

Comparative Performance of Objective Nutritional Indices for Identifying GLIM-Defined Malnutrition in Crohn's Disease

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Abstract

Background: Malnutrition is highly prevalent among patients with Crohn's disease (CD) and is associated with adverse clinical outcomes. The Global Leadership Initiative on Malnutrition (GLIM) provides a standardized framework for the diagnosis of malnutrition but does not specify a preferred screening tool for the initial assessment of nutritional risk. This study compared five objective nutritional indices: the Geriatric Nutritional Risk Index (GNRI), the Controlling Nutritional Status (CONUT) score, the Prognostic Nutritional Index (PNI), the Triglyceride–Total Cholesterol–Body Weight Index (TCBI), and the Naples Prognostic Score (NPS). Their associations with and discriminative performance for identifying GLIM-defined malnutrition in patients with CD were evaluated.

Methods: This retrospective cross-sectional study included 350 patients with CD, for whom demographic, clinical, anthropometric, and laboratory data were extracted from electronic medical records. Nutritional risk was initially screened using NRS-2002, and GLIM-defined malnutrition was subsequently determined according to the GLIM criteria in patients identified as being at nutritional risk. The associations between the five nutritional indices and GLIM-defined malnutrition were examined using logistic regression analysis. Their discriminative performance was evaluated using receiver operating characteristic (ROC) curve analysis, while the relationship between GNRI and GLIM-defined malnutrition was further characterized using restricted cubic spline analysis.

Results: All five nutritional indices remained significantly associated with GLIM-defined malnutrition after multivariable adjustment (all $P < 0.05$). GNRI yielded the highest observed area under the ROC curve (AUROC) for identifying GLIM-defined malnutrition (AUROC = 0.822, 95% confidence interval [CI]: 0.778–0.860). The optimal GNRI cutoff value was 100.96. Pairwise DeLong comparisons showed that the AUROC for GNRI was significantly higher than those for the other four indices (all $P < 0.05$). Restricted cubic spline analysis further demonstrated a significant nonlinear association between GNRI and GLIM-defined malnutrition (P for overall association < 0.001 ; P for nonlinearity < 0.001), with lower GNRI values associated with higher odds of malnutrition and the association gradually attenuating at higher GNRI values.

Conclusion: Among the five nutritional indices evaluated, GNRI yielded the highest observed AUROC for identifying GLIM-defined malnutrition in this cohort. However, because GNRI incorporates body weight–related information that partially overlaps with the phenotypic criteria used to define GLIM malnutrition, the comparatively higher discriminative performance observed for GNRI should be interpreted cautiously, and the cohort-derived cutoff value should be regarded as exploratory. GNRI may serve as a practical adjunct to nutritional assessment using routinely available laboratory and anthropometric data; however, external validation in independent CD cohorts is warranted.

INTRODUCTION

Crohn's disease (CD) is a chronic, relapsing inflammatory disorder of the gastrointestinal tract characterized by transmural inflammation and heterogeneous clinical manifestations^[1]. Patients with CD are particularly susceptible to malnutrition because of reduced dietary intake, impaired nutrient absorption, and increased metabolic demands associated with systemic inflammation^[2]. The reported prevalence of malnutrition in patients with CD ranges from 20% to 85%, depending on the diagnostic criteria and clinical setting, and malnutrition is associated with adverse clinical outcomes, including postoperative complications, prolonged hospitalization, disease relapse, and mortality^[3, 4]. Therefore, early identification of malnutrition and accurate assessment of nutritional status are important components of the clinical management of patients with CD^[5].

To standardize the diagnosis of malnutrition, a consensus-based framework was proposed by the Global Leadership Initiative on Malnutrition (GLIM) and has been increasingly used in patients with inflammatory bowel disease (IBD), including CD^[6]. The GLIM framework recommends a two-step approach consisting of initial nutritional risk screening followed by diagnostic assessment based on phenotypic and etiologic criteria^[7]. However, GLIM does not specify a preferred screening tool for the initial assessment of nutritional risk. Increasing evidence indicates that GLIM-defined malnutrition is associated with disease severity, the risk of complications, and adverse clinical outcomes in patients with IBD^[8, 9]. Despite this standardized framework, identifying patients who meet the GLIM criteria in routine clinical practice remains challenging because approaches to nutritional assessment vary considerably across clinical settings. Therefore, objective and readily available indicators that can facilitate the identification of GLIM-defined malnutrition in patients with CD are needed.

