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Impact of Inflammatory Bowel Disease on Skeletal Muscle Health

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Abstract

Background: Inflammatory Bowel Diseases (IBD), encompassing Ulcerative Colitis (UC) and Crohn's Disease (CD), are associated with systemic inflammation that can adversely impact nutritional status and muscle health. This study aimed to assess muscle mass, strength, and nutritional indicators in IBD patients and evaluate their correlation with disease activity.

Methods: A cross-sectional study was conducted among 100 IBD patients (50 UC and 50 CD). Anthropometric measurements, Subjective Global Assessment (SGA), Mid-Arm Muscle Circumference (MAMC), and Handgrip Strength (HGS) were used to assess nutritional and muscle status. Laboratory parameters, including serum albumin, CRP, ESR, and haemoglobin, were also recorded. Correlations between disease activity (Mayo score for UC, CDAI for CD) and muscle/nutritional indices were analysed.

Results: Malnutrition (SGA B+C) was observed in 58% of participants, more prevalent in CD (64%) than UC (52%). Low BMI (<18.5 kg/m²) was noted in 29% overall. Serum albumin <35 g/L was seen in 36%, with a higher frequency in CD (42%). Mean HGS was significantly lower in women (17.4 ± 4.8 kg) than men (28.1 ± 6.3 kg); 26% of participants had HGS below cutoff. Significant negative correlations were found between disease activity and BMI ($r = –0.38$, $p = 0.001$), serum albumin ($r = –0.42$, $p < 0.001$), MAMC ($r = –0.29$, $p = 0.004$), and HGS ($r = –0.46$, $p < 0.001$).

Conclusion: Malnutrition and impaired muscle function are highly prevalent in IBD, particularly in CD. Muscle strength and nutritional indicators correlate inversely with disease activity, highlighting the importance of routine assessment of muscle health in IBD management.

Keywords: Inflammatory Bowel Disease, Ulcerative Colitis, Crohn's Disease, Malnutrition, Sarcopenia, Muscle Strength, Nutritional Status

Introduction

Inflammatory Bowel Diseases (IBD), including Crohn's disease (CD) and ulcerative colitis (UC), are long-standing inflammatory conditions of the gastrointestinal tract that exhibit periodic relapses and remissions. These disorders not only affect the gut but also have systemic implications, with emerging attention on their extraintestinal manifestations such as impaired muscle health [1].

Sarcopenia, defined as the gradual loss of skeletal muscle mass and function, has been identified in up to 60% of individuals with IBD [2]. This decline in muscle health leads to increased fatigue, diminished physical function, and worsened clinical outcomes, such as extended hospital stays, postoperative complications, and higher mortality rates [3,4]. In contrast to age-related sarcopenia, muscle deterioration in IBD is usually a consequence of secondary factors, including chronic systemic inflammation, inadequate nutrient absorption, prolonged corticosteroid use, and physical inactivity [5,6]. A key contributor to muscle

wasting in IBD is persistent inflammation. Elevated levels of cytokines - such as tumour necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) - inhibit muscle protein synthesis while activating proteolytic systems like the ubiquitin–proteasome and autophagy–lysosome pathways, which promote muscle degradation [7,8]. Additionally, the ongoing gastrointestinal symptoms, coupled with increased resting energy expenditure and anorexia, create a caloric deficit that further accelerates muscle loss [9].

Malnutrition is another prevalent complication in IBD, often coexisting with muscle dysfunction. Inadequate intake of proteins and essential micronutrients - such as vitamin D, iron, and magnesium-impairs muscle regeneration and mitochondrial efficiency [10,11]. Furthermore, medications frequently used in IBD management, such as corticosteroids and biologics, may contribute to muscle atrophy by altering hormonal balance and mitochondrial pathways [12]. Recent advancements have enabled the use of imaging modalities like computed tomography (CT) and magnetic resonance imaging (MRI) to assess muscle mass objectively, particularly at the L3 vertebral level - a validated site for estimating whole-body muscle mass [13]. Alongside imaging, functional tools such as handgrip strength and gait speed have gained recognition for their ability to evaluate early signs of sarcopenia and functional decline [14]. Despite the growing evidence of its clinical relevance, muscle health remains under-assessed in the routine management of IBD. Current guidelines seldom include structured muscle evaluations. Early recognition of sarcopenia and its association with malnutrition and disease activity is essential for developing comprehensive strategies-such as personalized nutrition plans, resistance exercise, and anti-inflammatory treatments preserve muscle integrity and improve long-term outcomes [15].

