Original Article

Body mass index is not accurate to diagnose malnutrition in hospitalized patients: a cross-sectional analysis

Índice de massa corporal não é acurado para diagnosticar desnutrição em pacientes hospitalizados: uma análise transversal

DOI: 10.37111/braspenj.2022.37.4.09

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RESUMO

Introdução: A desnutrição é uma condição frequente em pacientes hospitalizados, e é associada com piores desfechos. O diagnóstico precoce de desnutrição permite que os profissionais direcionem intervenções nutricionais adequadas para redução das complicações. Neste contexto, ferramentas precisas devem ser adotadas ao invés do índice de massa corporal (IMC). Assim, o objetivo deste estudo foi confirmar a imprecisão do IMC para o diagnóstico de desnutrição em pacientes hospitalizados, considerando a Avaliação Subjetiva Global (ASG) como método de referência. **Método:** Foi realizado um estudo transversal com dados secundários de dois estudos longitudinais envolvendo pacientes com idade $\geq$ 18 anos, admitidos em dois hospitais do Sul do Brasil. Os pacientes foram avaliados, nas primeiras 72 horas após a admissão hospitalar, por uma equipe de pesquisa treinada que realizou o diagnóstico de desnutrição pelo IMC e ASG. As análises de acurácia e concordância foram estratificadas por idade, sexo e etnia. **Resultados:** No total, 1.348 pacientes foram incluídos na análise (54,5±15,2 anos, 51,9% do sexo feminino e 82,4% de cor branca autorreferida). O IMC identificou desnutrição em 8,7% (n = 117) da amostra total, enquanto a ASG diagnosticou desnutrição em 32,4% (n = 437) dos pacientes. A acurácia do IMC foi insatisfatória (curva AUC ROC = 0,541; CI95% 0,508-0,574); e sensibilidade (55,6%), especificidade (67,7%) e valor preditivo positivo (14,1%) foram baixos, enquanto o valor preditivo negativo (94,1%) foi alto. O coeficiente Kappa demonstrou baixa concordância entre IMC reduzido e ASG para diagnóstico de desnutrição (k = 0,100). O mesmo padrão de resultados foi observado na análise estratificada por idade, sexo e etnia. **Conclusão:** O IMC não foi preciso para o diagnóstico de desnutrição em uma grande amostra de pacientes, independentemente da idade, sexo e etnia. Assim, esses resultados confirmam que o IMC é inadequado para avaliação nutricional na prática clínica.

ABSTRACT

Introduction: Malnutrition is a frequent condition in hospitalized patients, and it is related to worse outcomes. The early diagnosis of malnutrition in hospitalized patients allows clinicians to target appropriate nutrition interventions to reduce complications. For this purpose, accurate tools should be adopted instead of body mass index (BMI). Then, we aimed to confirm the inaccuracy of BMI for malnutrition diagnosis in hospitalized patients, considering subjective global assessment (SGA) as the reference method. **Methods:** We conducted a cross-sectional study with secondary data from two longitudinal studies and analyzed data of patients aged $\geq$ 18 years included in two cohorts conducted in two South-Brazilian hospitals. They were evaluated in the first 72 hours after hospital admission by a trained research team that diagnosed malnutrition by BMI and SGA. Analysis of accuracy and concordance were stratified by age, sex and ethnicity. **Results:** A total of 1,348 patients were included in the analysis (54.5±15.2 years, 51.9% females, and 82.4% of white self-reported ethnicity). The BMI identified malnutrition in 8.7% (n = 117) of the total sample, while the SGA diagnosed malnutrition in 32.4% (n = 437) of patients. BMI accuracy was unsatisfactory (AUC ROC curve=0.541; CI95% 0.508-0.574); and sensitivity (55.6%), specificity (67.7%), and positive predictive value (14.1%) were low, while negative predictive value (94.1%) was high. The Kappa coefficient showed a poor concordance between reduced BMI and SGA for malnutrition diagnosis (k = 0.100). The same pattern of results was observed in analysis stratified by age, sex and ethnicity. **Conclusions:** BMI was not accurate for malnutrition diagnosis in a large sample of patients, regardless of age, sex and ethnicity and these results confirm that BMI is inappropriate for nutritional assessment in clinical practice.

Unitermos:
Desnutrição. Índice de massa corporal. Avaliação nutricional. Hospitalização.

