ORIGINAL ARTICLE
INFLAMMATORY DISEASE

doi.org/10.1590/S0004-2803.246102023-88

Body fat composition in patients with inflammatory bowel diseases: a comparative study between skinfolds and ultrasonography

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HIGHLIGHTS

- Inflammatory bowel diseases are associated with changes in nutritional status.
- Skinfolds measurements and ultrasound are valid methods for assessing body composition and body fat.
- These methods despite comparable are not identical and are useful in clinical nutritional practices in IBD.

Received: 13 June 2023
Accepted: 23 October 2023

Declared conflict of interest of all authors: PGK is a speaker and consultant for Abbvie, Janssen, Pfizer and Takeda. He also received scientific grants from Pfizer and Takeda. All other authors have no conflicts of interest.
Disclosure of funding: no funding received
Declaration of use of artificial intelligence: none
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ABSTRACT – Background – Inflammatory bowel diseases (IBD) are associated with important changes in nutritional status. **Objective** – The aim of the study was to compare body fat composition between two anthropometric methods: skinfolds and ultrasonography, in patients with IBD. **Methods** – Single-center cross-sectional study with IBD patients in remission or active disease. For the agreement analysis between the body fat assessment methods, the Bland Altman method was used. **Results** – A total of 101 patients with IBD were included, 75 with Crohn's disease and 26 with ulcerative colitis. Approximately 56% of the patients with Crohn's disease and 65.4% of those with ulcerative colitis had a body fat composition above normal levels, with no significant difference between the diseases (P=0.63). The Bland-Altman concordance analysis showed that the methods for assessing the percentage of fat by the adipometer and ultrasound were not in full agreement (P=0.001), despite both presented good correlation (CC 0.961; P=0.000). **Conclusion –** The analysis of body fat percentage in patients with IBD was different between the skinfolds and ultrasound. Both methods can be used to assess the of body fat percentage of patients with IBD. However, monitoring of body fat sequentially and longitudinally should always be performed using the same method throughout the disease course. Prospective longitudinal studies are warranted to precisely define the role of these two methods of measuring body composition in patients with IBD.

Keywords – Inflammatory bowel diseases; nutritional assessment; body fat percentage; ultrasonics; anthropometry.

INTRODUCTION

Inflammatory bowel diseases (IBD), ulcerative colitis (UC) and Crohn's disease (CD), are associated with important changes in the nutritional status (NS), such as malnutrition and obesity[1,2]. The precise etiology of CD and UC are not yet identified, but they can be considered multifactorial diseases, due to the influence of genetic, environmental, immunological factors and alterations in the microbiome[2].

Nutritional assessment is necessary for the diagnosis and appropriate management of patients with IBD[3]. Body composition analysis can be defined as the description and quantification of the various components, such as the amounts of fat, muscles, and bones. Skinfold measurements can be used to estimate the regional distribution of fat, determining the proportion of subcutaneous fat in the trunk and extremities, and to establish anthropometric profiles[4,5].

A new method that has been used to assess body composition is ultrasound (US), which is a portable body composition assessment method. This technique automatically calculates the percentage of body fat, lean mass, and body water, in addition to showing the image of the muscle and fat of the evaluated location[6]. US is a direct method of measuring subcutaneous fat without tissue compression[7].

The Consensus of the British Society of Gastroenterology describes alterations in the body composition of patients with IBD, such as an increase in fat mass (mainly visceral fat) and a decrease in lean mass. These alterations are frequently observed, and these nutritional aspects collaborate to increase cardiovascular risk, complications after surgical procedures and hospitalization of these patients[2]. Both malnutrition and obesity have a negative impact on the clinical evolution of patients with IBD, with increased risks of postoperative complications, such as anastomotic dehiscence, reoperations, prolonged hospitalizations, and increased mortality[8].

The nutritional status of patients with IBD, both in extreme degrees of malnutrition and obesity, can directly impact the treatment and outcomes linked to the inflammatory activity of the disease. Identifying nutritional status and intervening, when necessary, can positively contribute to the adequate management of IBD[9]. Thus, an accurate and detailed nutritional diagnosis is directly linked to the possibilities of adequate nutritional therapy, which can help in the clinical or surgical treatment of IBD patients[2,10].