Materials & Methods

Study Design and Setting

This prospective observational study was conducted in the Department of Gastroenterology and Hepatology at Tirunelveli Medical College over a period of 12 months. The study was designed to evaluate nutritional status, skeletal muscle mass, and muscle strength in patients with Inflammatory Bowel Disease (IBD), including Ulcerative Colitis (UC) and Crohn's Disease (CD), and to determine their association with disease activity during follow-up. Ethical approval was obtained from the Institutional Ethics Committee prior to commencement of the study, and all participants provided written informed consent before enrolment.

Study Population

A total of 100 adult patients with confirmed Inflammatory Bowel Disease were enrolled in the study, comprising 50 patients with Ulcerative Colitis and 50 patients with Crohn's Disease. Eligible participants were aged above 18 years and had a diagnosis established through clinical evaluation, biochemical investigations, endoscopic findings, and histopathological confirmation. Patients were included irrespective of whether they were in active disease or remission at the time of enrolment. Individuals with chronic illnesses known to influence skeletal muscle mass or nutritional status, including chronic kidney disease, chronic liver disease, congestive heart failure, chronic obstructive pulmonary disease, diabetes mellitus, malignancy, or neuromuscular disorders, were excluded to minimize potential confounding factors.

Sample Size

A total sample size of 100 participants was included in the study, consisting of 50 patients with Ulcerative Colitis and 50 patients with Crohn's Disease. The sample size was determined based on the feasibility of recruitment and the number of eligible patients attending the gastroenterology outpatient and inpatient services during the study period.

Sampling Technique

Eligible patients fulfilling the inclusion criteria were recruited consecutively using a convenience sampling technique until the desired sample size was achieved.

Study Procedure

After obtaining written informed consent, all participants underwent a comprehensive baseline assessment. Detailed demographic information, disease duration, medication history, smoking status, previous surgeries, and clinical characteristics were recorded using a structured case record proforma. Laboratory investigations, biochemical parameters, inflammatory markers, and endoscopic findings were documented from hospital records. Disease activity was evaluated using validated disease-specific scoring systems. Patients with Ulcerative Colitis were assessed using the Mayo Score, with remission defined as a total score of ≤2, severe disease as a score greater than 10, and clinical response defined as a reduction of at least three points from baseline. Patients with Crohn's Disease were evaluated using the Crohn's Disease Activity Index (CDAI), where remission was defined as a score below 150, mild disease as 150–220, moderate disease as 220–450, and severe disease as greater than 450.

All participants underwent nutritional assessment at baseline, six weeks, and twelve weeks. Body weight and height were measured using standardized techniques, and Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared. Nutritional status was further assessed using the Subjective Global Assessment (SGA), where Grade A represented well-nourished patients, Grade B indicated moderate malnutrition, and Grade C indicated severe malnutrition. Serum albumin concentration was measured as an additional biochemical marker of nutritional status. Undernutrition was defined by the presence of any of the following criteria: BMI less than 18.5 kg/m², SGA Grade B or C, or serum albumin concentration below 35 g/L.

Body composition was evaluated using anthropometric measurements. Mid-arm circumference (MAC) and triceps skinfold thickness (TSF) were measured using standardized techniques, and Mid-Arm Muscle Circumference (MAMC) was calculated to estimate skeletal muscle mass. Muscle strength was assessed using a calibrated Smedley handgrip dynamometer. Three measurements were obtained from the dominant hand, and the highest value was recorded for analysis. Low muscle strength was defined as handgrip strength less than 26 kg in men and less than 18 kg in women.

Participants were reassessed at six weeks and twelve weeks using the same clinical, nutritional, anthropometric, and muscle strength evaluation protocol to monitor longitudinal changes in disease activity and nutritional parameters.

Data Collection Tool

Data were collected using a structured and prevalidated case record proforma specifically designed for the study. The proforma included demographic variables, disease characteristics, laboratory investigations, disease activity scores (Mayo Score and CDAI), nutritional assessment parameters, anthropometric measurements, serum albumin values, body composition indices, handgrip strength measurements, and follow-up findings obtained at baseline, six weeks, and twelve weeks.

