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Comparison between Different Tools for Screening and Assessment of Nutritional Status of Patients with Crohn's Disease in an Ambulatory Setting

Marie-Pier Bachand*, Joannie Ruel and Sophie Plamondon

Department of Medicine, Division of Gastroenterology, Université de Sherbrooke, CHUS Hotel-Dieu, 580 rue Bowen Sud, Sherbrooke, Qc, J1G 2E8, Canada

***Corresponding author:** Marie-Pier Bachand, Department of Medicine, Division of Gastroenterology, Université de Sherbrooke, CHUS Hotel-Dieu, 580 rue Bowen Sud, Sherbrooke, Qc, J1G 2E8, Canada, E-mail: marie-pier.bachand2@usherbrooke.ca

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Abstract

Context: Crohn's disease (CD) may lead to malnutrition even in clinical remission. Few studies have examined the best malnutrition screening tools for ambulatory CD patients.

Objective: The objective of this study is to compare different methods of nutritional screening for CD patients in an ambulatory setting and to correlate these results with the European Society of Parenteral and Enteral nutrition (ESPEN) and the American Society of Parenteral and Enteral Nutrition (ASPEN) definitions of malnutrition.

Methods: This is a prospective study in our ambulatory clinic. CD patients in clinical remission or with minimal disease activity were included. Nutritional status and the performance of malnutrition screening tools in these patients were assessed.

Results: We included 69 CD patients between 2016 and 2017. Based on malnutrition definitions (ESPEN, ASPEN and combined definition (ESPEN and ASPEN), 14, 5 %, 17, 4% and 21, 7% patients respectively were malnourished. Among the malnutrition screening tools evaluated, the SGA had the best sensitivity and specificity for detecting malnutrition (sensitivity 66, 6%; specificity 94, 4%; kappa 0,642). The MUST had a sensitivity of 40% and a specificity of 98, 2%, and the SNAQ, a sensitivity of 53, 3% and specificity of 94, 4% (Kappa 0,472). Prior digestive surgery and dietary restrictions were independent predictors of malnutrition on multivariate analysis.

Conclusion: This study shows that even in remission, ambulatory CD patients suffer from malnutrition and dietary restrictions. Malnutrition screening should be included in routine clinical practice. In our study, SNAQ had the best agreement with ESPEN and ASPEN malnutrition definition. SGA is an assessment tools rather than a screening tool, but clinical judgement combined with SGA would be a good alternative to SNAQ in clinical practice.

Keywords: Crohn's disease; Adults; Malnutrition; Nutritional assessment

Introduction

Crohn's disease (CD) may lead to protein and caloric malnutrition (PCM) even when in clinical remission. The prevalence of malnutrition in hospitalised CD patients is approximately 70% [1]. Malnutrition in ambulatory CD patients is estimated to range from 30 to 40% depending on the assessment tool used [2]. PCM in CD is known to be associated with a higher rate of surgery and hospitalisation [1]. Malnutrition can also have an impact on response to therapy. Malnutrition screening and assessment should therefore be routinely performed in the ambulatory setting. Unfortunately, few studies have examined the best malnutrition screening tools for ambulatory CD patients. Also, malnutrition screening can be perceived as time consuming by doctors [3]. As a result, there is a need for quick and easy tools to screen malnutrition on an outpatient setting.

Such screening and assessment methods have been studied mainly in hospitalised patients. Many are not suitable for ambulatory patients [4]. However, even patients in remission can experience malnutrition and many have dietary restrictions and nutritional deficiencies [2,5].

Assessment of malnutrition can be complex using many different tools such as intake calendars, anthropometric measures, biochemical tests and measurement of body composition (for example by dual-energy X-ray absorptiometry). These strategies can be time consuming for patients and health professionals. Indeed, patients should first be screened for nutritional risk to determine who would benefit from further testing. Such screening tools include the following: Nutritional Risk Screening (NRS-2002), Malnutrition Screening Tool (MST), Malnutrition Universal Screening Tool

(MUST) and Short Nutritional Assessment Questionnaire (SNAQ). All of these screening tools have been studied in various populations. NRS-2002 has not been validated in ambulatory patients [6]. MUST and MST have been demonstrated to have the best concordance with other tools in both ambulatory and hospitalised patients [6-8]. None have been validated for CD outpatients.