There are few studies in the field of IBD that compare classic methods, such as anthropometric measurements, with methods of technological innovation, such as ultrasound. Thus, the aim of this study was to evaluate the agreement or possible differences between two anthropometric methods, skinfolds, and portable ultrasound in patients with IBD.

METHODS

Study design and participants

This was a single-center, cross-sectional study. The sample corresponds to 21.6% of the population of the patients with IBD treated at our center, and the patients were consecutively evaluated (convenience sample, no specific powered calculation) between July 2021 and April 2022. Patients were classified according to diagnosis (CD and UC) and allocated in subgroups according to disease activity and remission at the time of nutritional assessment. Diagnosis of UC and CD were based on clinical, biochemical, radiologic, endoscopic and/or histologic criteria.

The inclusion criteria were patients over 18 years of age, with CD or UC. Patients with insufficient information in the review of medical records or whose nutritional status was obese (BMI ≥30 kg/m^2) were excluded, as measurements of the skinfolds are inadequate for evaluating the percentage of body fat in patients with obesity.

Methodology

Data collection was carried out entirely by a single researcher (ISMS), always using the same equipment. The collection of clinical variables was performed on the same day as the anthropometric and ultrasound variables. The evaluator had training to perform the measurement of skinfolds, as well as specialized training for evaluation with ultrasound. Training in the use of ultrasound was carried out upon purchase of the equipment, upon completion of which a training certificate is received. Data were collected in a standardized way according to the following sequence: weight, height, calculation of body mass index [BMI= weight (in kg)/height^2 (in m^2)], waist circumference

(cm), percentage of body fat by skinfolds and portable ultrasound. The waist circumference classification was performed according to Ross et al. (2020)[11].

The skinfolds evaluation was performed using the Jackson and Pollock protocol[4,5]. Ultrasonography was performed using the Bodymetrix® PRO BX 2000 device (Bodymetrix® – IntelaMetrix, Inc. – Brentwood, CA) coupled to a Macbook PRO model A1708 (Apple® – CA) computer. Both assessments were performed using the seven skinfolds protocol by Jackson and Pollock (triceps, mid-thigh, mid axillary, pectoral, abdominal, suprailiac, subscapular). The body fat percentage (%BF) classification for men and woman was performed using the same protocol.

The US analysis was performed only once, at a frequency of 2.5 MHz. The device works with an interface via USB port to the computer. There is no need for specific preparation prior to the exam. Specific gel for the equipment, based on water and carboxyvinyl polymer, was used at the time of the evaluation. The BodyView Professional® software considers different reflection coefficients between the interface of the body fat-muscle layers as being 0.012 and between the interface of the muscle-bone layers as being 0.220, thus allowing the dimensioning of these layers[12]. The evaluation consists of applying the gel to the head of the equipment and the patient's skin, followed by the passage of ultrasound at the evaluation site[12]. The measurement with the Bodymetrix® PRO BX 2000® takes place through short duration ultrasound pulses, which are sent by a single transducer that also works as a receiver of the echoes reflected at the interfaces between the different body layers. The greatest reflections occur at major interfaces, for example: in the subcutaneous fat layer and in muscle. However, there is scattering of ultrasonic waves at small interfaces, making it possible to obtain images of intramuscular fat[6].

Clinical variables (sex, age, previous intestinal surgery, comorbidities, disease duration, medications used at the time of evaluation, disease activity) were accessed from the application of the clinical and nutritional assessment form.

CD patients' characteristics were detailed according to the Montreal classification. For the classification of remission and activity of IBD, the Harvey-Bradshaw Index[13] was used for CD and the Mayo partial score[14] was assessed for UC.

This study was evaluated and approved by the Ethics and Research Committee of the Pontifical Catholic University of Paraná, through the Plataforma Brazil website, under reference number CAAE 4.763.548/2021. An Informed Consent Form was signed by all included patients.