In routine clinical practice, various tools are used for nutritional screening and assessment. Commonly used nutritional screening tools include the Nutritional Risk Screening 2002 (NRS-2002), the Malnutrition Universal Screening Tool (MUST), and the Mini Nutritional Assessment Short Form (MNA-SF); these tools were developed and validated across different populations and clinical settings, including hospitalized patients and older adults^[10–12]. However, some components of these tools, including assessments of dietary intake and recent weight change, rely partly on patient recall and subjective reporting, which may limit their applicability in patients with chronic inflammatory diseases such as CD. By contrast, composite nutritional indices based on routinely available laboratory parameters and anthropometric measurements may offer practical advantages because they are readily calculable, reproducible, and less dependent on subjective information.

Several objective nutritional indices derived from routinely available laboratory and anthropometric variables have been developed and evaluated across a range of clinical settings. The Geriatric Nutritional Risk Index (GNRI), originally developed to assess nutrition-related risk in older patients, has subsequently been evaluated in a broader range of clinical populations^[13–15]. The Controlling Nutritional Status (CONUT) score, derived from serum albumin, total cholesterol, and lymphocyte count, reflects nutritional and immune status and has been evaluated in diverse clinical populations^[16, 17]. The Prognostic Nutritional Index (PNI), calculated from serum albumin and lymphocyte count, reflects both nutritional

and immune status and has been widely evaluated in surgical and oncological populations ^[18, 19]. The Triglyceride–Total Cholesterol–Body Weight Index (TCBI), calculated from triglyceride, total cholesterol, and body weight, is a simple metabolic and nutritional index that has been evaluated primarily in cardiovascular populations ^[20, 21]. The Naples Prognostic Score (NPS) integrates nutritional and inflammatory parameters, including serum albumin, total cholesterol, the neutrophil-to-lymphocyte ratio, and the lymphocyte-to-monocyte ratio, and was originally developed in patients with colorectal cancer ^[22]. However, direct comparative evidence regarding the ability of these indices to identify GLIM-defined malnutrition in patients with CD remains limited.

This knowledge gap is clinically relevant because nutritional status is closely associated with disease burden and inflammatory activity in patients with CD. Persistent intestinal inflammation may contribute to nutritional depletion, whereas malnutrition may further compromise immune function and is associated with adverse clinical outcomes ^[2, 23]. Although the GLIM criteria have been applied in patients with CD ^[6, 9], previous studies have primarily evaluated individual nutritional indices or specific clinical outcomes, and the relative discriminative performance of multiple objective nutritional indices within a GLIM-based framework remains unclear. Therefore, this study aimed to compare the associations of GNRI, CONUT, PNI, TCBI, and NPS with GLIM-defined malnutrition and to evaluate their discriminative performance for identifying GLIM-defined malnutrition in patients with CD.

MATERIALS AND METHODS

Study population

Consecutive patients with CD treated at the Department of Gastroenterology, Affiliated Huai'an Hospital of Xuzhou Medical University, between August 2022 and August 2025 were screened for inclusion in this retrospective cross-sectional study. The diagnosis of CD was established based on a combination of clinical, endoscopic, radiologic, and histopathologic findings. Clinical, anthropometric, and laboratory data were retrospectively extracted from electronic medical records.

Patients were eligible if they met both of the following criteria: (1) age ≥ 18 years and (2) a confirmed diagnosis of CD. Patients were excluded if they had active malignancy, other active autoimmune diseases, or severe systemic diseases that could substantially affect nutritional assessment, or if essential clinical, anthropometric, or laboratory data required for nutritional assessment were missing. A total of 384 consecutive patients with CD were screened for eligibility. Thirty-four patients were excluded based on the predefined exclusion criteria, leaving 350 patients for the final analysis (Fig. 1). Because the study was based on existing medical records, no formal a priori sample size calculation was performed; instead, all consecutive eligible patients identified during the predefined study period were included.

The study was approved by the Ethics Committee of Huai'an Second People's Hospital (approval no. HEYLL202627) and was conducted in accordance with the Declaration of Helsinki. The requirement for

written informed consent was waived by the Ethics Committee because of the retrospective design of the study and the use of de-identified clinical data.