The primary objective of this study is to compare different methods of nutritional screening in ambulatory CD patients and to assess their concordance with an evaluation using ESPEN and ASPEN malnutrition definitions. Secondary endpoints are to investigate malnutrition prevalence and factors influencing nutritional status, dietary practices and beliefs in ambulatory CD patients and to evaluate the impact of malnutrition on short-term disease progression.

Definitions of tools used in this study

ESPEN definition of malnutrition:

- BMI <18,5

Or

- Involuntary weight loss >10% or >5% in 3 months combined with:
- BMI <20 kg/m^2 if <70 years-old or <22 kg/m^2 if ≥70 years-old

Or

- Fat free mass index <15 and 17 kg/ m^2 for women or men respectively [4].

ASPEN definition of malnutrition: ASPEN considers that if ≥2 of the following 6 characteristics are present, the patient is malnourished: insufficient energy intake, weight loss, loss of muscle mass, loss of subcutaneous fat, localized or generalized weights loss, and diminished functional status as measured by handgrip strength. We used the malnutrition criteria for chronic disease-related malnutrition [9].

Combined ESPEN and ASPEN malnutrition definition: Total number of patients with either malnutrition based on ASPEN or ESPEN malnutrition definition.

Body mass index: Weight (kg) divided by squared height (m). Underweight is classified as BMI <18, 5 kg/m^2 (or <21 kg/ m^2 if >70 years old).

Subjective global assessment: The SGA is a screening and evaluation tool that provides information regarding loss of weight, changes in food intake, gastrointestinal symptoms/ signs (vomiting, diarrhoea, anorexia), stress imposed by disease, and a physical examination that evaluates loss of muscle and adipose mass as well as the presence of edema.

The classification is as follows: SGA grade 'A' if well nourished, grade 'B' if moderately malnourished and grade 'C' if severely malnourished.

Malnutrition screening tool: MST analyses weight loss (kilograms) and loss of appetite. A score of 2 or more classifies the patient as at risk of malnutrition.

Malnutrition universal screening tool: The MUST verifies BMI, percentage weight lost in the last 3-6 months and loss of appetite in the last 5 days. A score of 2 or more indicates the patient is at risk of malnutrition.

Short nutritional assessment questionnaire: The SNAQ scoring system is as follows: 3 points for loss of 6 kg in 6 months; 2 points for loss of 3 kg in 1 month; 1 point for loss of appetite in the last month;1 point if need for enteral nutrition or supplement in the last month. A score of 2 or more indicates the patient is at risk of malnutrition.

Decreased Hand-grip strength: The value is obtained from the Lafayette dynamometer. Malnutrition results in an HGS below 2 standard deviations for age and sex.

Disease activity: In this study, clinical remission is defined as a Harvey-Bradshaw index (HBI) score <4 and minimal activity as a HBI 5-7. Scores of 8 and over were classified as moderate or severe disease activity.

Methods

Study population

This study was a single center, observational, prospective study conducted at the Centre Hospitalier Universitaire de Sherbrooke, Canada. We included patients over 18 years of age with CD presenting at our outpatients clinic from 2016 to 2017. Patients had to be in remission (HBI <4) or have mild disease activity (HBI 5-7). Patients were excluded if they were pregnant, had moderately to severely active disease, had short bowel syndrome or if they were already on nutritional support.

Data collection

The primary objective was to compare different methods of malnutrition screening for CD patient in remission or minimal disease activity in an ambulatory setting and to verify the agreement between the results of these tests and the ESPEN and ASPEN definitions for nutritional status. The sensitivity and specificity of each tool were also assessed.

Secondary endpoints were to determine

Malnutrition prevalence in our CD patients in ambulatory settings using ESPEN/ ASPEN definitions of malnutrition.The influence of type (ideal or colonic CD) and behaviour of CD (penetrating or structuring CD) and medications (biologic or not) on malnutrition rate. The influence of malnutrition on the need for surgery or hospitalisation within the 6 months following the initial nutritional evaluation. Dietary beliefs and behaviours (food restrictions) in these patients.

