineral provision during therapy (Al-Dorzi; Stapleton; Arabi, 2022).

Therefore, this study aimed to assess micronutrient adequacy in critically ill obese patients admitted to the Intensive Care Unit (ICU) who received exclusive enteral nutrition at a hospital in northwest Espírito Santo, comparing the prescribed volumes with the administered volumes.

2 METHODS

2.1 STUDY POPULATION AND DESIGN

This is an observational, quantitative, retrospective, cross-sectional study. Conducted with 46 patients admitted to ICUs at a hospital in the northwest region of Espírito Santo, from June 2019 to December 2023. The study included only overweight individuals (BMI equal to or greater than 30 kg/m²), aged 18 years or older, of both sexes, who had a hospital stay of 24 hours or longer and received exclusive enteral nutrition. Patients were excluded if they lacked necessary data on infused enteral nutrition in 24-hour fluid balance records, presented with a BMI below 30 kg/m², received mixed feeding (oral and enteral), or received supplemental parenteral nutrition.

2.2 DATA COLLECTION

Data were collected regarding enteral nutrition infusions from 24-hour fluid balance records and the *Magma*® database (version 4.0) and *SoulMv*®. The variables collected included: age, sex, ethnicity, average volume of infused formula, infusion percentage, body mass index (BMI), reason for hospitalization, pre-existing conditions, *Nutrition Risk Screening* (NRS 2002) classification, *Subjective Global Assessment* (SGA), days on mechanical ventilation, length of stay in the intensive care unit, and mortality.

Patients with a BMI >30 kg/m² (adults and elderly) were classified as critically ill obese patients.

The daily infused volume and the micronutrients assessed (sodium, calcium, potassium, chloride, magnesium, copper, phosphorus, manganese, zinc, iodine, molybdenum, selenium, vitamin A, D, E, K, C, thiamine, riboflavin, niacin, pyridoxine, biotin, folic acid, and cobalamin) were calculated based on the labels of commercial formulas (Novasource Senior©, Novasource Hi Protein©, Novasource GC©, Novasource GC 1.5©, Peptamen HN©, Isosource 1.5©, Nutrison Energy©) and recorded over a three-day monitoring period following full diet progression.

In this study, micronutrient adequacy was assessed using the DRIs. The RDA was used as the reference value for calculating the percentage of adequacy. Adequacy was classified as follows: appropriate when intake was between 90-110% of the RDA, inadequate if intake was less than 90%, and excessive if intake exceeded 110%.

2.3 ETHICAL CONSIDERATIONS

This study was approved by the Research Ethics Committee of the University Center of Espírito Santo UNESC, under CAAE registration number 740344323.0.0000.5062.

2.4 STATISTICAL ANALYSIS

Results were described using percentages for categorical variables, mean and standard deviation for normally distributed data, and median and interquartile range for non-normally distributed data. The *Kolmogorov-Smirnov test* was used to assess the

normality of quantitative variables. Data were analyzed using the *Statistical Package for the Social Sciences* (SPSS) software (version 25.0).

3 RESULTS

Forty-six patients admitted to the Intensive Care Unit (ICU) who met the established inclusion criteria were enrolled in the study. The median age was 67 years (interquartile range - IQR = 58.00 - 76.00), with a male predominance (63%), and 56.5% of patients were Caucasian. The most prevalent admission diagnosis was respiratory system diseases (60.9%), with a median ICU length of stay of 21.5 days (IQR = 15.00 - 35.75). Regarding pre-existing conditions, the majority of patients had arterial hypertension (80.4%). Conversely, 89.2% did not present with dyslipidemia, and an equal proportion (89.2%) had no chronic kidney disease. Finally, 47.8% of patients had diabetes mellitus (**Table 1**).

Table 1 - Demographic and Clinical Characteristics of Patients Admitted to the ICU.

Variables	Median (IQR)
Age	67 years (58.75 – 76.00)
Life Stage	n (%)
Adult	12 (26.08)
Elderly	34 (73.91)
Gender	
Male	29 (63)
Female	17 (37)
Ethnicity	
White	26 (56.5)
Non-White	20 (43.5)
Reason for Admission	
Cardiovascular diseases	6 (13)
Respiratory diseases	28 (60.9)
Digestive system diseases	1 (2.2)
Genitourinary system diseases	2 (4.4)
Others*	9 (19.6)
Pre-existing Conditions	
Diabetes	
Yes	22 (47.8)
No	24 (52.2)
Hypertension	
Yes	37 (80.4)
No	9 (19.6)
Dyslipidemia	
Yes	5 (10.9)

