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ORIGINAL

Discriminative ability of a nutritional risk questionnaire applied to patients with celiac disease

Capacidad de discriminación de un cuestionario de riesgo nutricional aplicado a pacientes con enfermedad celíaca

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ABSTRACT

A questionnaire can be a rapid tool to identify nutritional risk, allowing early intervention, especially in people with diseases such as celiac disease, where poor absorption of nutrients can cause severe deficiencies. This study assessed nutritional risk in 35 patients with prior informed consent, using a validated questionnaire, and analyzing its sensitivity and specificity. The study revealed that 65,7 % are malnourished, with 48,6 % underweight, especially children (72,7 %) and adults (54,5 %). In addition, 5,7 % of patients, especially young people, are obese (16,7 %). The application of the "Nutritional Screening Initiative" questionnaire showed that 66,7 % are at nutritional risk, requiring improved eating habits. The correlation analysis indicated a significant association between BMI and nutritional risk. The ROC curve indicated a low discriminatory capacity, although the sensitivity was high (91,7 %), correctly identifying cases at nutritional risk. However, at other thresholds, decision-making is almost random, as indicated by the sensitivity and specificity. It is concluded that the ROC curve suggested limitations in the capacity to discriminate nutritional risk, with a high sensitivity but moderate specificity. It is crucial to implement personalized nutritional interventions and improve classification models to more accurately identify risk in this population.

Keywords: Nutritional Risk; ROC; Specificity; Sensitivity; Celiac Disease.

RESUMEN

Un cuestionario puede ser una herramienta rápida para identificar el riesgo nutricional, permitiendo una intervención temprana, sobre todo en personas con enfermedades como la celiaquía, en donde la mala absorción de nutrientes puede causar deficiencias graves. Este estudio evaluó el riesgo nutricional en 35 pacientes previo consentimiento informado, utilizando un cuestionario validado, y analizando su sensibilidad y especificidad. El estudio reveló que el 65,7 % presenta malnutrición, con un 48,6 % en bajo peso, especialmente niños (72,7 %) y adultos (54,5 %). Además, el 5,7 % de los pacientes sobre todo jóvenes tienen obesidad, (16,7 %). La aplicación del cuestionario "Nutritional Screening Initiative" mostró que el 66,7 % está en riesgo nutricional, requiriendo mejoras hábitos alimentarios. El análisis de correlación indicó una asociación significativa entre IMC y riesgo nutricional. La curva ROC señaló baja capacidad discriminativa, aunque la sensibilidad fue alta (91,7 %), identificando correctamente los casos en riesgo nutricional, sin embargo

en otros umbrales la toma de decisiones es casi aleatorio, como lo señala la sensibilidad y especificidad. Se concluye indicando que la curva ROC sugirió limitaciones en la capacidad de discriminación del riesgo nutricional, con una sensibilidad alta pero especificidad moderada. Es crucial implementar intervenciones nutricionales personalizadas y mejorar los modelos de clasificación para identificar de manera más precisa el riesgo en esta población.

Palabras clave: Riesgo Nutricional; ROC; Especificidad; Sensibilidad; Celiaquía.

INTRODUCTION

The discriminative ability of a questionnaire determines its effectiveness in relation to different groups or conditions; it must correctly identify those who do or do not have a specific characteristic or disease.[1]

Brief questionnaires to identify nutritional risk are practical and efficient tools used for patients with potential nutritional deficiencies or at risk of developing malnutrition. These assessments provide an initial screening that facilitates the identification of individuals needing more in-depth nutritional intervention, helping prevent complications associated with poor nutritional status, such as infections or a worse prognosis in chronic diseases.[2]

This nutritional risk questionnaire is used in various population groups, such as the elderly, hospitalized patients, and patients with chronic diseases,[3] providing results within minutes and allowing for early intervention.

Malnutrition in celiac patients is a common challenge due to the nature of the disease, an autoimmune disorder affecting the small intestine in response to gluten consumption. The inflammation and damage to the intestinal villi characteristic of this disease impair the proper absorption of essential nutrients, such as iron, calcium, B vitamins, and other micronutrients, which can lead to severe nutritional deficiencies.

Although celiac disease predominantly affects the digestive system, its effects extend to multiple body systems, manifesting in symptoms such as fatigue, anemia, weight loss, and osteoporosis, as a consequence of prolonged poor nutrient absorption.[4]

In many cases, malnutrition is the first sign of celiac disease, especially in undiagnosed children and adults or those not strictly following a gluten-free diet.[5]

Thus, it is important to perform a nutritional risk assessment for early detection of deficiencies or excesses that can affect health. This approach allows the identification of individuals or populations at risk of developing health problems related to diet, such as malnutrition, obesity, or non-communicable chronic diseases (NCDs) like diabetes and cardiovascular diseases. It is based on the collection of clinical, biochemical, anthropometric, and dietary data to assess nutritional status and determine potential interventions.