A three-part study was designed to collect these data's. First, all patients included were assessed for anthropometric measurements (BMI, weight, height, triceps skinfold using a Herpenden skinfold caliper Baty, midarm circumference) and HGS. They were then evaluated with SGA, MUST, MST and SNAQ questionnaires (change in weight, appetite, and use of

supplemental oral nutrition). We compared screening tools with ESPEN and ASPEN malnutrition definitions (see definitions above). We also collected demographic data, extent and duration of CD, medication, especially use of corticosteroids in the last 3 months, smoking habits, prior surgery for CD, endoscopic and radiologic activity if available, and the presence of comorbidities. Clinical activity was also evaluated the day of the interview using the HBI.

The second part of the study assessed dietary beliefs and behaviours. All patients who consented to the first part of the study were invited to participate in the second part. Patients answered a 21- item questionnaire about the impact of CD on their social functioning, working ability and love life. The questionnaire also included queries about level of physical activity, specific food restrictions, food intolerance, type of diet followed and beliefs about nutrition and CD.

The third section of the study data was collected retrospectively, 6 months after the initial visit. We looked at admission rates, need for nutritional support and need for surgery or change in medication according to nutritional status at the start of the study. Study data were collected and managed using Excel®.

Statistical analysis

The sample calculation was estimated through a kappa test, based on a similar study and with the Query (6, 12). Considering an estimated proportion of malnourished patients of 20%, a margin error of 10%, a confidence interval of 95%, an expected sensitivity of 80%, and a statistical significance level of 5%, a sample size of 62 subjects was determined. Our study was powered to 80%. With 62 subjects, a significance difference between an observed kappa of 0, 8 (as observed in the Stratton study [7]) and a theoretical observed kappa of 0, 50 could be identified.

Qualitative variables were described as percentages, while quantitative variables of symmetric and asymmetric distributions were described as means and standard deviations or medians and 25-75 percentile values, respectively. To compare our tools, ESPEN and ASPEN nutrition definitions were used as the standard [4,9]. Proportions were estimated with sensitivity, specificity and negative and positive predictive values. Cochran's test was used to compare different methods for diagnosis of malnutrition. Sub-group analysis was performed to evaluate external influence.

The Pearson's chi-square test and Fisher's exact test were used to evaluate the association between qualitative variables. Both the Student's t-test and Mann-Whitney test were used to compare the quantitative variables of symmetric and asymmetric distribution, respectively.

Ethical aspects

This protocol was approved by the Ethics Committee of the Centre de Recherche Etienne Lebel. Written informed consent was obtained from all patients participating in the study.

Results

Study population

We included 69 CD patients in our study. Clinical and demographic data are shown in **Table 1**. Mean patient age was 46, 1 years old (range 31- 63,5); 53,6% of them were females. Six patients (8, 7%) were smoker, 28 (40, 6%) reported previous bowel surgery. The median duration of the disease was 7 years (range 4-7 years). The distribution of CD treatment was as follows: 37 (53, 6%) were on biologics, 32 (46, 4%) were on Immunomodulator Monotherapy.

Malnutrition screening tools

Six patients had a BMI <18, 5 kg/m^2 (8, 7%), 4 had an albumin <35 g/L (5, 8%), 11 (15,9%) had an HGS below 2 standard deviations from normal. Fifty-six (56) (81, 2%) were classified as SGA A and 13 (18, 8%) as SGA B. None were classified as SGA C. The malnutrition screening tools score results showed that 7 patients (10, 1%) evaluated with MST, 7 (10, 1%) evaluated with MUST and 11 patients (15, 9%) evaluated with SNAQ were at nutritional risk **(Table 2)**.

Table 3 describes the sensitivity and specificity of the screening tools to identify nutritional risk, using the ESPEN/ ASPEN definitions of malnutrition as the standard. MUST had the best specificity (98, 2%) followed by MST (96, 3%). SGA had the best sensitivity (66, 6%) and kappa (0,561) followed by SNAQ (sensitivity: 53, 3% and kappa: 0,531). Gender, race and medication did not influence the results of the malnutrition screening tools which must have the best positive predictive value (85, 7%). SGA had the best negative predictive value (91, 1%) followed by SNAQ (87, 9%).