No	41 (89.1)
Chronic Kidney Disease	
Yes	5 (10.9)
No	41 (89.1)
Days in ICU	21.5 days (15.00 – 35.75)
Mechanical Ventilation	
Yes	43 (93.5)
No	3 (6.5)
Mortality	
Yes	33 (71.7)
No	13 (28.3)

Caption: *Others: Decreased level of consciousness, infrarenal aortic aneurysm, critical ischemia, septic shock, endoleaks; ICU: Intensive Care Unit; TRS: Renal Replacement Therapy; VM: Mechanical Ventilation.
Source: Author, 2025.

The nutritional characteristics and the volumes of enteral formula administered to patients in the intensive care unit are summarized. According to the NRS 2002 screening tool, 91.3% of patients were identified as being at nutritional risk, while 69.56% were classified as well-nourished by SGA. The mean volume of enteral nutrition administered was 800.5 mL (± 288.60) (**Table 2**).

Table 2 - Nutritional Characteristics and Infused Diet Volume in ICU Patients.

Variables	n (%)
NRS 2002 Classification	
No risk	4 (8.69)
At risk	42 (91.3)
Subjective Global Assessment	
SGA A	32 (69.56)
SGA B + C	14 (30.43)
Infused Volume	Mean ± SD
Volume	800.55 ± 288.60

Caption: BMI: Body Mass Index; NRS: Nutrition Risk Screening; SGA: Subjective Global Assessment; SGA A: Well-nourished; SGA B+C: Malnourished.
Source: Author, 2025.

The adequacy percentages of 27 micronutrients were collected and evaluated according to their prevalence classification as below, adequate, or above recommended levels. Among these: 12 micronutrients predominantly showed values below recommendations, including sodium (89.1%), calcium (71.9%), potassium (100%), chloride (100%), magnesium (78.3%), folic acid (95.7%), pyridoxine (41.3%),

copper (63%), vitamin A (50%), vitamin D (60.9%), pantothenic acid (71.7%), and chromium (60.9%).

The remaining fifteen micronutrients were predominantly above recommended levels: phosphorus (54.3%), thiamine (52.2%), riboflavin (45.7%), niacin (52.2%), cobalamin (73.9%), manganese (60.9%), zinc (58.7%), biotin (50%), iodine (56.5%), molybdenum (84.8%), selenium (47.8%), vitamin E (84.8%), vitamin K (45.7%), vitamin C (86.6%), and iron (78.3%). No nutrient demonstrated balanced adequacy prevalence, that is, within the 90-110% adequacy range (**Table 3**).

Table 3 - Percentage of Micronutrient Adequacy in 46 Obese Patients Admitted to the ICU.

Variables	n (%)	Variables	n (%)
Sodium		Thiamine	
Below	41 (89.1)	Below	13 (28.3)
Adequate	5 (5)	Adequate	9 (19.6)
Above	-	Above	24 (52.2)
Calcium		Riboflavin	
Below	33 (71.7)	Below	18 (39.1)
Adequate	11 (23.9)	Adequate	7 (15.2)
Above	2 (4.3)	Above	21 (45.7)
Potassium		Folic Acid	
Below	46 (100)	Below	44 (95.7)
Adequate	-	Adequate	1 (2.2)
Above	-	Above	1 (2.2)
Chloride		Niacin	
Below	46 (100)	Below	14 (30.4)
Adequate	-	Adequate	8 (17.4)
Above	-	Above	24 (52.2)
Phosphorus		Pyridoxine	
Below	13 (28.3)	Below	19 (41.3)
Adequate	8 (17.4)	Adequate	11 (23.9)
Above	25 (54.3)	Above	16 (34.8)
Vitamin C		Molybdenum	
Below	3 (6.5)	Below	4 (8.7)
Adequate	3 (6.5)	Adequate	3 (6.5)
Above	40 (86.6)	Above	39 (84.8)
Copper		Selenium	
Below	29 (63)	Below	14 (30.4)
Adequate	3 (6.5)	Adequate	10 (21.7)
Above	14 (30.4)	Above	22 (47.8)
Manganese		Vitamin A	
Below	13 (28.3)	Below	23 (50)
Adequate	5 (10.9)	Adequate	8 (17.4)