Keywords:
Malnutrition. Body mass index. Nutrition assessment. Hospitalization.

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Submission:
June 17, 2022

Accepted for publication:
December 16, 2022

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INTRODUCTION

Malnutrition has a complex and multifactorial etiology, which involves insufficient nutrient intake, impaired nutrient absorption due to disease or trauma, and consequently increased metabolic demand[1,2]. Malnutrition prevalence can reach up to 60% of patients at hospital admission, and it is associated with worse outcomes, including delayed wound healing and ineffective response to infection treatment, prolonged hospitalization, as well as hospital readmission, risk of death, and higher healthcare costs among these patients[3-7]. Then, the early diagnosis of malnutrition as well as the prompt initiation of appropriate nutrition-focused interventions is essential to improve clinical outcomes by reducing complications and mortality[8].

Despite malnutrition being a highly prevalent condition in the hospital setting and being associated with negative clinical outcomes, it is commonly underdiagnosed by healthcare providers. A Brazilian study involving 4,000 hospitalized patients diagnosed 48.1% of malnutrition, but less than 18.8% of medical records presented information about nutrition-related issues[9]. On the same note, a Canadian study found that less than 33% of hospitalized patients' nutritional assessment registries contained information on weight loss history, appetite status, current oral intake, and functional status[10]. One reason for this is probably the lack of a universally accepted tool for malnutrition diagnosis.

The Subjective Global Assessment (SGA) developed by Detsky et al.[11] is a well-established and widely used method for performing malnutrition diagnosis in hospitalized patients, being considered the reference tool for this assessment[8]. The SGA consists of nutritionally relevant features of the clinical history, including decreased nutrient intake, unintentional weight loss, symptoms affecting oral intake, functional capacity, and metabolic demand added to a physical examination that focuses on subcutaneous fat loss, muscle wasting, and fluid accumulation[11].

Although the SGA has been published for more than 30 years, many studies and clinicians still use body mass index (BMI) alone to diagnose malnutrition. Eschbach et al.[12] have demonstrated that 54% of German geriatric trauma centers adopted BMI to diagnose malnutrition. In addition, in a systematic review regarding hospital malnutrition prevalence, among 66 included studies 21 of them used BMI for malnutrition diagnosis[3]. This causes concern because the use of BMI in hospital clinical practice presents several limitations. It does not differentiate between muscle and adipose tissue and may also be influenced by fluid accumulation and mask malnutrition in patients with an excess of fat mass[13]. Furthermore, BMI does not recognize the history of body weight loss - an essential component for malnutrition diagnosis according to SGA and other tools validated for this proposal[14,15].

Due to these limitations, the accuracy of BMI for malnutrition diagnosis in hospital settings is questionable and related to the under-identification of this condition. In fact, in a cohort of 1,015 hospitalized patients, the proportion of malnourished patients by SGA at hospital admission was 45%, while 9% had a low BMI[16]. As of yet, published data on the accuracy of low BMI compared to SGA as a reference method have been limited to hospitalized[17] and in long-term care facilities elderly[18], oncology[19], critically ill[20], and surgical[21] patients, being required further confirmation in a large population of general hospitalized patients considering their sex, ethnicity, and age. Thus, the current study aimed to confirm the inaccuracy of BMI for malnutrition diagnosis in hospitalized patients considering some specific sociodemographic features.

METHODS

We conducted a cross-sectional study through a secondary analysis of two prospective studies involving patients admitted to two South-Brazilian hospitals, previously published[22,23]. The inclusion criteria for both studies were patients of both sexes aged equal to or older than 18 years old, lucid, and able to walk. The exclusion criteria were patients unable to communicate, pregnant or lactating women, patients with anasarca, and patients in intensive care units.

The sample was selected by convenience, and we did not perform a sample size estimation. We included all patients with data available from both cohorts. Both cohort studies presented similar protocols, and the Ethics Committee of Hospitals approved them (number 360.639 and number 2.735.945).