HGS was influenced by physical activity described by patients in the short questionnaire. In fact, 33,3% of patients with an HGS result below 2 deviation standard for sex and age described being physically inactive while only 11,1% of patients with a normal HGS were physically inactive (p=0,038).

Malnutrition rate and nutritional assessment

Based on malnutrition definitions (ESPEN, ASPEN and combined ESPEN and ASPEN (combined definition)), 14, 5%, 17, 4% and 21, 7% patients respectively were malnourished **(Tables 1-3)**. In the multivariate analysis, digestive surgery showed a trend toward significance and seemed to influence the rate of malnutrition (60% of malnourished patients had prior bowel surgery compared with 35, 2% in non-malnourished patients, p=0,083; Table 1). Also, dietary restrictions influenced the rate of malnutrition in our CD patients, although the trend did not reach statistical significance (66, 7% of malnourished patients had dietary restrictions compared with 40, 7% in non-malnourished patients, p=0,075; **(Tables 4 and 5)**.

Among patients assessed to be malnourished, 40% had a BMI < 18 kg/m^2 (or 21 if over 70 years old), 46, 7% had an abnormal HGS, 66, 7% were evaluated as SGA B, 40 % had a

MUST score ≥ 2, 33,3% had an MST ≥ 2, 53,3% had a SNAQ ≥ 2 and 33, 3% presented with low albumin (< 35 g/L). **Table 2** summarizes values of nutritional screening according to the different methods used.

Table 1: Clinical and demographic data.

Parameters	Overall population (n=69)	Malnourished patients (n=15)	Well-nourished patients (n= 54)	P-value
Mean age, years, (P25-P75)	46,1 (31-63,5)	53,1 (37-69)	44,1 (30,7-56)	0,126
Sex, n (%)				0,142
Female	37 (53,6%)	11 (73,3%)	26 (48,1%)	
Male	32 (46,4%)	4 (26,7%)	28 (51,9%)	
Smoking habit, n (%)	6 (8,7%)	3 (20,0%)	3 (5,6%)	0,112
CD location, n (%)				0,858
Ileal/ileocecal	15 (21,7%)	4 (26,7%)	11 (20,4%)	
Colonic	17 (24,6%)	3 (20,0%)	14 (25,9%)	
Ileocolonic	37 (53,6%)	8 (53,3%)	29 (53,7%)	
Clinical behavior, n (%)				0,922
Non penetrating/non stricturing	40 (57,9%)	9 (60,0%)	31 (57,4%)	
Stricturing	8 (11,6%)	1 (6,7%)	7 (13,0%)	
Penetrating	18 (26,1%)	4 (26,7%)	14 (25,9%)	
Stricturing and penetrating	3 (4,3%)	1 (6,7%)	2 (3,7%)	
Bowel surgery, n (%)	28 (40,6%)	9 (60,0%)	19 (35,2%)	0,083
Stomia in place	10 (14,5%)	2 (13,3%)	8 (14,8%)	0,920
Median duration of the disease, years, (P25-P75)	7 (4-17)	13,7 (7-20)	10,4 (3,75-12,5)	0,256
Harvey Bradshaw >4, n (%)	8 (11,6%)	3 (20,0%)	5 (9,3%)	0,358
Cortison last 3 months, n (%)	8 (11,6%)	3 (21,4%)	5 (9,6%)	0,351
Medications, n (%)				1000
Biologic	37 (53,6%)	8 (53,3%)	29 (53,7%)	
Non biologic	32 (46,4%)	7 (46,7%)	25 (46,3%)	
Malnutrition according to definition				
ASPEN	12 (17,4%)			
ESPEN	10 (14,5%)			
Combined definition	15 (21,7%)			

Influence of malnutrition after 6 months follow up

Table 4 shows the results of the 6-month follow-up period. Malnutrition had a numerical impact on the rate of hospitalisation within the next 6 months after the nutritional assessment, but the number of patients was too small to reach significance.

Dietary beliefs and behaviours

Table 5 shows the results of our dietary and activity questionnaire. Fifty-two per cent (52.1%) of patients believed that diet could be a precipitating factor in CD onset and 65,2% felt it could trigger a disease flare. Moreover, 52,2% of patients chose to follow selective diets during a CD flare-up and 46,4% still persisted in avoiding certain foods even in remission or with minimal disease activity.