Statistical analysis

Results were expressed as mean and standard deviation or median and interquartile range depending on the variable distribution (quantitative variables), or as frequencies and percentage (qualitative variables). The proportions were analyzed using the chi-square test and Fisher's exact test when appropriate. Student's *t* test was used to compare quantitative variables. For the analysis of agreement between the methods of assessing body fat percentage, the Bland-Altman method. The significance level adopted for the study was 5%. Data were collected and stored in a Microsoft Excel® spreadsheet and later transferred for data analysis in the SPSS v.20.0 computer statistical program (IBM® Corporation, New York D.C., USA).

RESULTS

Patients' baseline characteristics

From 130 patients with IBD scheduled for evaluation, 27 were excluded because they were obese (BMI ≥30 kg/m^2) and 2 due to missing data from medical records. In total, 101 patients (75 with CD and 26 with UC) were included in the final analysis (FIGURE 1).

TABLE 1 describes the baseline characteristics of the population, mostly comprised by young patients. Regarding patients' sex, the distribution was proportional in CD and there was a predominance of females in UC. The average disease duration (from diagnosis to evaluation) in both diseases was between 6 and 7 years. Most patients were using immunosuppressants or biologics with no previous intestinal surgery.

According to the Montreal classification for CD, the main characteristics identified were diagnosis between 17 and 40 years old, 66.67% with ileocolonic disease, and 64.00% with inflammatory phenotype (TABLE 2). According to the HBI disease activity in-

dex, 86.67% of CD patients were in remission at the time of evaluation (TABLE 2). Similarly, most patients with UC (73.9%) were in remission, and the predominant disease extension was left-sided colitis (57.7%) (TABLE 3).

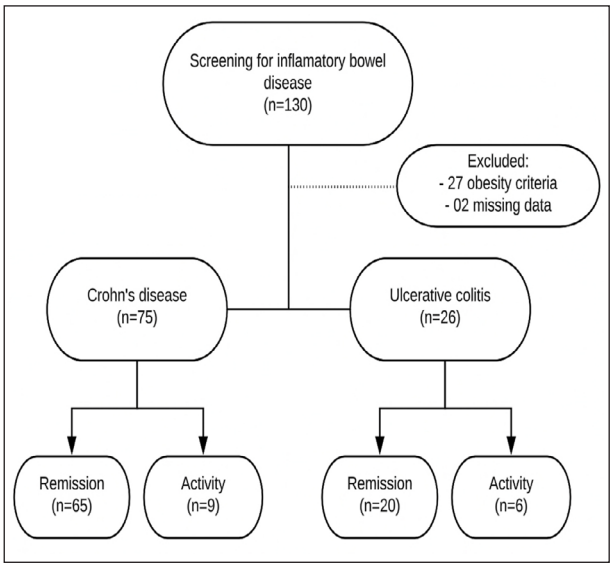

FIGURE 1. Flowchart of the study.

TABLE 2. Montreal classification and HBI score for CD.

Variable	CD (n=75)	%
Montreal classification for CD		
Age at diagnosis		
A1	4	5.3
A2	70	93.4
A3	1	1.3
Disease location		
L1	7	9.3
L2	18	24.0
L3	50	66.7
Disease phenotype		
B1	48	64.0
B2	11	14.7
B3	3	21.3
HBI score		
Remission	65	86.7
Mild activity	6	8
Moderate activity	3	4
Severe activity	1	1.3

CD: Crohn's disease; HBI: Harvey-Bradshaw Index.

TABLE 1. Baseline Characteristics of Patients with IBD.