Therefore, the evaluation of nutritional risk using tools that include questionnaires, biomarkers, and more precise instruments such as body measurements not only focuses on risk identification but also helps in the initial prevention and management of causal factors that can improve quality of life and reduce healthcare costs.[6]

The objective of this research was to evaluate the nutritional risk of celiac patients through a previously validated “Nutritional Screening Initiative” questionnaire, as well as to determine its sensitivity and specificity.

METHOD

This was a descriptive study in which 70 % of the celiac population registered with the “Celiacs of Ecuador” Foundation participated, from which patient recruitment was conducted. Random selection was not applied; thus, a sample was not taken, as the number did not exceed 60 participants.

A “Nutritional Screening Initiative” (NSI) questionnaire developed by the American Academy of Family Physicians was applied, which primarily assesses risk in older adults but is also useful for patients with chronic diseases. Additionally, anthropometric data of weight and height were collected, with all participants signing an informed consent or providing assent when unable to consent, ensuring the confidentiality of patient data and their well-being during the study. They were informed that participation was voluntary. Inclusion criteria included patients diagnosed with celiac disease of all age groups, both male and female, who follow a gluten-free diet. Patients with additional pathologies that could affect weight, those who did not sign the consent form, and patients who did not complete the nutritional risk questionnaire in a way that prevented accurate assessment were excluded. This resulted in a final sample of 35 patients diagnosed with celiac disease.

The nutritional risk questionnaire consisted of 10 dichotomous items, which included the following: “I have an illness or condition that changes the type or amount of food I eat; I eat fewer than two meals per day; I eat few fruits, vegetables, or dairy products; I drink three or more alcoholic beverages almost every day; I have dental or other problems making it difficult to eat; I do not always have enough money to buy the food

I need; I eat alone most of the time; I take three or more prescribed or over-the-counter medications; I have unintentionally lost or gained 5 kg in the past three months; I am not able to shop, cook, or feed myself." The questionnaire is interpreted based on cutoff points as follows: if the score is 0 to 2, it is considered as "no risk" or "good," and a reassessment of nutritional status is recommended in six months. A score of 3 to 5 implies a moderate nutritional risk, in which case steps should be taken to improve dietary habits and lifestyle, with reassessment in three months. A score of 6 or more indicates high nutritional risk, and nutritional status should be improved accordingly.[7,8,9,10]

Anthropometric assessment was conducted by measuring weight and height, with weight measured using a calibrated scale capable of weighing individuals from different age groups, and height measured with a stadiometer to obtain more precise results. Body mass index (BMI) was calculated using weight and height, using the ranges indicated by the WHO: <16,5 indicates undernutrition, 16,5 to 18,5 indicates thinness, 18,5 to 25 is normal, 25 to 30 is overweight, 30 to 40 is moderate obesity, and >40 is severe or massive obesity.[11] Measurements were taken in a comfortable environment, with patients instructed to wear light clothing. A standardized protocol was followed for measurements, such as body positioning, measurement technique, and being in a fasting state or having not eaten for three hours prior to weight measurement.

For statistical analysis, SPSS version 22 was used for descriptive analysis and inferential analysis in constructing a regression model and ROC curves, where the following formulas were applied to identify sensitivity and specificity:

$$LRx = \exp((\ln(p1/p2)+1{,}96 \times \sqrt{(1-p1/p1xn1)+(1-p2/p2xn2)})$$

Where: LRx = LR+, p1 = sensibility, p2 = (1-specificity) p1xn1 = A y p2xn2 = B.

RESULTS AND DISCUSSION

The research was conducted with patients from the "Celiacs of Ecuador" Foundation, presenting the following results.

Nutritional Status According to BMI

The results were divided by age group and sex, showing that 65,7 % of the population presented malnutrition, of which 48,6 % were underweight, mainly children (72,7 %) and adults (54,5 %). Additionally, 5,7 % of celiac patients were found to be obese, particularly among young adults (16,7 %). No significant statistical differences were found by age group and sex (p>0,05). The figure illustrates the high percentage of underweight patients, and if we compile malnutrition due to excess, the percentage is also high, especially among young adults (33,4 %), adults (18,2 %), and older adults (17,1 %).