Outcome Measures

The primary outcome measure was the association between disease activity and skeletal muscle strength among patients with Inflammatory Bowel Disease. Secondary outcome measures included assessment of nutritional status, prevalence of undernutrition, changes in anthropometric measurements, body composition, serum albumin levels, and longitudinal changes in nutritional and muscle health parameters during follow-up.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation for normally distributed data or median with interquartile range for non-normally distributed variables. Categorical variables were summarized as frequencies and percentages. Comparisons between categorical variables were performed using the Chi-square test or Fisher's exact test, while continuous variables were analysed using the Student's independent t-test or Mann-Whitney U test, as appropriate. Longitudinal changes in repeated measurements were evaluated using Repeated Measures Analysis of Variance (ANOVA) for normally distributed variables or the Friedman test for non-parametric data. Correlations between disease activity, nutritional parameters, and muscle strength were assessed using Pearson's or Spearman's correlation coefficients depending on data distribution. A p-value of less than 0.05 was considered statistically significant

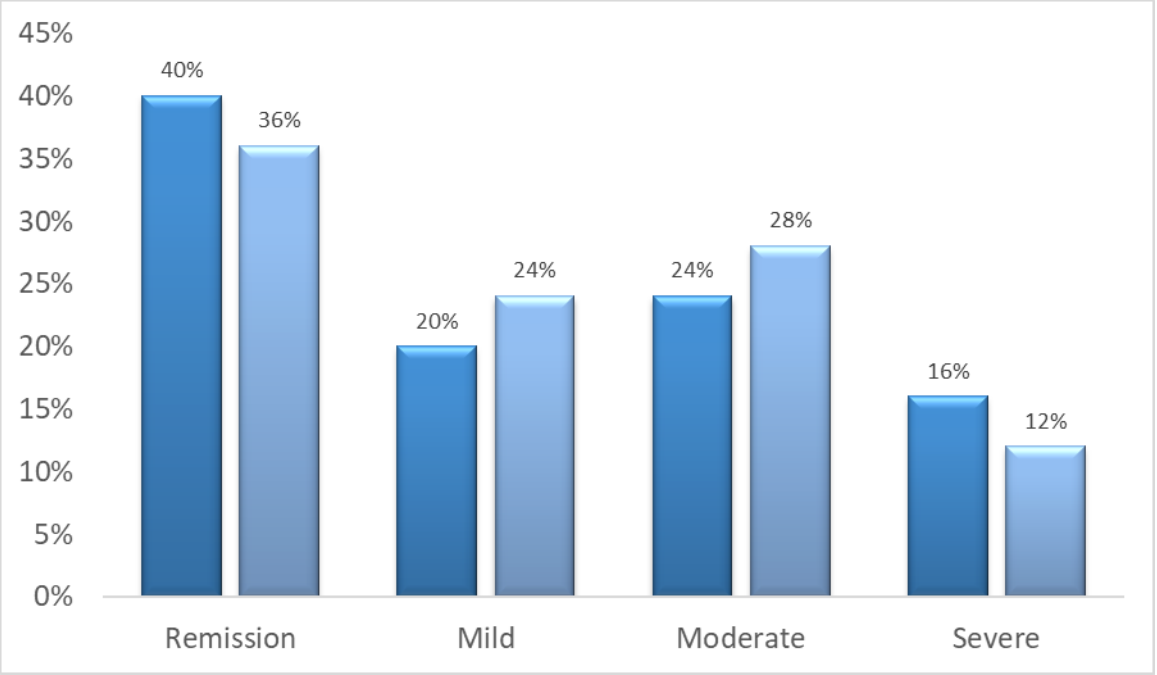
Results

Table 1: Baseline Demographic and Clinical Characteristics (n = 100)

Characteristic	Total (n = 100)	UC (n = 50)	CD (n = 50)	*p*-value
Age (years), mean ± SD	36.7 ± 12.5	38.1 ± 11.2	35.3 ± 13.7	0.241
Male, n (%)	58 (58%)	30 (60%)	28 (56%)	0.683
Duration of illness (yrs)	3.4 ± 2.1	3.2 ± 1.9	3.6 ± 2.3	0.427
Smokers, n (%)	22 (22%)	8 (16%)	14 (28%)	0.134

The mean age was 36.7 ± 12.5 years, with no significant difference between UC and CD groups (p = 0.241). Males comprised 58% of the total, similarly distributed across both groups (p = 0.683). The average disease duration was 3.4 years, comparable between UC and CD (p = 0.427). Smoking was more common in CD (28%) than UC (16%), though not statistically significant (p = 0.134).