We collected sociodemographic, clinical, and nutritional data through the databases of the both cohorts, including patients' self-reported ethnicity, age, and gender. We also obtained data on the hospital admission reason and medical history - these data were obtained from medical records in the primary studies. In addition, we extracted the data of nutritional assessment from the databases. In both primary cohorts, the dietitians assessed patients in the first 72 hours after hospital admission and obtained anthropometric measurements [body weight (kg) and height (cm)] with patients wearing as light clothing as possible and not shoes. Body index mass (BMI) was calculated as [weight/ (height*height)] and expressed in kg/m^2. Patients were classified as malnourished if their BMI was < 18.5 kg/m^2 for patients with < 65 years old and $<$ 22 kg/m^2 for patients with ≥ 65 years old, considering the cutoff points proposed by the World Health Organization[24] and Lipschitz[25], respectively. The other categories of BMI (kg/m^2) for adults proposed by the World Health Organization included: normal weight 18.5–24.9; overweight 25.0–29.9; obesity class I 30.0–34.9; obesity class II 35.0–39.9; obesity class III ≥ 40, and for older people, as proposed by Lipschitz[25], normal weight: 22–27 and overweight >27.

For malnutrition diagnosis according to SGA, dietitians interviewed the patients about their actual and usual body weight (in the previous six months), and the percentage of body weight loss was calculated ([usual body weight - actual body weight] *100/usual body weight). Information about changes in food intake (amount and consistency of food intake) and gastrointestinal symptoms (diarrhea, nausea, vomiting, anorexia) in the last two weeks. Self-reported daily activities guide us to evaluate functional capacity, and the stress of disease orients us to stratify metabolic demand as mild, moderate, or severe. In the physical examination, we investigate the loss of muscle and fat mass and its magnitude. Also, we investigated fluid accumulation in the extremities and ascites. And for each finding from a physical examination, we adopted four possible categories: normal (not present), mild, moderate, or severe. After that, we subjectively classified the patients as well-nourished (SGA A), suspect or moderate malnourished (SGA B), or severely malnourished (SGA C)[11].

For data analysis descriptive statistics, we calculated mean and standard deviation for parametric quantitative variables, median and interquartile amplitude for non-parametric variables, and absolute and relative frequency for categorical variables. Categories SGA-B and SGA-C were grouped as malnutrition for data analysis. We calculated the Kappa (k) coefficient and constructed the receiver operating characteristics (ROC) curve with a confidence interval (CI) of 95%. We classified Kappa values as 0.20 as poor, 0.21-0.40 as fair, 0.41-0.60 as moderate, 0.61-0.80 as substantial, 0.81-0.99 as almost perfect, and 1.00 as perfect[26]. Sensitivity, specificity, positive and negative predictive values were obtained, and the following cutoffs for classification were used: 90 to 100% as high, 80 to 89% as moderate, and 79% as low[27]. We also conducted analysis stratified by self-reported ethnicity (white or non-white), gender (males or females), and age (65 years or older). All analyses were carried out using the SPSS 23.0 program, and P values of 0.05 were considered statistically significant.

RESULTS

We included a total of 1,348 patients in the study, the mean age was 54.5 ± 15.2 years, and the most of patients were females (n = 700; 51.9%) and of self-reported white ethnicity (n = 1111; 82.4%). The major causes of hospitalization were cancer (n = 451; 33.5%), gastrointestinal (n = 209; 15.5%), heart (n = 161; 12.0%), and lung (n = 118; 8.8%) diseases. The mean of actual body weight and height were 73.59 ± 17.53 kg and 162.07 ± 9.38 cm, respectively. The mean BMI was 27.98 ± 6.09 kg/m^2. The BMI identified malnutrition in 8.7% (n = 117) of the total sample, while the SGA diagnosed malnutrition in 34.3% (n = 462) of patients.

Table 1 describes the results of BMI performance for diagnosing malnutrition, considering SGA as a reference method. The concordance of BMI with SGA in diagnosing malnutrition was poor, and the sensitivity, specificity, and positive predictive value were low, while the negative predictive value was high.

The analyses stratified by self-reported ethnicity, sex, and age of patients revealed the same pattern of results (Table 2). In the subgroup of patients with < 65 years old (n = 972), 34.8% (n = 338) and 5.9% (n = 57) were classified as malnourished according to SGA and reduced BMI, respectively. Figure 1A presents the frequency of malnourished patients according to SGA distributed in the categories of BMI in this subgroup. It was observed that a high proportion of malnourished patients by SGA (35.5%) were classified as eutrophic according to BMI. In patients with > 65 years old (n = 376), the prevalence of malnutrition was 33.2% and 16% according to SGA and BMI, respectively. Figure 1B shows the frequency of malnourished patients according to SGA distributed in the categories of BMI in this subgroup: the majority of malnourished patients (42.7%) presented BMI > 27 kg/m^2.