Variable	CD (n=75)	%	UC (n=26)	%
Age (years)				
18–40	46	61.3	13	50.0
41–64	26	34.7	8	30.8
≥65	3	4.0	5	19.2
Sex				
Female	37	49.3	16	61.5
Male	38	50.7	10	38.5
Previous intestinal surgery				
Yes	35	46.7	3	11.5
No	40	53.3	23	88.5
Disease duration in months (MD±SD)	82.36±65.35	-		-
Comorbidities				
Yes	6	8	4	15.4
No	69	92	22	84.6
Medications used				
None	2	2.7	2	7.7
Immunosuppressants	34	45.3	19	73.5
Corticosteroids	1	1.3	0	0
Immunosuppressants + corticosteroids	1	1.3	2	7.7
Biologicals	10	13.3	2	7.7
Immunosuppressants + biologicals	27	36	1	3.8

CD: Crohn's disease; UC: ulcerative colitis; SD: standard deviation; MD: average.

TABLE 3. Montreal classification and Mayo score for UC.

Variable	UC (n=26)	%
Montreal classification for UC	6	23.1
E1 - proctitis	15	57.7
E2 - left-sided colitis	5	19.2
E3 - extensive colitis		
Mayo Score		
Remission	20	77.0
Mild activity	3	11.5
Moderate activity	3	11.5

UC: ulcerative colitis.

Nutritional status

Regarding patients with CD and UC, 50% were eutrophic, followed by overweight (41.3%; 46.2% respectively), with no difference between the groups (*P*=0.94). Approximately 56% of the patients with CD and 65.4% of those with UC had a body fat percentage above normal levels, but with no significant difference between the diseases (*P*=0.63) (TABLE 4). There was no significant difference between sexes for BMI and waist circumference in CD and UC. Body fat percentage was adequate for men and above normal for women in both diseases (TABLE 5).

In relation to nutritional status, waist circumference and body fat percentage in both methods, there were no significant differences between remission vs active disease and sex (TABLE 6). According to the Bland-Altman plot (FIGURE 2), the analysis between the two methods to evaluate the percentage of body fat demonstrated that both were not in full agreement (*P*=0.001; SD=3.11–1.57).

DISCUSSION

The present study demonstrated that the anthropometric assessment methods used (adipometer and US) were not considered identical. The two methods are easily accessible in the dietitian's clinical practice, both have their particularities and limitations, but can be used to assess body fat in patients with IBD.

TABLE 4. Classification of nutritional status and body fat percentage of patients with IBD.

Variable	Classification	CD (n=75)	%	UC (n=26)	%	*P* value
BMI	Underweight	5	6.7	1	3.8	0.94
	Eutrophic	39	52.0	13	50.0	
	Overweight	31	41.3	12	46.2	
Body fat (%)	Low	1	1.3	–	–	0.63
	Adequate	32	43.7	9	34.6	
	High	42	56.0	17	65.4	
Waist circumference (cm)	Adequate	62	82.7	20	76.9	0.56
	Above	13	17.3	6	23.1	

c^2 test. BMI: body mass index; CD: Crohn's disease, UC: ulcerative colitis.

TABLE 5. Body fat percentage of CD and UC patients according to sex.

Variables	Crohn's disease			Ulcerative colitis		
	Female (n=37) (MD±SD)	Male (n=38) (MD±SD)	*P* value	Female (n=16) (MD±SD)	Male (n=10) (MD±SD)	*P* value
BMI (kg/m²)	24.16±3.23	23.47±3.41	0.648	24.44±2.85	25± 3.89	0.188
Waist circumference (cm)	81.00±9.58	84.21±9.89	0.695	81.63±9.34	87.50±9.39	0.130
Body fat by the adipometer (%)*	30.11±6.29	18.17±5.96	-	29.84±5.23	21.93±6.67	-
Body fat by portable US (%)*	29.64±6.13	16.95±5.16	-	29.75±5.35	20.46±8.04	-

*It is not recommended to compare body fat percentage between the sexes. *t*-Student test; BMI: body mass index; US: ultrasound; MD: average; DP: standard deviation.

TABLE 6. Body fat percentage of CD and UC patients, according to disease activity and sex.