Table 2: Nutritional assessment according to the different methods

Parameters	Overall population (n= 69)	Malnourished patients (n = 15)	Well-nourished patients (n = 54)
BMI (Kg/m2) †, n (%)			
< 18,5 (< 21 if > 70 years)	6 (8,7%)	6 (40,0%)	0 (0,0%)
> 18,5 (> 21 if < 70 years)	63 (91,3%)	9 (60,0%)	54 (100,0%)
Abnormal Hand-grip strength : less than 2 standard derivation (kg/f)	11 (15,9%)	7 (46,7%)	4 (7,4%)
SGA‡			
A	56 (81,2%)	5 (33,3%)	51 (94,4%)
B	13 (18,8%)	10 (66,7%)	3 (5,6%)
MUST§			
≥2	7 (10,1%)	6 (40,0%)	1 (1,9%)
<2	62 (89,9%)	9 (60,0%)	53 (98,1%)
MST ¶			
≥2	7 (10,1%)	5 (33,3%)	2 (3,7%)
<2	62 (89,9%)	10 (66,7%)	52 (96,3%)
SNAQ¥			
≥2	11 (15,9%)	8 (53,3%)	3 (5,6%)
<2	58 (84,1%)	7 (46,7%)	51 (94,4%)
Albumin (g/L)			
≥35	47 (68,1%)	8 (66,7%)	39 (100,0%)
<35	4 (5,8%)	4 (33,3%)	0 (0,0%)

† BMI: Body mass index; ‡ SGA: subjective global assessment; § MUST: malnutrition universal screening tool; ¶ MST: Malnutrition screening tool; ¥ SNAQ: Short Nutritional Assessment Questionnaire.

Table 3: comparison between coefficient of correlation of malnutrition definitions with malnutrition screening tools.

Screening methods	Sensitivity (%)	Specificity (%)	Kappa for combined ASPEN and ESPEN malnutrition definitions	Kappa for ESPEN malnutrition definition	Kappa for ASPEN malnutrition definition	Predictive positive value	Predictive negative value
BMI†	40,00%	100%	0,511	0,72	0,372	100%	85,70%
Abnormal Hand-grip strength	46,70%	92,60%	0,434	0,158	0,531	63,60%	86,20%
SGA B-C ‡	66,60%	94,44%	0,642	0,74	0,561	76,92%	91,10%
MUST ≥ 2 §	40,00%	98,20%	0,472	0,666	0,457	85,70%	85,50%
MST ≥ 2¶	33,30%	96,30%	0,367	0,399	0,457	71,40%	83,90%
SNAQ ≥ 2¥	53,30%	94,40%	0,529	0,382	0,531	72,20%	87,90%

† BMI: Body mass index; ‡ SGA: subjective global assessment; § MUST: malnutrition universal screening tool; ¶ MST: Malnutrition screening tool; ¥ SNAQ: subjective nutrition assessment questionnaire.

Fifty-three per cent of participants reported having received professional nutritional advice. Worsening symptoms with specific foods in CD patients in remission was reported by 39, 1%. Of all our patients, 32 (46, 6%) followed a restrictive diet while in remission. Coffee (43, 5%), alcohol (37, 7%), fibers (44,9%), nuts (40,6%) and vegetables (43,5%) were the most frequently avoided foods **(Figure 1)**.

Table 4: Nutritional influence on Crohn's disease at 6 months.

Parameters	Overall population (n=69)	Malnourished patients (n=15)	Well-nourished patients(n= 54)	P-value
Change of medication, n (%)	15 (21,7%)	4 (26,7%)	11 (20,4%)	0,725
Bowel surgery, n (%)	1 (1,4%)	1 (1,9%)	0 (0,0%)	1000
Hospitalisation, n (%)	5 (7,2%)	4 (26,7%)	1 (1,9%)	0,007

Table 5: Results of short questionnaire on Crohn's disease impact on food consumption and daily activity.