Data collection

Demographic, clinical, anthropometric, and laboratory data were extracted for all participants, including age, sex, height, weight, body mass index (BMI), calf circumference, disease duration, and disease phenotype according to the Montreal classification. Disease location was categorized as L1 (ileal), L2 (colonic), or L3 (ileocolonic). L4 was recorded as an upper gastrointestinal modifier and could coexist with L1, L2, or L3 disease. Patients with upper gastrointestinal involvement but no documented ileal or colonic disease were classified as having isolated L4 disease. Disease behavior was categorized as B1 (non-stricturing, non-penetrating), B2 (stricturing), or B3 (penetrating), whereas perianal disease was recorded separately as a modifier ^[24]. Clinical disease activity was assessed using the Crohn's Disease Activity Index (CDAI), which was calculated according to the original criteria described by Best et al. ^[25]. Laboratory parameters included white blood cell count (WBC), hemoglobin, neutrophil-to-lymphocyte ratio (NLR), lymphocyte-to-monocyte ratio (LMR), erythrocyte sedimentation rate (ESR), fecal calprotectin, serum albumin, total cholesterol, and triglycerides. GNRI, CONUT, PNI, TCBI, and NPS were calculated using their original formulas, as described below.

Calculation of objective nutritional indices

The GNRI was calculated using the following formula: $GNRI = 1.489 \times \text{serum albumin (g/L)} + 41.7 \times (\text{actual body weight/ideal body weight})$. Ideal body weight was estimated using sex-specific equations: $0.75 \times \text{height (cm)} - 62.5$ for men and $0.60 \times \text{height (cm)} - 40$ for women. According to the original GNRI methodology, the actual-to-ideal body weight ratio was capped at 1.0 when actual body weight exceeded ideal body weight ^[13, 14, 26]. The CONUT score was calculated from three laboratory parameters: serum albumin (g/L), total lymphocyte count ($\times 10^9/L$), and total cholesterol (mg/dL). Albumin levels were scored as follows: ≥ 35 g/L (0 points), 30–34.9 g/L (2 points), 25–29.9 g/L (4 points), and < 25 g/L (6 points). Lymphocyte counts were scored as follows: $\geq 1.60 \times 10^9/L$ (0 points), $1.20 - 1.59 \times 10^9/L$ (1 point), $0.80 - 1.19 \times 10^9/L$ (2 points), and $< 0.80 \times 10^9/L$ (3 points). Total cholesterol levels were scored as follows: ≥ 180 mg/dL (0 points), 140–179 mg/dL (1 point), 100–139 mg/dL (2 points), and < 100 mg/dL (3 points). The total CONUT score was obtained by summing the scores assigned to the three components ^[16, 27]. The PNI was calculated using the following formula: $PNI = 10 \times \text{serum albumin (g/dL)} + 0.005 \times \text{total lymphocyte count (cells/mm}^3\text{)}$ ^[28, 29]. The TCBI was calculated as follows: $TCBI = (\text{triglycerides} \times \text{total cholesterol} \times \text{body weight})/1000$, where triglycerides and total cholesterol were expressed in mg/dL and body weight was expressed in kilograms ^[20, 30]. The NPS was calculated from four parameters: serum albumin, total cholesterol, NLR, and LMR. For each parameter, 0 points were assigned when serum albumin was ≥ 40 g/L, total cholesterol was ≥ 4.65 mmol/L, NLR was < 2.96 , or

LMR was ≥ 4.44 ; otherwise, 1 point was assigned. The total NPS was obtained by summing the scores assigned to the four components [22, 31].

Assessment of GLIM-defined malnutrition

GLIM-defined malnutrition was assessed using the two-step GLIM framework. Initial nutritional risk screening was performed using NRS-2002. Patients with an NRS-2002 score ≥ 3 were considered to be at nutritional risk and subsequently underwent GLIM diagnostic assessment. According to the GLIM framework, malnutrition was diagnosed when at least one phenotypic criterion (involuntary weight loss, low BMI, or reduced muscle mass) and at least one etiologic criterion (reduced food intake or assimilation, or disease-related inflammation) were present [7, 9, 32]. Reduced muscle mass was assessed using calf circumference, an anthropometric surrogate recommended by GLIM when direct measures of body composition are unavailable. Low calf circumference was defined as < 33 cm for men and < 32 cm for women according to the updated GLIM recommendations [33]. The etiologic criterion was considered fulfilled in the presence of reduced food intake or disease-related inflammation.

Statistical analysis

Continuous variables were expressed as medians with interquartile ranges (IQRs) and compared using the Mann–Whitney U test. Categorical variables were presented as numbers and percentages and compared using the Pearson chi-square test.