Variables	Crohn's disease				Ulcerative colitis			
	Female (n=37) (MD±SD)	*P* value	Male (n=38) (MD±SD)	*P* value	Female (n=16) (MD±SD)	*P* value	Male (n=10) (MD±SD)	*P* value
	R/A 24.13±3.35 24.4±2.61	0.431	R/A 23.72± 3.48 22.40±3.21	0.622	R/A 24.45±2.84 24.75±3.59	0.688	R/A 26.25± 3.06 20.00±2.83	0.820
Waist circumference (cm)	81.09±9.54 80.40±10.97	0.893	84.75±3.35 82.80±10.08	0.790	82.18±10.83 81.00±6.22	0.118	90.75±6.41 74.50±9.19	0.603
Body fat by the adipometer (%)	30.19±6.52 29.78±5.11	0.427	18.73±5.63 15.81±7.77	0.714	30.43±5.95 28.40±3.81	0.484	23.59±6.28 14.79±1.04	0.270
Body fat by portable US (%)	29.68±6.34 29.40±5.22	0.607	17.30±5.19 15.60±5.40	0.796	29.97±6.06 29.30±4.46	0.561	22.62±7.46 11.80±2.40	0.088

R: remission; A: activity; t-Student test; BMI: body mass index; US: ultrasound; M: Average; DP: Standard Deviation.

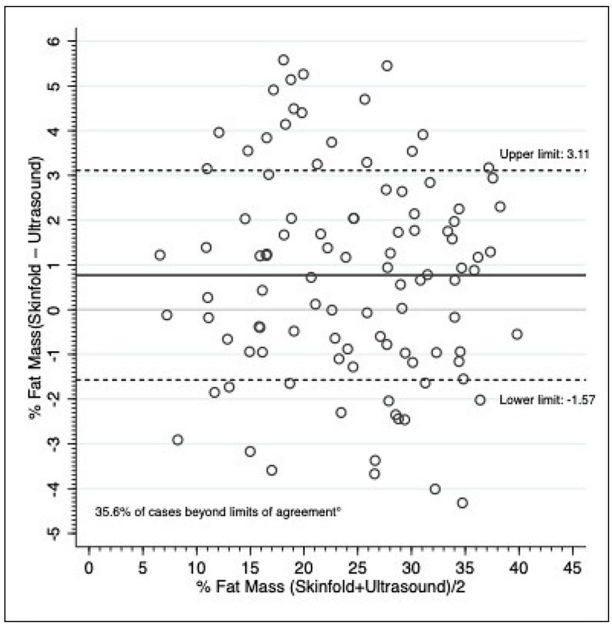

FIGURE 2. Bland-Altman plot.
Bland Altman plot for data from table 5 with the representation of the limits of agreement (dotted line), from -1.96 to +1.96.

In view of what was expected decades ago, when patients with IBD were mostly malnourished or underweight, a different patient profile was identified in our population. In the era of biologics, the nutritional profile has changed. Approximately 50% of patients were eutrophic, with no differences between CD and UC. Biologics have changed the profile of patients under treatment for inflammatory bowel disease. However, there are other factors that should be considered in the relationship between IBD and dysmetabolism. Chronic inflammation can be associated to genetic factors, microbiome alterations, body fat percentage and other gastrointestinal hormonal factors[15-17]. Continuous research on the possible association of these factors with development of IBD and response to medical therapy are warranted.

The percentage of body fat was higher in patients in remission. It is noteworthy that 20.7% of the patients were not included in this study due to obesity, with limitations in measuring skinfolds.

The assessment of the body fat percentage of patients with IBD is of paramount importance in nutritional management, considering that BMI calculation in isolation has limited utility[18]. This method is universally applicable and should continue to be used. However, it is necessary to associate other clinical measures that assist in the diagnosis of patients' nutritional status (circumferences and clinical evaluation), since BMI can underestimate or overestimate its classification: patients with a large amount of lean mass can be classified as overweight or obese patients by BMI, and the percentage of body fat can be within the normal range[19,20]. Despite this consideration, there are data which identified that BMI per se can be a reliable measure to predict visceral fat accumulation in individuals with CD in comparison with healthy controls[21]. Discussion between isolated measurement of BMI or its association with other variables still persists.