Parameters	Overall population (n=69)	Malnourished patients (n=15)	Well-nourished patients (n= 54)	P-value
Believe nutrition impact CD exacerbations, n (%)	45 (65,2%)	10 (66,7%)	35 (64,8%)	0,451
Believe nutrition is the etiology of CD, n (%)	36 (52,1%)	9 (60,0%)	27 (50,0%)	0,394
Daily activity affected, n (%)	12 (17,4%)	5 (33,3%)	7 (13%)	0,066
Daily work affected, n (%)	20 (28,9%)	7 (46,7%)	13/40 (24,1%)	0,085
Love life affected, n (%)	15 (21,7%)	8 (53,3%)	7 (13,0%)	0,001
Sport activity affected, n (%)	23 (33,3%)	6 (40,0%)	17 (31,5%)	0,536
Social activity affected, n (%)	17 (24,6%)	6 (40,0%)	11 (20,4%)	0,119
Do weekly physical activity, n (%)	54 (78,3%)	10 (66,7%)	44 (81,5%)	0,218
Nutrition affected by CD†, n (%)	27 (39,1%)	7 (46,7%)	20 (37%)	0,499
Follow diet for CD, n (%)	32 (46,4%)	10 (66,7%)	22 (40,7%)	0,075
Follow diet during flare-up, n (%)	36 (52,2%)	11 (73,3%)	25 (46,3%)	0,25
Seek nutritionist advice, n (%)	37 (53,6%)	9 (60,0%)	28 (51,9%)	0,576
Want to meet a nutritionist, n (%)	17 (24,6%)	4 (26,7%)	13 (24,1%)	1,000
Have a book about nutrition and CD, n (%)	20 (28,9%)	6 (40,0%)	14 (25,9%)	0,288
Have discussed nutrition with gastroenterologists, n (%)	40 (57,9%)	10 (66,7%)	30 (55,6%)	0,441

† CD: Crohn's disease

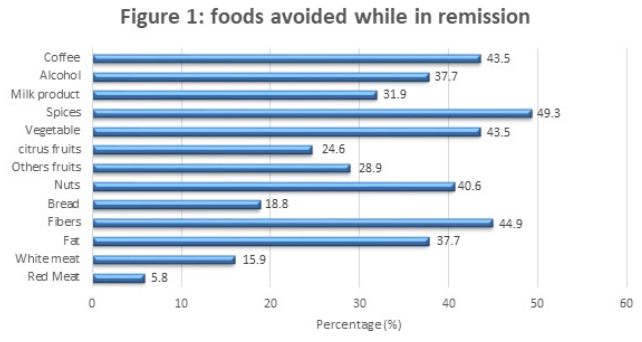

Figure 1: Foods avoided while in remission.

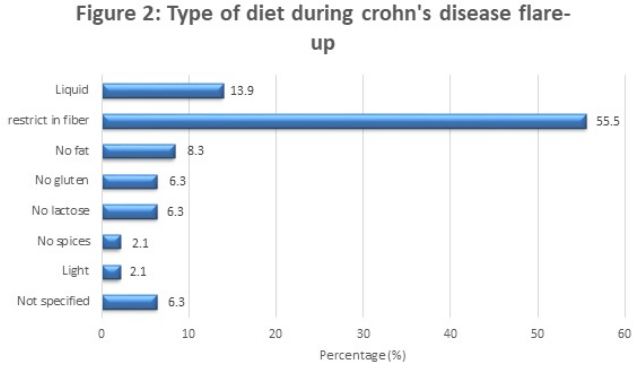

Figure 2: Type of diet during Crohn's disease flare-up.

In this study, 47 patients (68, 1%) restricted food during flar e-ups **(Figure 2)**. Patients with previous bowel surgery were more likely to restrict their diets during an exacerbation (82, 1% (23/28) vs. 58, 5% (24/41) p=0,039).

Discussion

There are few studies assessing malnutrition screening tools for CD patients in an ambulatory setting. Nutritional screening is easy to perform but can be influenced by multiple factors. Many questionnaires and methods exist, all with various advantages and disadvantages. ESPEN guidelines state that the ideal screening tool should be easy and quick to use and have a high sensitivity and specificity, with a good accuracy in detecting nutritional risk and nutrition-related outcomes [4]. Van Bokhorst-de van der Shueren et al. carried out a systematic review to assess the validity and predictive validity of nutrition screening tools [10]. The authors concluded that not one single screening tool is capable of adequate nutritional screening and predicting malnutrition-related outcomes. Also, many other authors concluded that development of new tools would be redundant [10,11]. Given these conclusions, screening tools have to be easily applied by health professionals. Our study shows higher specificity than sensitivity for most screening tools, which means that more well-nourished patients were correctly identified as not being at nutritional risk which is an important issue, especially in our center with limited services in clinical nutrition. In fact, a screening tool with high specificity will be less likely to categorize well-nourished patients as at risk of malnutrition and therefore will generate fewer inappropriate referrals. However, both high sensitivity and specificity are desirable to correctly identify individuals who are in fact at risk.