Univariable and multivariable logistic regression analyses were performed to assess the associations between the five nutritional indices and GLIM-defined malnutrition. All nutritional indices were standardized as z-scores before logistic regression analysis; therefore, the reported odds ratios (ORs) represented the change in the odds of GLIM-defined malnutrition associated with a one-standard-deviation increase in each index. Separate multivariable models were constructed for GNRI, CONUT, PNI, TCBI, and NPS. Covariates were selected a priori based on clinical relevance and potential confounding, whereas variables included in the calculation of the nutritional indices or directly overlapping with the GLIM phenotypic criteria were excluded to minimize mathematical coupling and overadjustment. Each multivariable model was adjusted for age, sex, disease duration, hemoglobin, fecal calprotectin, disease behavior, and perianal disease. Disease behavior was modeled as a categorical variable, with B1 serving as the reference category. Multicollinearity among covariates was assessed using variance inflation factors (VIFs), with VIF values > 5 considered indicative of relevant multicollinearity. All covariates retained in the final models had VIF values < 5 .

Receiver operating characteristic (ROC) curves were constructed to evaluate the discriminative performance of GNRI, CONUT, PNI, TCBI, and NPS for identifying GLIM-defined malnutrition. AUROCs with 95% confidence intervals (CIs) were calculated for each index. The optimal cutoff value for each index was determined by maximizing the Youden index, and the corresponding sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV) were calculated. P values

for individual AUROCs were derived from comparisons with the null value of 0.50. Pairwise comparisons of AUROCs were performed using the DeLong test, with detailed results presented in Supplementary **Table S1**.

Given the highest observed AUROC for GNRI, restricted cubic spline (RCS) analysis was subsequently performed to characterize the shape and potential nonlinearity of its association with GLIM-defined malnutrition. GNRI was modeled on its original scale, and the RCS model was adjusted for age, sex, disease duration, hemoglobin, fecal calprotectin, disease behavior, and perianal disease. P values for the overall association and for nonlinearity were calculated.

Statistical analyses were performed using IBM SPSS Statistics version 27.0, MedCalc version 20.0, R version 4.5.2, and Zstats version 1.0. SPSS was used for descriptive analyses, between-group comparisons, logistic regression analyses, and assessment of multicollinearity. MedCalc was used for ROC curve analysis and pairwise comparisons of AUROCs using the DeLong test. RCS analyses and the corresponding plots were generated using the restricted cubic spline module of Zstats version 1.0. All statistical tests were two-sided, and $P < 0.05$ was considered statistically significant.

RESULTS

Patient characteristics

A total of 350 patients with CD were included in the analysis. Among them, 144 (41.1%) were classified as having GLIM-defined malnutrition. The median age was 42 years (IQR, 31.75–55.00), and 257 (73.4%) patients were male. No significant between-group differences were observed in age or sex. Compared with patients without GLIM-defined malnutrition, those with GLIM-defined malnutrition had significantly lower body weight, BMI, and calf circumference but a longer disease duration (all $P < 0.05$; **Table 1**). Disease behavior differed significantly between groups, with B2 and B3 being more common among patients with GLIM-defined malnutrition and B1 being more common among those without GLIM-defined malnutrition ($P < 0.001$). No significant between-group differences were observed in disease location or upper gastrointestinal involvement. WBC count, ESR, and fecal calprotectin were significantly higher in patients with GLIM-defined malnutrition, whereas hemoglobin, serum albumin, total cholesterol, and triglyceride levels were significantly lower (all $P < 0.001$). Patients with GLIM-defined malnutrition had significantly lower GNRI, PNI, and TCBI values and higher CONUT and NPS scores (all $P < 0.001$).

Associations between objective nutritional indices and GLIM-defined malnutrition

The associations between the five objective nutritional indices and GLIM-defined malnutrition are shown in **Fig. 2**. Because all five nutritional indices were standardized as z-scores, the reported odds ratios (ORs) represent the change in the odds of GLIM-defined malnutrition associated with each 1-standard-deviation (SD) increase in the respective index. In univariable analyses (Model 1), all five nutritional

indices were significantly associated with GLIM-defined malnutrition (all $P < 0.001$). These associations remained significant in the separate multivariable models (Model 2).