Table 1 – Performance of reduced BMI for malnutrition diagnosis considering SGA as reference method.

Statistics	Results
AUC ROC curve (95% CI) *(P value)*	0.541 (0.508 - 0.574) (0.013)
Sensitivity	55.6%
Specificity	67.7%
Positive predictive value	14.1%
Negative predictive value	94.1%
Kappa coefficient (P value)	0.100 (<0.001)

Table 2 – Performance of reduced BMI for malnutrition diagnosis stratified by self-reported ethnicity, sex and age of patients (SGA as reference).

Statistics	Self-reported ethnicity		Sex		Age	
	White (n = 1111)	**Non-white (n = 237)**	**Males (n= 648)**	**Females (n = 700)**	**< 65 years (n = 972)**	**≥ 65 years (n = 376)**
AUC ROC curve (95% CI) (P value)	0.539 (0.502 - 0.575) (0.036)	0.546 (0.468 - 0.624) (0.246)	0.538 (0.490 - 0.586) (0.118)	0.543 (0.498 - 0.589) (0.058)	0.532 (0.493 - 0.571) (0.098)	0.532 (0.493 - 0.571) (0.098)
Sensitivity	53.1%	66.7%	51.7%	59.6%	59.6%	51.7%
Specificity	68.6%	63.2%	68.8%	66.8%	66.8%	70.6%
Positive predictive value	13.8%	13.5%	14.0%	13.8%	10.1%	25.0%
Negative predictive value	93.9%	95.7%	93.5%	94.9%	96.4%	88.5%
Kappa coefficient (P value)	0.095 (<0.001)	0.106 (0.013)	0.093 (0.002)	0.105 (<0.001)	0.080 (<0.001)	0.155 (0.001)

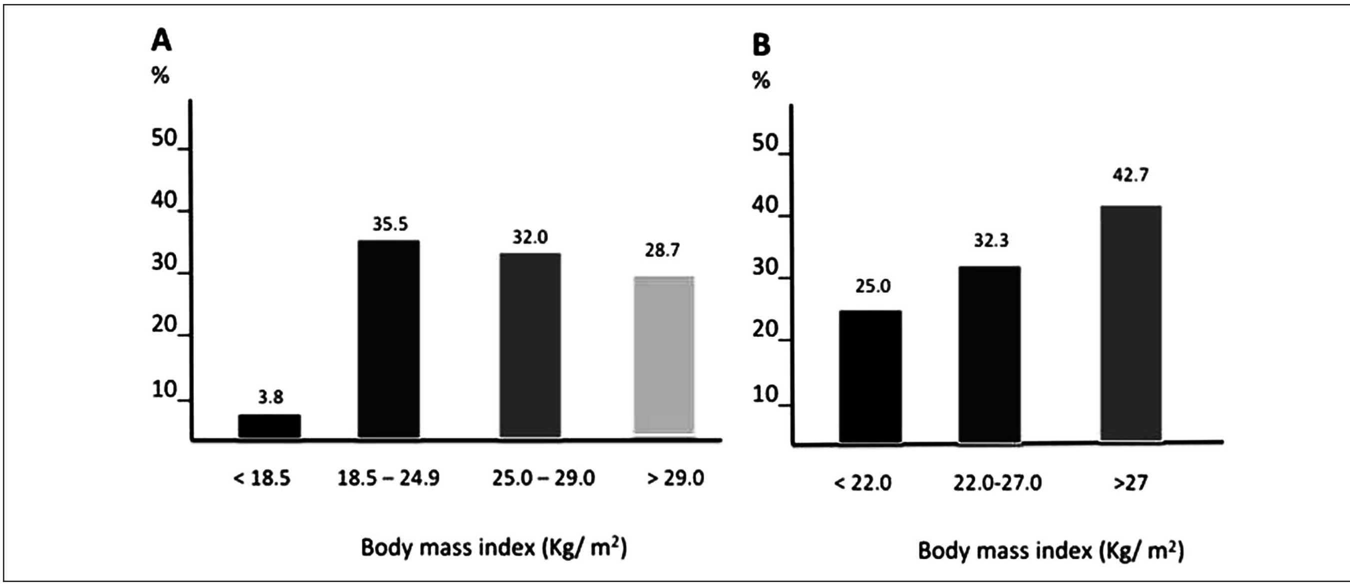

Figure 1 - *Frequency of malnutrition, according to SGA, into the categories of BMI for patients with < 65 years (n of malnourished patients = 265/791) and > 65 years (n of malnourished patients = 197/557).*