Our data showed that 50% of included patients were eutrophic, but with a body fat percentage above the recommended levels and were in remission of the disease. The relationship observed between these results and IBD is still unknown. However, it is likely to be multifactorial and to involve decreased physical activity in patients with active IBD, the

effect of inflammatory cytokines on muscle mass and protein metabolism, excessive use of corticosteroids, or a primary role of visceral fat in triggering intestinal inflammation[22-26].

Regarding to visceral fat, studies have shown that visceral fat may be greater in CD patients as compared to healthy controls, regardless of the nutritional status[21] and this accumulation of subcutaneous and even visceral fat may be associated with postoperative complications and disease severity[27,28]. In the study by Velho et al. (2022), authors speculated that a lower amount of muscle mass and a high visceral fat index were related to more severe phenotypes in patients with CD[29]. The focus of nutritional management, in addition to the treatment of malnutrition, should be extended to tackle obesity and increasing muscle mass[30]. In our study, 17.3% of patients with CD and 23.1% with UC had a waist circumference above normal levels, a measure which is strongly associated with increased visceral fat percentage.

We observed that approximately 86.6% of patients with CD and 73.9% with UC were in remission at the time of evaluation, and this clinical condition is related to the current nutritional status presented by the patients. This can be explained by the characteristics of our unit: a tertiary referral center in the management of IBD, which uses the most advanced forms of medical and surgical treatment. More than 75% of patients were using some immunosuppressant or biological agent. As the clinical course of IBD is unpredictable, clinical follow-up should be frequent and medical treatment should be optimized whenever there is an unsatisfactory response[9].

Krueger et al.[31], using a similar methodology as ours, described that overweight subjects presented greater similarity between the values obtained using caliper and ultrasound equipment. The values obtained by the US were lower than those obtained by the evaluation with a caliper[30]. Furthermore, the reliability of the US method to estimate body fat percentage is superior to the skinfold method according to Wagner et al.[32].

When US is compared with the evaluation made by Dual-energy X-ray Absorptiometry (DXA), considered the gold standard measurement method, there are also adequate estimates, as this device is portable, easy to handle and has a lower operating cost[18]. In addition, DXA is an exam that requires a specialized radiologist, is a high-cost procedure which represents a barrier to routine use in public outpatient clinics[33]. Ripka et al. compared DXA with ultrasound, and obtained a similar result, in relation to the Bland Altman, analysis where no complete agreement between the methods was identified[34]. These findings were similar to our results, which concluded that the methods are different and should not be compared. It should be noted that our study was the first to be performed in patients with IBD rather than on healthy subjects. Our recommendation is that the same method should be always used to analyze the percentage of body fat of patients in the continuous evaluation throughout their disease course.

Bioimpedance is an important nutritional assessment tool, it has a good correlation with DXA, although few studies have evaluated it in patients with IBD. It is important to emphasize that patients with active IBD have frequent episodes of diarrhea, which can cause dehydration, possibly leading to lower body water values, what can impact bioimpedance results[35]. Although bioimpedance and DXA are good tools to assess the nutritional status of patients, our objective was to compare a new technique (US) with an established method (adipometer), in order to identify alternatives which could be more easily implemented in clinical practice.

In both CD and UC, the %BF was adequate for men and above normal for women. In the study by Bryant et al.[19], which analyzed %BF of patients with CD, there were lower rates in male patients and normal in female. In the same study, in UC, the %BF was normal in men and increased in women, similarly to the results of our study. These findings are also similar to those of Guerreiro et al.[36], who suggested that there were differences between the %BF of men and women with CD. This study showed no significant difference in %BF between the diseases or between the groups regarding disease activity. In the study by Valentini et al.[37], similarly, no significant difference was identified in the %BF of patients with CD and those with UC[37]. In the study by Ulbricht et al.[12], the body fat results by US were lower than those measured by measuring skinfolds.

In the study by Ripka et al.[34], when DXA was

compared with US, a strong correlation was obtained for males, but not for females, possibly due to differences in the stage of puberty between patients, since US tended to underestimate the values of body fat percentage. The study by Neves et al.[6] found overestimated results of body fat measured by the US, which can be explained by possible variation of US compression used by the examiner and by the better application of the adipometer in the points of greater ease of clamping. Based on the results of the studies, there is controversy in the literature regarding the agreement between the %BF measurement methods[37], although both can be used to measure body fat percentage.