After multivariable adjustment, each 1-SD increase in GNRI was associated with lower odds of GLIM-defined malnutrition (OR = 0.290, 95% CI: 0.192–0.438, $P < 0.001$), whereas each 1-SD increase in CONUT score was associated with higher odds of GLIM-defined malnutrition (OR = 2.114, 95% CI: 1.450–3.083, $P < 0.001$). Similarly, each 1-SD increase in PNI and TCBI was associated with lower odds of GLIM-defined malnutrition (PNI: OR = 0.495, 95% CI: 0.340–0.721, $P < 0.001$; TCBI: OR = 0.454, 95% CI: 0.312–0.661, $P < 0.001$), whereas each 1-SD increase in NPS was associated with higher odds of GLIM-defined malnutrition (OR = 2.201, 95% CI: 1.612–3.005, $P < 0.001$).

Diagnostic performance of objective nutritional indices

The discriminative performance of the five objective nutritional indices for identifying GLIM-defined malnutrition was evaluated using ROC curve analysis (Fig. 3; **Table 2**). GNRI yielded the highest observed AUROC (0.822; 95% CI: 0.778–0.860). The corresponding AUROCs for CONUT, PNI, TCBI, and NPS were 0.730 (95% CI: 0.680–0.776), 0.752 (95% CI: 0.703–0.796), 0.735 (95% CI: 0.686–0.781), and 0.720 (95% CI: 0.669–0.766), respectively. The optimal GNRI cutoff value was 100.96, with a sensitivity of 61.81% and a specificity of 93.20%. Pairwise comparisons using the DeLong test showed that the AUROC for GNRI was significantly higher than those for CONUT, PNI, TCBI, and NPS (all $P < 0.05$), whereas no significant differences were observed among the remaining four indices (all pairwise $P > 0.05$). Detailed pairwise comparison results are provided in Supplementary **Table S1**.

Nonlinear association between GNRI and GLIM-defined malnutrition

Restricted cubic spline analysis demonstrated a significant nonlinear association between GNRI and GLIM-defined malnutrition (P for overall association < 0.001 ; P for nonlinearity < 0.001 ; Fig. 4). Lower GNRI values were associated with higher odds of GLIM-defined malnutrition, and this association gradually attenuated at higher GNRI values, approaching a plateau.

DISCUSSION

This study compared the associations and discriminative performance of five objective nutritional indices for identifying GLIM-defined malnutrition in patients with CD. All five indices were significantly associated with GLIM-defined malnutrition in univariable analyses, and these associations remained significant after multivariable adjustment. Among the evaluated indices, GNRI yielded the highest observed AUROC, which was significantly higher than those of the other four indices in pairwise DeLong comparisons. Restricted cubic spline analysis further demonstrated a significant nonlinear association between GNRI and GLIM-defined malnutrition, with lower GNRI values associated with higher odds of malnutrition and the association gradually attenuating at higher GNRI values. Nevertheless, these

findings should be interpreted cautiously, particularly because GNRI contains body weight–related information that overlaps partly with the phenotypic criteria used to define GLIM malnutrition.

Malnutrition remains a common and clinically significant complication in CD and is associated with adverse clinical outcomes ^[6, 34]. Its development is multifactorial, involving persistent intestinal inflammation, reduced dietary intake, impaired nutrient absorption, and increased metabolic demands ^[2, 23]. In this context, the comparatively higher discriminative performance of GNRI observed in the present study may partly reflect its incorporation of serum albumin and body weight, which reflect complementary aspects of nutritional and systemic disease status ^[13, 14]. Importantly, body weight is incorporated into GNRI, whereas the GLIM phenotypic assessment includes weight-related criteria such as involuntary weight loss and low BMI ^[13, 33]. This partial overlap may have contributed to both the observed association and the relatively high AUROC of GNRI. Therefore, the relatively high AUROC observed for GNRI should be interpreted within the GLIM-based diagnostic framework used in this study and may partly reflect shared weight-related information between the index and the reference definition rather than entirely independent discriminative ability.

By contrast, CONUT, PNI, and NPS are composed primarily of laboratory-derived variables, whereas TCBI combines lipid parameters with body weight. However, several of these components, including serum albumin, lymphocyte-based measures, and lipid parameters, may themselves be influenced by systemic inflammation and other non-nutritional factors. Accordingly, differences in the biological domains reflected by these indices may partly explain the variation in discriminative performance observed in this cohort.