DISCUSSION

The current study aimed to investigate the performance of established cut-off points of BMI for malnutrition diagnosis in adults and elderly hospitalized patients, demonstrating that it is inaccurate for this purpose due to the poor concordance with SGA and low sensitivity/specificity in comparison to this reference method. So, the BMI should not be adopted alone for malnutrition diagnosis in hospital settings.

There is no worldwide gold standard for malnutrition diagnosis in the hospital setting. However, the SGA is by far the most highly validated tool for malnutrition diagnosis in hospitalized patients. Recently, the Global Leadership Initiative on Malnutrition (GLIM) proposed a new framework for malnutrition diagnosis and published guidance for tool validation[15]. The authors recommend that the studies adopt a semi-gold standard for evaluating the concurrent validity and mention the SGA for this purpose. Similarly, a recent systematic review convened a 5-member technical expert panel who agreed that there is currently no universally accepted gold-standard for malnutrition assessment and measurement in hospital settings[28]. However, SGA was referred to as a semi-gold standard for classifying malnutrition, considering it to be the most highly respected and usually adopted in the research environment and in clinical practice. Taken together with this evidence, the SGA was considered the reference method for malnutrition diagnosis in the present study.

This study identified, according to SGA, malnutrition in more than 30% of patients, while according to BMI, less than 10% of patients had malnutrition. Our findings are also consistent with several other reports comparing malnutrition prevalence by SGA and BMI. Among 1152 older hospital inpatients, the SGA criteria revealed malnutrition in 36% of participants, whereas the BMI identified this condition in 7.8% of participants[16]. In a prospective study including 300 surgical patients assessed at hospital admission, the authors found malnutrition in 64% of the sample by SGA, while only 6% of the patients met the underweight criteria[21]. Vliet et al.[29] reported that among the 430 hospitalized patients analyzed, malnutrition risk was present in 42% of them according to the Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF), while only 3% had low BMI. Taken together these studies show that regardless of patient condition, the use of isolated BMI will underdiagnose malnutrition, and is therefore contraindicated for use at an individual patient level.

The accuracy of BMI to identify malnourished patients was unsatisfactory, as we identified a low AUC of the ROC curve, independent of age, sex, and self-reported ethnicity. A prospective cohort study involving gastric and colorectal cancer patients also showed an inaccuracy of low BMI to identify malnutrition due to low AUC of the ROC curve (0.560) and sensitivity (17.4%)[19]. Almeida et al.[21] showed poor concordance (k = 0.068) and low values of sensitivity (43% and specificity (39%) when comparing low BMI to SGA for malnutrition diagnosis in a sample of 300 patients. Similarly, Tran et al.[20] also showed that the isolated use of BMI is inappropriate to identify malnutrition in a study involving 693 hospitalized adults in acute care settings. Although they found moderate accuracy (AUC = 0.700), its sensitivity (39.6%) and positive predictive value (39.4%) were very low[20].

One of the main shortcomings of BMI for nutritional assessment is its emphasis on specificity rather than sensitivity, which may hinder its ability to detect malnourished patients early and could mislead clinicians and dietitians. Indeed, our findings and several studies confirmed its high specificity and low sensitivity for diagnosing malnutrition[17-21]. Thus, while

BMI can diagnose well-nourished patients, its use to identify malnutrition will generate a high number of false negatives, which is problematic, as it can contribute to negligible care. In fact, in any diagnostic test evaluation, it is essential to consider its intrinsic properties as sensitivity (probability of a positive test given the condition presence) and specificity (probability of a negative test given the condition absence)[30]. For their part, positive predictive value (the percentage of correct positive diagnoses) and negative predictive value (the percentage of correct negative diagnoses) have greater relevance in clinical practice because they determine the test's usefulness for a specific condition diagnosis[30]. In our study, the low sensitivity and low positive predictive value of BMI demonstrated its inaccuracy, resulting in malnutrition underdiagnosis. It highlights the problem of relying exclusively on the BMI for nutritional diagnosis because it exposes patients to health risks by neglecting to allow them to receive mandatory nutrition therapy, early and adequate, which increases the chances of nutritional decline in the patients.