In our study, compared with the ESPEN and ASPEN malnutrition definitions, SGA had higher sensitivity and specificity than the other tools tested. However, although SGA can be classified as a screening tool, it is more often used as an assessment malnutrition tool. SGA performs better when used by experienced professionals and requires a longer evaluation and physical examination [10]. Time constraints and experience may therefore affect the use of the SGA as a screening tool in ambulatory clinical practice. It may be more practical to use it to assess nutritional status after another initial screening test has demonstrated a nutritional risk. SGA has been shown to be well correlated with prognosis, mortality and healthcare costs in hospitalised populations [11-13].

In our study, other than SGA, SNAQ followed by MUST had the best specificity and sensitivity. MUST had the best positive predictive value and SNAQ the best negative predictive value. In another study comparing screening tools to SGA for hospitalised patients, MUST had a sensitivity of 61, 2%, a specificity of 78,6% with a positive predictive value of 64,6% and a negative predictive value of 76,1% [14]. In our study of CD outpatients, the sensitivity of MUST was lower (40%) with a higher specificity (98, 2%). Our negative predictive value was similar to the literature in hospitalised population, at around 85, 5%.

Mourao et al. demonstrated that all malnutrition screening tools showed high specificity in hospitalised individuals. They also considered MUST a sensitive tool for surgical patients [15]. Stratton et al. demonstrated that MUST was the easiest tool to screen for malnutrition in ambulatory patients [7]. Another study of colorectal cancer patients showed that sensitivity of MUST compared with SGA was 96% and specificity was 75% with an excellent diagnostic accuracy [16]. MST had a sensitivity of 56% and a specificity of 84% which is similar to our study. They concluded that screening and assessment tools all showed varied diagnostic accuracy. Of course, the sensitivity and specificity depend on the gold standard used for comparison.

BMI can be elevated in malnourished patients. With the high obesity rates in most North American populations, it has become more difficult to rely on BMI as a screening tool for malnutrition. It has been shown not to be adequate to screen for malnutrition [11].

Hand-grip dynamometry may be a better way to detect early muscle loss. A 2008 study found that the hand-grip test correlated with cellular mass and was lower in inflammatory bowel disease patients compared with controls [17]. Many other studies demonstrated that HGS could test muscle fiber mass and detect malnutrition in its early stages [17-19]. However, not one of these studies correlated their findings with physical activity. In the current study, we could not show any advantage of HGS over other screening tools. Our study was not powered to look at the impact of physical activity on HGS results, but patients with lower HGS also reported lower levels of physical activity. This should be further investigated in a subsequent study.

Our study also showed that 18, 8% of ambulatory patients with mild to no disease activity were malnourished according to SGA. This value is lower than what was previously described in previous outpatient CD study, which was around 30% [2]. However, our results were concordant with a recent study that described a prevalence of malnutrition in IBD patients in ambulatory setting of 16% with SGA [5]. This observation confirms that a significant proportion of patients in clinical remission or with minimal disease activity are in fact malnourished. This was further ascertained using other screening tools, showing malnutrition risk in 8, 7% with BMI alone, 10,1% with MUST and MST, 15,9% with SNAQ and HGS. Bin et al. reached similar conclusions, showing that 18,7% CD patients in remission met the criteria for malnutrition according to SGA, 6,7% according to BMI, 37,3% with tricipital skin folds and 73,3% with the HGS test. Disease location, treatments and CRP levels were not associated with nutritional status, an observation we also made in our study [18]. A more recent study on a new malnutrition screening tool for CD patients in remission found similar numbers with a prevalence of malnutrition according to BMI, SGA and serum albumin around 2-16%. They also found no added value in HGS evaluation [20].