From a clinical perspective, these findings may have practical relevance. Although the GLIM framework provides standardized criteria for diagnosing malnutrition, it does not specify a preferred screening tool for the initial assessment of nutritional risk ^[33]. GNRI may serve as a practical adjunct to nutritional assessment because it can be readily calculated using routinely available serum albumin and anthropometric data without the need for specialized body-composition measurements. The relatively high specificity of GNRI (93.20%), coupled with its moderate sensitivity (61.81%), suggests that it may be better suited as a complementary indicator to support the identification of patients likely to have GLIM-defined malnutrition rather than as a stand-alone screening tool. Accordingly, GNRI should not replace validated nutritional risk screening tools or a complete GLIM diagnostic assessment.

The other nutritional indices may also offer complementary information for nutritional assessment in clinical practice. Selection of an index should not be based solely on its AUROC but should also take into account data availability, ease of calculation, the clinical setting, and the intended purpose of nutritional assessment. Further studies are warranted to determine whether the relative discriminative performance of these indices, particularly GNRI, remains consistent across CD populations with different disease phenotypes and degrees of inflammatory activity.

Several limitations should be considered when interpreting these findings. First, this was a retrospective cross-sectional study conducted at a single center. Although consecutive eligible patients were included, center-specific referral and management patterns may have influenced the case mix of the study population, thereby limiting the generalizability of the findings to other CD populations. Moreover, the cross-sectional design allowed associations and discriminative performance to be assessed at a single time point but precluded causal inference and assessment of longitudinal predictive performance.

Second, reduced muscle mass as a GLIM phenotypic criterion was assessed using calf circumference as an anthropometric surrogate rather than direct measures of body composition, such as computed tomography, dual-energy X-ray absorptiometry, or bioelectrical impedance analysis. Although calf circumference is practical for routine clinical assessment, some misclassification of reduced muscle mass cannot be excluded.

Third, GNRI incorporates body weight–related information that partially overlaps with the phenotypic criteria used to define GLIM malnutrition; this methodological overlap should be considered when interpreting its relatively high AUROC. In addition, GNRI was originally developed for older hospitalized patients, whereas the present cohort was substantially younger. The GNRI cutoff identified in this study should therefore be regarded as a cohort-derived exploratory threshold and should not be interpreted as replacing established GNRI risk categories. Its applicability should be externally validated in independent CD cohorts spanning a broader age range.

Finally, NRS-2002 was systematically used as the initial nutritional risk screening tool within the GLIM diagnostic pathway. Because NRS-2002 formed part of the diagnostic pathway, the resulting GLIM classification was not fully independent of the initial screening step, which should be considered when interpreting the observed discrimination estimates. MUST and MNA-SF were not routinely available, precluding direct comparisons between these conventional screening tools and the five objective nutritional indices. These findings should be prospectively validated in independent multicenter CD cohorts across diverse clinical settings.

Conclusion

In this retrospective cross-sectional study of patients with CD, all five objective nutritional indices—GNRI, CONUT, PNI, TCBI, and NPS—remained significantly associated with GLIM-defined malnutrition after multivariable adjustment. Among the evaluated indices, GNRI yielded the highest observed AUROC and showed a significant nonlinear association with GLIM-defined malnutrition. However, because GNRI incorporates body weight–related information that partially overlaps with the phenotypic criteria used to define GLIM malnutrition, its comparatively higher discriminative performance should be interpreted cautiously. GNRI may serve as a practical adjunct to nutritional assessment using routinely available laboratory and anthropometric data; however, the cohort-derived cutoff value should be regarded as exploratory. These findings should be prospectively validated in independent multicenter CD cohorts before broader clinical application.

Declarations

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Author Contribution

CH: Conceptualization, Data curation, Formal analysis, Writing – original draft. MZ: Methodology, Validation, Writing – review and editing. CS: Data curation, Writing – review and editing. YR: Data curation, Investigation, Writing – review and editing. NY: Investigation, Writing – review and editing. CX: Investigation, Writing – review and editing. JG: Formal analysis, Writing – review and editing. QC: Data curation, Visualization, Writing – review and editing. XQ: Conceptualization, Supervision, Writing – review and editing. All authors read and approved the final manuscript.

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Data Availability

The datasets used and/or analyzed during the current study are not publicly available due to patient privacy and ethical considerations but are available from the corresponding author on reasonable request, subject to applicable ethical and institutional requirements.

Tables

Tables 1-2 are available in the Supplementary Files section.