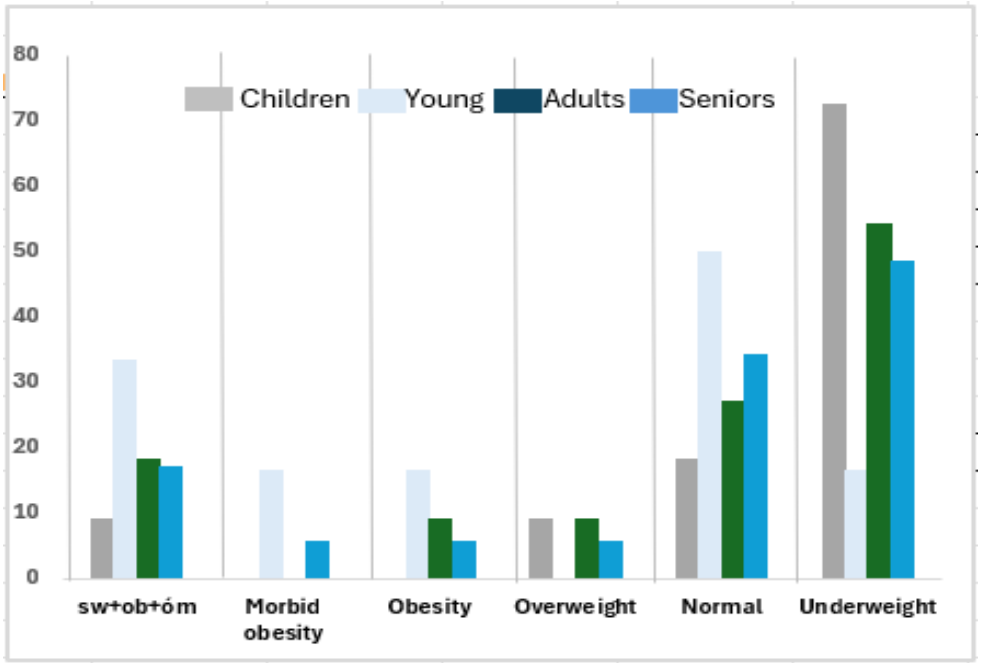

Figure 1. Nutritional status according to BMI, classified by age group

Figure 2 presents the descriptive results of the body mass index by age group, conducted on the patients who participated in the study, with young adults showing overweight (26,65±10,46).

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Cluster	Average	Desvest	V_Min	V_Max
Children	18.56	4.43	12.70	18.56
Young People	26.65	10.46	15.21	26.65
Adults	20.28	7.28	13.36	20.28
Older Adults	16.39	3.86	13.66	16.39

Figure 2. Descriptive statistics for BMI by age group

Nutritional Risk with the "Nutritional Screening Initiative" Questionnaire

The application of the questionnaire includes three cutoff points, classifying nutritional status as: good, moderate risk, and high risk. The highest frequency percentage is in the moderate nutritional risk category with 45,5 %, and 21,2 % are at high nutritional risk. This means that 66,7 % of patients are at risk, indicating that measures should be taken to improve dietary habits and lifestyle, according to the applied questionnaire.

Cohort points	Nutritional Risk	Pcts_Celiac	%_Pcts	%_Valid	%_Cumulative
0 to 2	Good	11	31.4	33.3	33.3
3 to 5	Moderate Risk	15	42.9	45.5	78.8
6 or more	High Risk	7	20.0	21.2	100.0

Figure 3. Nutritional risk of celiac patients by cutoff points

Discriminative Ability of the Nutritional Risk Questionnaire

Correlation Analysis

A non-parametric measure of rank correlation was applied since there was an ordinal variable; the strength and direction of the association between BMI and cutoff points according to the questionnaire used were measured. In this case, Kendall's tau-b gave a value of 0,487 with a probability (p = 0,003), implying an acceptable association of variables with significant correlation at the 0,01 level (2-tailed).

ROC Curve

The Receiver Operating Characteristic (known as the ROC curve) is an important tool used to distinguish nutritional risk or no risk in celiac patients. The study utilized the ROC curve to assess the capacity of the binary classification model at different thresholds.

The area under the curve (AUC) distinguished patients at risk versus no risk at a confidence interval (CI = 0,95), yielding a value of 0,504, close to no discrimination, meaning that the ability to distinguish between celiac patients with or without nutritional risk is not very good. Nonetheless, it is important to mention that the AUC is a sample estimator of a population parameter, whose interval includes the value 0,50 (95 % CI: 0,31-0,70), without which it would not be possible to assert that the AUC of PCT concentration is different from no discrimination. The asymptotic significance was 0,971, indicating insufficient evidence to conclude that the model is significantly different from a random model.

On the other hand, the sensitivity was 0,917, indicating that the model is correctly identifying 91,7 % of truly positive cases, which suggests it is effective in minimizing false negatives (FN). However, it has moderate specificity, with a value of 0,636, implying that the model is correctly identifying only 63,6 % of negative cases, but will incorrectly label 37 % as positive.