Figure 1: Disease Activity Scores



At baseline, 40% of UC patients and 36% of CD patients were in clinical remission. Mild disease was seen in 20% (UC) and 24% (CD), moderate in 24% (UC) and 28% (CD), and severe activity in 16% (UC) and 12% (CD). The mean Mayo score for UC was 5.6 ± 2.3, while the mean CDAI for CD was 235.7 ± 78.4, indicating moderate disease activity in both groups.

Table 2: Nutritional Status (SGA, BMI, Albumin)

Nutritional Indicator	Total (n = 100)	UC (n = 50)	CD (n = 50)	*p*-value
SGA A (Well-nourished)	42 (42%)	24 (48%)	18 (36%)	0.203
SGA B (Mild–Moderate malnutrition)	38 (38%)	18 (36%)	20 (40%)	0.692
SGA C (Severe malnutrition)	20 (20%)	8 (16%)	12 (24%)	0.315
BMI <18.5 kg/m²	29 (29%)	12 (24%)	17 (34%)	0.237
Serum albumin <35 g/L	36 (36%)	15 (30%)	21 (42%)	0.181

Overall, 42% of patients were well-nourished (SGA A), while 38% had mild to moderate malnutrition (SGA B), and 20% showed severe malnutrition (SGA C). UC patients had a slightly higher proportion of well-nourished individuals (48%) compared to CD (36%), though not statistically significant. A BMI <18.5 kg/m² was more frequent in CD (34%) than UC (24%). Similarly, hypoalbuminemia (serum albumin <35 g/L) was observed in 42% of CD patients versus 30% of UC patients. However, none of these differences reached statistical significance.

Table 3: Anthropometric Measurements

Parameter	Total (mean ± SD)	UC (mean ± SD)	CD (mean ± SD)	*p*-value
Height (cm)	165.3 ± 8.5	164.7 ± 7.9	165.9 ± 9.1	0.521
Weight (kg)	58.2 ± 11.2	59.6 ± 10.4	56.8 ± 12.0	0.248
MAC (cm)	26.4 ± 3.2	26.7 ± 3.0	26.1 ± 3.4	0.354
TSF (mm)	9.8 ± 2.5	10.2 ± 2.3	9.4 ± 2.7	0.118
MAMC (cm)	20.3 ± 2.7	20.6 ± 2.4	20.0 ± 2.9	0.321

The mean height and weight were similar across both groups, with UC patients averaging 164.7 cm and 59.6 kg, and CD patients 165.9 cm and 56.8 kg ($p > 0.05$). Mid-arm circumference (MAC), triceps skinfold thickness (TSF), and mid-arm muscle circumference (MAMC) were also comparable, with slightly higher values in UC patients, but none of the differences were statistically significant. These findings suggest overall comparable anthropometric measurements between UC and CD groups.

Table 4: Handgrip Strength (HGS) Measurements

Sex	n	Mean HGS (kg) ± SD	HGS Below Cutoff, n (%)
Men	58	28.1 ± 6.3	12 (20.7%)
Women	42	17.4 ± 4.8	14 (33.3%)
Total	100	23.5 ± 7.1	26 (26%)

The overall mean handgrip strength (HGS) among participants was 23.5 ± 7.1 kg, with 26% of individuals falling below the gender-specific cutoff values. Men had a significantly higher mean HGS (28.1 ± 6.3 kg) compared to women (17.4 ± 4.8 kg). However, a greater proportion of women (33.3%) had reduced HGS compared to men (20.7%), indicating a higher prevalence of muscle weakness among female patients.