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Figures

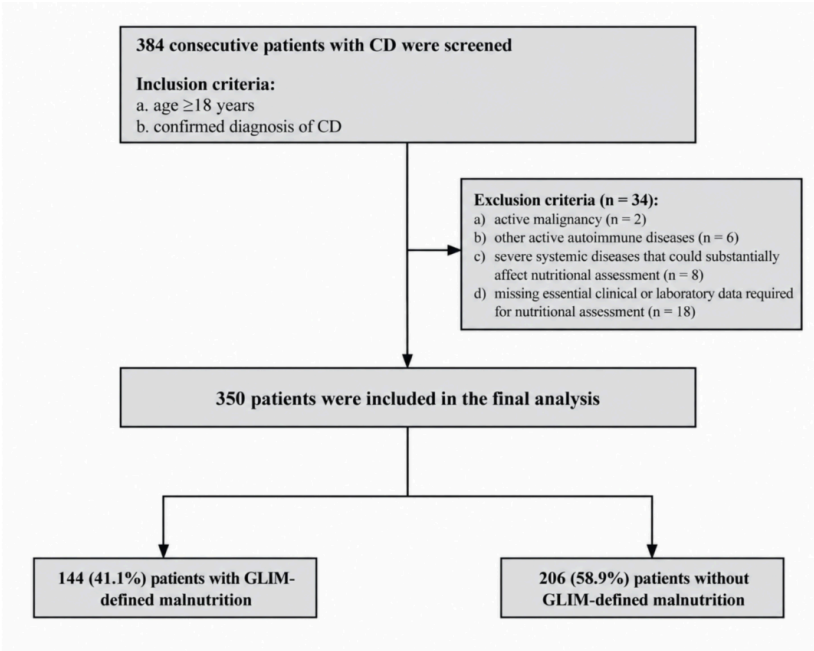


Figure 1. Flow diagram of patient selection. CD, Crohn’s disease; GLIM, Global Leadership Initiative on Malnutrition.

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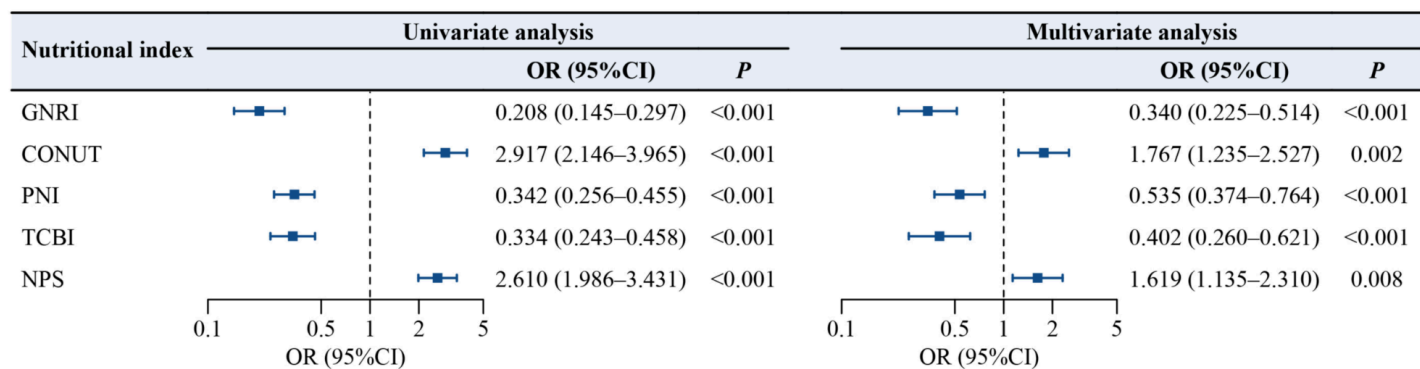


Figure 2. Univariable and multivariable logistic regression analyses assessing the associations between objective nutritional indices and GLIM-defined malnutrition. Multivariable logistic regression models were adjusted for age, sex, disease duration, hemoglobin level, fecal calprotectin, disease behavior, and perianal disease. Separate multivariable models were constructed for each nutritional index. ORs and 95% CIs represent the change in odds associated with a one-standard-deviation increase in each nutritional index. GLIM, Global Leadership Initiative on Malnutrition; GNRI, Geriatric Nutritional Risk Index; CONUT, Controlling Nutritional Status; PNI, Prognostic Nutritional Index; TCBI, Triglyceride–Total Cholesterol–Body Weight Index; NPS, Naples Prognostic Score.