The threshold was also calculated using the Youden index (J = Sensitivity + Specificity - 1), which helps identify the cutoff point. In this case, as BMI is a continuous value, we found a threshold that divides individuals into "nutritional risk" or "no nutritional risk" with a value of 16,04, which maximizes the difference between sensitivity and specificity. In other words, if a person's BMI is equal to or less than 16,04, the model would classify them as being at nutritional risk.

In the figure 4, it can be seen that the curve partially crosses a diagonal, which may indicate that the model is effective for certain decision thresholds but that decision-making is almost random at other thresholds, as indicated by sensitivity and specificity.

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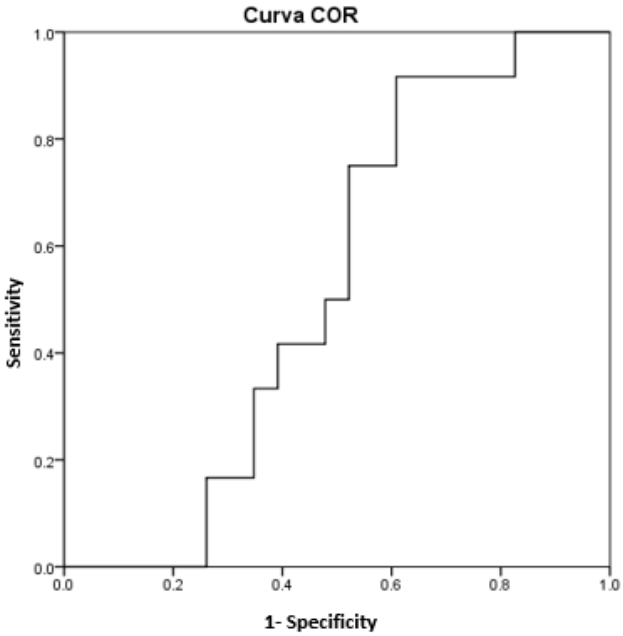

Figure 4. ROC Curve

DISCUSSION

The results of the study on nutritional status based on Body Mass Index (BMI) and the nutritional risk of celiac patients reveal important findings regarding the prevalence of malnutrition across different age groups and sexes. It was found that 65,7 % of the population had malnutrition, with 48,6 % being underweight, predominantly children (72,7 %) and adults (54,5 %). These findings are consistent with previous studies highlighting the high prevalence of malnutrition in celiac patients, who, despite following a gluten-free diet, may still face issues with nutrient absorption and underweight status.[12]

While underweight is a significant issue, malnutrition due to excess was also observed in a substantial percentage of the population, particularly among young adults (33,4 %). These results align with studies showing an increase in obesity among celiac patients, especially in young adults, who may gain weight when adopting gluten-free diets, suggesting poor dietary management and unhealthy eating habits.[13] Additionally, 5,7 % of celiac patients were found to be obese, with young adults being most affected (16,7 %). This phenomenon is consistent with the global trend of increasing obesity in the young population, particularly among those with chronic conditions like celiac disease.[14]

Regarding nutritional risk assessment, the application of the "Nutritional Screening Initiative" identified that 45,5 % of the patients were at moderate risk and 21,2 % at high risk, indicating that 67,7 % of the studied population was at nutritional risk. These results underscore the need for intervention in the eating habits of this population, as the high percentage of people at nutritional risk could be related to dietary deficiencies or poor control of a gluten-free diet, which can negatively impact their long-term health.[15]

Furthermore, the correlation analysis between BMI and the cutoff points from the questionnaire revealed a significant correlation (Kendall's tau-b = 0,487, p = 0,003), suggesting a moderate association between the two variables. This result is important as it indicates that the questionnaire, while not perfect, is a useful indicator for evaluating nutritional risk in celiac patients, as noted in studies using tools to assess nutritional status in this population.[16]

However, the analysis of the ROC curve indicated that the model is good at identifying true positives but has moderate performance in identifying true negatives. Although this result is not ideal, it is common in clinical studies for some classification models not to show high discriminative capacity.[17,18] The asymptotic significance of 0,971 also reinforces the lack of evidence to assert that the model is significantly better than a random one.

CONCLUSION

Overall, the results of this study highlight the high prevalence of malnutrition and nutritional risk in celiac patients, particularly among younger and adult age groups. Although BMI is a useful tool for assessing nutritional status, the ROC curve results suggest that improvements are needed in classification models for more accurate identification of nutritional risk in this population. Personalized nutritional interventions and the implementation of strategies to improve eating habits are necessary to reduce nutritional risk and improve the quality of life of these patients.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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