According to ESPEN and ASPEN malnutrition definitions, 14, 5% and 17, 4% of our patients were malnourished. However, the definition of malnutrition remains controversial, and this limited the accuracy of these criteria in our patients. To try to overcome this problem and accurately diagnose all the

malnourished patients, we put together both definitions to try to assess our population. We found a maximum of 21, 7% of malnourished CD patients using these definitions.

This study was not powered to identify the cause of malnutrition in our CD patients in remission. However, we found that prior digestive surgery for CD was associated with malnutrition. Other studies have also described similar findings [5,21]. Malnutrition in IBD is not only due to inflammation or malabsorption, but also to diminished intake for a variety of reasons [1,2,22]. A significant number of patients avoid important food groups such as fat, dairy and vegetables, most often under the belief that this may prevent disease flares. In fact, our survey showed that 46,4% still avoid foods even in remission or with minimal disease activity. It has been shown in other studies that patients find that food can affect their symptoms and this is one of the causes of diminished intake [5,23]. Casanova et al. showed that the vast majority (77%) of IBD patients have self-imposed food restriction behaviour to prevent a disease flare and for fear of worsening disease symptoms [5]. In their study, 63% patients avoided spicy food, 48% alcohol, 40% fat and 38% carbonated beverages. Sousa Guerreiro et al. also showed that CD patients tend to exclude milk (28%), vegetables (18%) and fruits (11%) from their diet [23]. We showed that CD patients tend to avoid coffee (43, 5%), alcohol (37, 7%), fibers (44, 9%), nuts (40, 6%) and vegetables (43,5%). All these factors can affect nutritional status in our patients. In the Casanova study, avoidance of some food groups was associated with malnutrition (OR 10, 3) [5]. We found that patients with malnutrition were more prone to use a specific diet. Scientific evidence to support specific dietary advice in patients with IBD is currently lacking. We also found that 52% believe that nutrition can be a cause of IBD, which is similar to other studies [5,24]. These results are relevant, because one of the mechanisms of malnutrition in IBD patients is self-imposed food restrictions [22]. However, our study was not powered to look at specific diet in malnourished and well-nourished patients. Only approximately 50% of our patients received professional advice from qualified nutritionists, which is similar to another study [25]. In view of these observations, misconceptions and unwarranted dietary restrictions should be addressed specifically with CD patients, and professional advice be used more frequently to ensure better prevention of nutritional complications.

The present study has several limitations. Categorizing our patients as malnourished versus well-nourished was challenging because of the lack of a universal malnutrition definition. Thus, our reference tool (a composite of the ESPEN and ASPEN definitions) has some limitations. Also, we did not measure body composition which would have been useful in nutritional evaluations. It would have been interesting to evaluate the evolution of the patients' nutritional status at 6 months at the same time point the rate of hospitalisation, surgery and change in medication were assessed. The possibility of bias also exists, since the patients who agreed to participate may have been the ones more focused on nutritional aspects of the disease. Strengths of the present study were its prospective design and the inclusion of nutritional assessment of all patients who completed the questionnaire. To our knowledge, this is the first study to specifically look at many screening tools and compare them to ESPEN/ASPEN definitions of nutritional status in CD patients in an ambulatory setting.

Conclusion

In conclusion, our study shows that even in remission or with minimal disease activity, approximately 15% of CD patients suffer from malnutrition. This highlights the importance of routine screening and education in this population. Screening and assessment should be included in routine clinical practice. In our study, the best malnutrition screening tools according to kappa calculation in an ambulatory setting is the SNAQ. On the other hand, MUST have a better specificity than SNAQ. However, there is no single tool to screen malnutrition with perfect accuracy. Further studies need to investigate the accuracy of these screening tools in the context of ambulatory CD patients. SGA is an excellent tool, but is an assessment tool rather than a screening tool.

Our study also demonstrates that CD patients believe that nutrition plays a key role in their symptoms and may be a trigger in both disease onset and flares. A very high proportion of patients still avoid certain foods even in remission. Dietary behaviours should be systematically assessed in clinic to avoid malnutrition or nutrient deficiencies.

Data availability: The data used to support the findings of this study are included within the article.

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