Above	28 (60.9)	Above	15 (32.6)
Zinc		Vitamin D	
Below	16 (34.8)	Below	28 (60.9)
Adequate	2 (4.3)	Adequate	7 (15.2)
Above	27 (58.7)	Above	11 (23.9)
Biotin		Vitamin E	
Below	14 (30.4)	Below	4 (8.7)
Adequate	9 (19.6)	Adequate	3 (6.5)
Above	23 (50)	Above	39 (84.8)
Iodine		Vitamin K	
Below	14 (30.4)	Below	16 (34.8)
Adequate	6 (3.9)	Adequate	9 (19.6)
Above	26 (56.5)	Above	21 (45.7)
Cobalamin		Magnesium	
Below	7 (15.2)	Below	36 (78.3)
Adequate	5 (10.9)	Adequate	6 (13)
Above	34 (73.9)	Above	4 (8.7)
Pantothenic Acid		Chromium	
Below	(71.7)	Below	28 (60.9)
Adequate	9 (19.6)	Adequate	2 (4.3)
Above	4 (8.7)	Above	16 (34.9)
Iron			
Below	6 (13.0)		
Adequate	4 (8.7)		
Above	36 (78.3)		

Caption: Below (<90%), Adequate (90-110%), Above (>110%).
Source: Author, 2025.

4 DISCUSSION

The present study identified inadequacies in 12 out of 27 evaluated micronutrients (sodium, calcium, potassium, chloride, magnesium, folic acid, pyridoxine, copper, vitamin A, vitamin D, pantothenic acid, and chromium) among BMI-classified obese patients admitted to the ICU.

Adequate micronutrient intake is essential for all patient populations; however, in critically ill obese patients, it represents a crucial aspect of nutritional management, as obesity may be associated with dietary deficiencies leading to unfavorable clinical outcomes (Fedele *et al*., 2021).

The enteral formulas used in this study have distinct compositions, adapted to different clinical needs and metabolic profiles. While formulas such as Novasource Senior© are specifically developed for the elderly, with adjustments in protein, fiber, and micronutrients, others such as Novasource Hi Protein© and Peptamen HN© are characterized by high protein content and protein hydrolysates, aiming to meet

hypercatabolic demands and compromised gastrointestinal tolerance (Iacone *et al*., 2016; Breik *et al*., 2022). Formulas with increased energy density, such as Novasource GC 1.5© and Isosource 1.5©, allow for adequate nutritional supply in reduced volumes, a relevant factor for obese patients on hypocaloric therapy, but may result in variable micronutrient concentrations per infused volume.

The heterogeneity in formula selection, while clinically justified, introduces variability in micronutrient delivery, since each product has a specific vitamin-mineral matrix formulated for healthy eutrophic populations (Iacone *et al*., 2016). This diversity may partly explain the findings of micronutrient inadequacy such as vitamin D, magnesium, and folic acid, since the infused volume – on average 800.5 mL – was insufficient to meet the Dietary Reference Intakes (DRIs) when considering the micronutrient density of each formula (Breik *et al*., 2022). Thus, the choice of enteral formula, combined with the volume actually administered, proves to be a critical determinant for nutritional adequacy, especially in critically ill obese patients, in whom volume restriction is frequent and specific micronutrient recommendations are still scarce. Thus, the variability in the micronutrient composition of the diets, combined with infused volumes frequently less than 1 liter, constitutes a relevant practical aspect for the interpretation of the identified deficits.

Similar findings have been reported in the literature, describing inadequacies in nine other micronutrients not addressed in the present study, namely sodium, calcium, potassium, chloride, magnesium, folic acid, copper, vitamin A and vitamin D in critically ill patients receiving exclusive enteral nutrition in the ICU. Their study reinforces the notion that current enteral nutrition practices may be insufficient to meet recommended dietary intakes, especially in hypermetabolic patients (Viana *et al*., 2025)

Research indicates that vitamin and mineral deficiencies are particularly prevalent among obese individuals, demonstrating reduced levels of various micronutrients (Valentino; Sriram; Shankar, 2011; Via; Mechanick, 2017). Our findings revealed that 12 trace elements were deficient in this patient cohort.

A study published by the Brazilian Society of Parenteral and Enteral Nutrition (BRASPEN) in 2015 analyzed 13 articles and found that vitamin D deficiency ranges from 53.3% to 97.7% in intensive care units (Cavalcante *et al*., 2015). Critically ill patients, regardless of nutritional status, frequently exhibit low levels of this vitamin due to factors such as lack of sun exposure, inadequate diet, and medical conditions affecting absorption (Sousa-Gomes; Cabral; Oliveira, 2017). The present study found

low vitamin D delivery levels (60.9%). Other studies corroborate our findings, showing that low vitamin D levels are linked to adverse clinical outcomes (Amrein *et al*., 2018; Kasti *et al*., 2023).