The present study is associated with some limitations that need to be outlined. Initially, the cross-sectional study design has limitations which may be inherent to a single measurement occasion. Most included patients were in remission, which can possibly lead to similar results as studies carried out in healthy controls. In addition, the real influence of CD and UC, especially when active, on body fat percentage measurements, may have been underestimated. Another limitation of the study is that the composition analysis methods used are not considered as gold standards, due to some limitations of DXA: high acquisition cost, patient exposure to radiation and lack of applicability in clinical practice. The measurement of the percentage of body fat by skinfolds (adipometer) presents an important limitation. Patients with a BMI ≥30 kg/m^2 (obese) are not good candidates for this type of assessment since the results are not reliable. Therefore, the study population was limited to overweight patients, excluding those with obesity. Eventually, in a longitudinal study, possible differences between the methods could be detected if a greater number of evaluations were performed. Despite these limitations, the study has strengths, mostly for being the first with a comparative methodology in IBD patients, for having its measurements performed by a single evaluator and for being performed in a tertiary referral center. This is a real-life study that can add knowledge for dietitians evaluating patients with IBD.

CONCLUSION

In summary, the analysis of body fat percentage in patients with IBD with skinfolds and ultrasound did not present full agreement. Both methods can be used to assess the of body fat percentage of patients with IBD. However, monitoring of body fat sequentially and longitudinally should always be performed using the same method throughout the disease course. Prospective longitudinal studies are warranted to precisely define the role of these two methods of measuring body composition in patients with IBD.

Authors' contribution

Tuma ISM and Kotze PG: data collection, research execution, text writing. Cambi MPC: data collection, research execution. Moraes TP: statistical analysis. Magro DO: text writing, statistical analysis.

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Tuma ISM, Cambi MPC, Moraes TP, Magro DO, Kotze PG. Composição da gordura corporal em pacientes com doenças inflamatórias intestinais: um estudo comparativo entre dobras cutâneas e ultrassonografia. Arq gastroenterol. 2024;61:e23088.

RESUMO – Contexto – As doenças inflamatórias intestinais (DII) estão associadas a alterações importantes no estado nutricional. **Objetivo –** O objetivo do estudo foi comparar a composição da gordura corporal entre dois métodos antropométricos: dobras cutâneas e ultrassonografia, em pacientes com DII. **Métodos –** Estudo transversal de centro único com pacientes com DII em remissão ou doença ativa. Para a análise de concordância entre os métodos de avaliação da gordura corporal foi utilizado o método de Bland-Altman. **Resultados –** Foram incluídos 101 pacientes com DII, 75 com doença de Crohn e 26 com colite ulcerativa. Aproximadamente 56% dos pacientes com doença de Crohn e 65,4% daqueles com colite ulcerativa apresentaram composição de gordura corporal acima dos níveis normais, sem diferença significativa entre as doenças (*P*=0,63). A análise de concordância de Bland-Altman mostrou que os métodos de avaliação do percentual de gordura pelo adipômetro e ultrassonografia não foram totalmente concordantes (*P*=0,001), apesar de ambos apresentarem boa correlação (CC 0,961; *P*=0,000). **Conclusão** – A análise do percentual de gordura corporal em pacientes com DII foi diferente entre as dobras cutâneas e a ultrassonografia. Ambos os métodos podem ser usados para avaliar o percentual de gordura corporal de pacientes com DII. Entretanto, o monitoramento da gordura corporal de forma sequencial e longitudinal deve ser sempre realizado utilizando o mesmo método durante todo o curso da doença. Estudos longitudinais prospectivos são necessários para definir com precisão o papel desses dois métodos de medição da composição corporal em pacientes com DII.

Palavras-chave – Doenças inflamatórias intestinais; avaliação nutricional; percentual de gordura corporal; ultrassom; antropometria.

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