Table 5: Laboratory Parameters

Parameter	UC (mean ± SD)	CD (mean ± SD)	*p*-value
Hemoglobin (g/dL)	11.8 ± 1.4	11.2 ± 1.7	0.048*
CRP (mg/L)	10.3 ± 7.1	13.7 ± 9.4	0.027*
ESR (mm/hr)	28.6 ± 13.5	33.2 ± 14.8	0.091
Serum Albumin (g/L)	37.2 ± 4.3	35.5 ± 5.1	0.049*

Crohn's disease (CD) patients exhibited significantly lower hemoglobin levels (11.2 ± 1.7 g/dL) compared to ulcerative colitis (UC) patients (11.8 ± 1.4 g/dL, $p = 0.048$), indicating a greater burden of anemia in CD.

Inflammatory markers were also more elevated in CD, with CRP significantly higher (13.7 ± 9.4 mg/L vs. 10.3 ± 7.1 mg/L, p = 0.027), while ESR showed a non-significant trend towards elevation. Serum albumin was notably lower in CD patients (35.5 ± 5.1 g/L) than in UC (37.2 ± 4.3 g/L, p = 0.049), reflecting poorer nutritional and inflammatory status.

Table 6: Correlation of Disease Activity with Muscle Mass and Strength (n = 100)

Variable	Disease Activity Score	*r* (Pearson/Spearman)	*p*-value
BMI	Mayo/CDAI	–0.38	0.001**
Serum Albumin	Mayo/CDAI	–0.42	<0.001**
MAMC	Mayo/CDAI	–0.29	0.004**
HGS	Mayo/CDAI	–0.46	<0.001**

Disease activity (Mayo/CDAI) showed significant negative correlations with BMI (r = –0.38, p = 0.001), serum albumin (r = –0.42, p < 0.001), MAMC (r = –0.29, p = 0.004), and handgrip strength (r = –0.46, p < 0.001). These findings highlight that higher disease activity in IBD is associated with poorer nutritional status and reduced muscle mass and strength.

Discussion

Our study assessed muscle health and nutritional indicators in patients with ulcerative colitis (UC) and Crohn's disease (CD). Findings showed a significant proportion of IBD patients had impaired muscle mass, decreased handgrip strength (HGS), and indicators of malnutrition, with more pronounced derangements among CD patients.

In our cohort, reduced HGS was observed in 26% of patients, with a higher prevalence in females. This aligns with Schneider et al., who documented diminished muscle strength in 27% of IBD patients, especially in women and those with active disease (16). Bryant et al. also emphasized that muscle dysfunction can manifest even before noticeable muscle mass loss, highlighting the utility of functional tools like HGS in early detection (17). Although differences in anthropometric indicators like MAMC and BMI were not statistically significant between UC and CD, CD patients tended to have lower values. This is consistent with existing literature indicating that CD is more often associated with nutritional deficiencies and sarcopenia, primarily due to its small bowel involvement and frequent relapses (18).

Serum albumin was significantly lower in CD patients (35.5 ± 5.1 g/L) compared to UC (37.2 ± 4.3 g/L), reflecting systemic inflammation and reduced protein intake. Valentini et al. reported similar findings, noting that hypoalbuminemia in CD correlated with both inflammation and nutritional impairment (19).
Gender-specific trends were evident in HGS values, with female patients exhibiting significantly lower mean HGS and a higher proportion below the cutoff. Boparai et al. observed a comparable gender disparity in their study and suggested that body composition differences and hormonal influences could explain these findings (20). We identified significant negative correlations between disease activity and BMI, MAMC, serum albumin, and HGS, indicating that increased disease severity is associated with poorer nutritional and muscle health. Subramaniam et al. similarly demonstrated a direct link between inflammatory burden and catabolic muscle loss in IBD patients (21). Severe malnutrition (SGA C) was found in 20% of our participants. This is within the range reported in other studies, which suggest that 15–25% of IBD patients experience severe nutritional compromise, particularly during active disease phases (22). Moreover, underweight status (BMI <18.5 kg/m²) was seen in 29% of patients, closely aligning with the findings of O'Sullivan et al., who stressed that nutritional risk often remains underdiagnosed in IBD patients during routine care (23).

Conclusion

This study shows that patients with IBD, especially Crohn's disease, often have poor nutritional status and reduced muscle strength. Higher disease activity was linked to lower BMI, MAMC, serum albumin, and handgrip strength. Simple tools like SGA and HGS can help identify at-risk patients early and guide timely interventions.

Conflict of Interest: Nil

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