Vitamin A, an essential antioxidant for immune function, skin health, and vision, is particularly susceptible to deficiency in critically ill patients. This may result from inadequate absorption, suboptimal enteral formula delivery, and increased metabolic demands (Berger *et al*., 2022). Our study identified a deficiency in 50% of evaluated patients. Similar findings were reported in other studies involving patients receiving exclusive enteral nutrition (Kasti *et al*., 2023; Roust; DiBaise, 2017).

Minerals such as calcium, potassium, chloride, sodium, and magnesium are essential for various physiological functions, including blood pressure regulation, muscle activity, and immune function. The deficiency of these minerals may lead to clinical complications, including muscular weakness, cardiac arrhythmias, and impaired immune function (Lee, 2010).

Hypomagnesemia is frequently observed among hospitalized patients, particularly in critically ill individuals presenting with concomitant electrolyte abnormalities. This condition is strongly associated with other electrolyte disturbances, including hypokalemia and hypocalcemia (Lee, 2010). The current study similarly identified inadequate magnesium intake in 78.3% of hospitalized patients. These findings are supported by multiple studies demonstrating high prevalence rates of magnesium deficiency in critically ill patients, irrespective of nutritional status (Hansen; Bruserud, 2018; Terlisten *et al*., 2023; Upala *et al*., 2016).

It should be emphasized that electrolytes such as phosphorus, magnesium, calcium, and potassium, when present in reduced concentrations, may lead to refeeding syndrome, characterized by metabolic and electrolyte disturbances (Reber *et al*., 2019; Pereira *et al*., 2022). This study verified that enteral nutrition administration did not exceed the Tolerable Upper Intake Level (UL) for other micronutrients, indicating no risk of adverse health effects from excessive intake.

Literature remains scarce regarding studies analyzing folic acid adequacy levels in enteral formulas for intensive care unit patients, underscoring the significance of our research.

According to Berger *et al*. (2022), the Dietary Reference Intakes (DRIs) present significant limitations for application in critically ill patients, as they were developed based on healthy populations and do not account for the increased requirements,

metabolic alterations, hyperinflammatory states, and abnormal micronutrient losses frequently observed in acute and critical conditions. In settings such as sepsis, trauma, major burns, or continuous renal replacement therapy, DRIs may be insufficient to replenish deficits or meet elevated metabolic demands.

In light of this, the guideline from the European Society for Clinical Nutrition and Metabolism (ESPEN) emphasizes the need for a patient-tailored approach, which includes regular laboratory monitoring of specific micronutrients (such as selenium, zinc, and vitamins C, D, and B complex) and consideration of pharmacological supplementation alongside appropriate nutritional support when there is evidence of deficiency, increased losses, or significant inflammatory responses, all accompanied by ongoing clinical and biochemical reassessment for therapeutic adjustment (Berger *et al*., 2022).

This study has inherent limitations. First, its retrospective design precluded the control for potential confounders, including detailed clinical and hemodynamic variables. Second, the assessment of micronutrient adequacy was based solely on enteral intake compared to DRIs, without the complementary data of plasma level measurements to confirm biochemical status. Further studies are imperative to better comprehend the role of these nutrients in this population and the complications associated with their inadequacy.

Notably, no available publications have examined this specific patient population (critically ill obese individuals), making it impossible to compare our findings with existing literature. This highlights the novel contribution of the present study to the field of clinical nutrition.

5 CONCLUSION

The findings of this study demonstrate that exclusive enteral nutrition administered to critically ill obese patients in the ICU failed to meet dietary recommendations for 12 essential micronutrients. However, nutrient provision remained within tolerable upper limits, thereby avoiding risks of toxicity.

The identified nutritional inadequacy underscores the need for a more individualized approach when prescribing enteral formulas for this population, considering the specific challenges of critical obesity and hypermetabolic states. The lack of specific guidelines for micronutrient adequacy in critically ill obese patients

highlights the urgent need for further research, including prospective studies and clinical trials, to inform updates in nutritional recommendations.

Furthermore, the complexity of enteral nutrition prescription and administration emphasizes the fundamental role of clinical dietitians within the ICU multidisciplinary team. Continuous assessment of nutritional support is crucial for minimizing deficiencies and enhancing clinical outcomes in this patient population.

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DECLARATION OF CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest linked to this research.

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