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Univariable and multivariable logistic regression analyses assessing the associations between objective nutritional indices and GLIM-defined malnutrition. Multivariable logistic regression models were adjusted for age, sex, disease duration, hemoglobin level, fecal calprotectin, disease behavior, and perianal disease. Separate multivariable models were constructed for each nutritional index. ORs and 95% CIs represent the change in odds associated with a one-standard-deviation increase in each nutritional index. GLIM, Global Leadership Initiative on Malnutrition; GNRI, Geriatric Nutritional Risk Index; CONUT, Controlling Nutritional Status; PNI, Prognostic Nutritional Index; TCBI, Triglyceride–Total Cholesterol–Body Weight Index; NPS, Naples Prognostic Score.

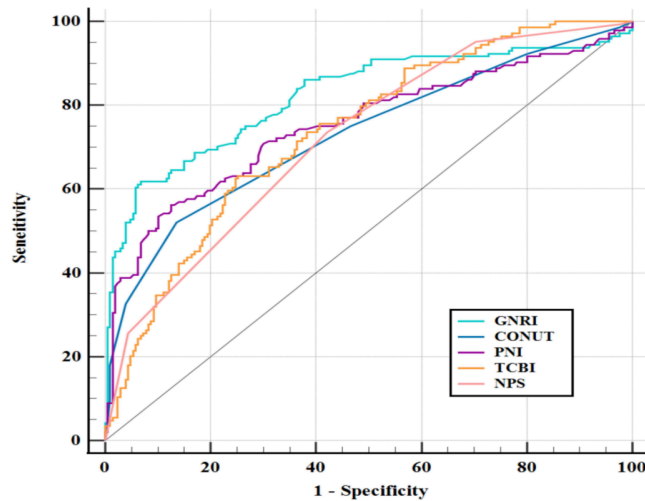


Figure 3. Receiver operating characteristic curves of five objective nutritional indices for identifying GLIM-defined malnutrition in patients with Crohn's disease. The diagonal line represents the reference line corresponding to no discriminative ability (AUROC = 0.50). ROC, receiver operating characteristic; AUROC, area under the receiver operating characteristic curve; GLIM, Global Leadership Initiative on Malnutrition; GNRI, Geriatric Nutritional Risk Index; CONUT, Controlling Nutritional Status; PNI, Prognostic Nutritional Index; TCBI, Triglyceride–Total Cholesterol–Body Weight Index; NPS, Naples Prognostic Score.

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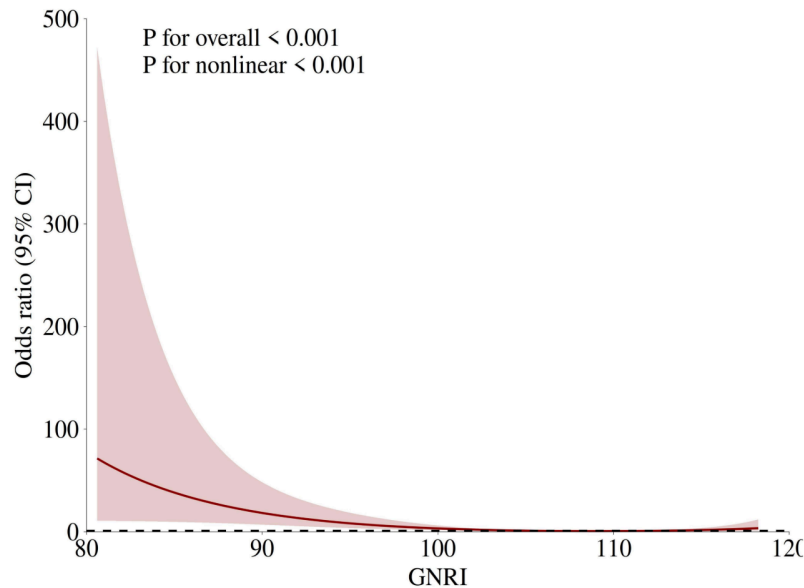


Figure 4. Restricted cubic spline analysis of the association between GNRI and GLIM-defined malnutrition in patients with Crohn's disease. The solid line represents the adjusted odds ratio (OR), the shaded area represents the 95% confidence interval (CI), and the dashed horizontal line indicates an OR of 1.0. The model was adjusted for age, sex, disease duration, hemoglobin, fecal calprotectin, disease behavior, and perianal disease. GNRI, Geriatric Nutritional Risk Index; GLIM, Global Leadership Initiative on Malnutrition; OR, odds ratio; CI, confidence interval.

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