The BMI inaccuracy is due to some factors. First, it does not reflect body composition, mainly in older adults[31]. Second, in overweight or obese cases, it demands a massive weight reduction before meeting underweight criteria. Third, in the same sense, the BMI does not capture the weight loss pattern. The proportion and pattern of weight loss are critical data for the nutritional assessment of the patient[11]. Weight loss is a known nutrition concern because it per se is an independent predictor of poor outcomes. Barazzoni et al.[32] analyzed the nutritionDay database of non-critically ill hospitalized patients and demonstrated that short-term (3-month) self-reported weight loss was an independent predictor of 30-day mortality, even in overweight and obese patients.

It is necessary to keep in mind that malnutrition is a continuum, starting with a lack of uptake or intake of nutrition, leading to diminished physical function, and finally resulting in altered body composition and underweight[11]. Then, although the association between low BMI and poor clinical prognosis in hospitalized patients is substantial and confirmed by several studies available on this topic[33,34], it's a late parameter, because it detects patients in the final stage of malnutrition. This limitation is further amplified in overweight or obese patients because the weight loss needs to be very severe to change the BMI category. Our findings show that more than 60% of malnourished patients by SGA over the age of 65 are overweight or obese. In addition, among malnourished elderly patients, almost 43% of them presented with overweight or obesity. Similarly, Vilet et al.[29] showed that 36% of the 258 inpatients with overweight or obesity according to BMI were at risk for malnutrition according to the PG-SGA SF.

The strengths of this study include its large and representative sample and the use of SGA - a reference method in the nutritional assessment of hospitalized patients. On the other hand, the use of the SGA can also be seen as a weakness of the study because it is subject to errors due to its inherent subjectivity and the dependence of its diagnostic accuracy on the observer's know-how in identifying nutritional changes. However, to minimize these limitations, the research coordinator - with methodological expertise in the area - trained all observers *in loco* and supervised all evaluations during the first week of the studies. Also, the research coordinator reviewed and, if needed, corrected all SGA data collection forms completed for both cohorts. Concerning the external validity of the present study, although our sample is heterogeneous, representing the population of patients in high complexity hospitals, the eligibility criteria applied (inclusion of lucid patients, able to communicate to answer the interview, and to walk to the anthropometric scale for weighing, as well as the exclusion of patients with anasarca and critically ill) may compromise the generalization of our findings.

Regarding the clinical applicability of our results, they confirmed that BMI is an extremely deficit surrogate for determining nutritional status, could mislead clinicians/dietitians, and its use is inappropriate for malnutrition diagnosis or to guide clinical decision-making at an individual patient level[13]. Therefore, the ideal is to adopt a multidimensional evaluation using a comprehensive nutritional assessment tool that involves a group of malnutrition components, such as loss of appetite, insufficient energy intake, impaired nutrients assimilation due to inflammation, weight loss, loss of muscle mass and subcutaneous fat, edema/fluid accumulation and reduction of functional capacity. For this purpose, several tools are available, such as SGA[11], AND-ASPEN[14], and GLIM[15]. Our research group has already validated both AND-ASPEN[23] and GLIM criteria[7] for malnutrition diagnosis of non-critically ill patients considering SGA as a reference method and demonstrated that they have similar accuracy[35], and the choice for one or other should be made respecting the particularities of each Nutrition Service.

CONCLUSION

Reduced BMI for adults and the elderly was not accurate for malnutrition diagnosis in a large sample of hospitalized patients, regardless of their age, sex, and self-reported ethnicity, and its use is inappropriate in clinical practice for nutritional assessment.

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Institution where the study was conducted: Universidade Federal de Ciências da Saúde de Porto Alegre, Porto Alegre, RS, Brazil.

Conflict of interest: The authors have no conflicts of interest to declare.

Funding/financial disclosures: Simone Bernardes received a scholarship as a Master's student from the Coordination for the Improvement of Higher Education Personnel (CAPES). Flávia Moraes Silva received a productivity scholarship (PQ2) from the Brazilian National Council for Scientific and Technological Development (CNPq).