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Metabolic Syndrome in Inflammatory Bowel Disease: Prevalence, Risk Factors, and Impact on Disease Outcomes in a North African Cohort

Hamza Sboui

hamza.sboui@gmail.com

Department of Gastroenterology, CHU Taher Sfar

Olfa Ghannei

Department of Gastroenterology, CHU Taher Sfar

Trimech Mayada

Department of Gastroenterology, CHU Taher Sfar

Ben Amor Soumaya

Department of Gastroenterology, CHU Taher Sfar

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Abstract

Background

Inflammatory bowel disease (IBD) which includes Crohn’s Disease (CD) and Ulcerative Colitis (UC), is a chronic inflammatory condition. Metabolic syndrome (MetS) defined as an aggregation of cardiometabolic risk factors, is becoming more common among individuals with IBD, but the prevalence and significance of MetS in IBD patients have not been well documented, especially in North African populations.

Methods

We conducted a retrospective cross-sectional study including 161 patients with IBD followed at a secondary care center in Tunisia between 1998 and 2025. Clinical, biological, radiological, and treatment-related data were collected from medical records. MetS was defined according to the modified NCEP ATP III criteria. We assessed its prevalence, identified associated factors through logistic regression, and examined its relationship with IBD outcomes.

Results

MetS was identified in 52 patients, corresponding to a prevalence of 32.3%. The prevalence was comparable between CD and UC (34.3% vs. 30.8%, p = 0.64). In multivariable analysis, age (OR = 1.07; 95% CI [1.03–1.11]; p < 0.001), BMI (OR = 1.29; 95% CI [1.16–1.44]; p < 0.001), female sex (OR = 1.89; 95% CI [1.02–3.49]; p = 0.042), and hepatic steatosis (OR = 3.12; 95% CI [1.34–7.27]; p = 0.008) were independently associated with MetS. Furthermore, MetS was independently associated with adverse IBD outcomes, including hospitalization, corticosteroid dependency, and treatment escalation (OR = 2.41; 95% CI [1.25–4.66]; p = 0.009).

Conclusion

In this Tunisian IBD cohort, MetS affected nearly one in three patients and was associated with older age, higher BMI, female sex, and hepatic steatosis. Importantly, MetS was independently linked to a more severe disease course, underscoring the need for systematic metabolic screening in IBD care, particularly in older and overweight patients.

1. Introduction

Inflammatory bowel diseases (IBD), comprising Crohn's disease (CD) and ulcerative colitis (UC), are chronic immune-mediated disorders of the gastrointestinal tract characterized by recurrent episodes of intestinal inflammation. Their etiology is multifactorial, involving complex interactions among genetic

susceptibility, dysregulated immune responses, and environmental triggers (1). Over recent decades, IBD incidence has risen steadily worldwide, with an accelerating trend in previously low-incidence regions, including North Africa and the Middle East (2)

Metabolic syndrome (MetS) is a cluster of interrelated cardiometabolic abnormalities — abdominal obesity, insulin resistance, hypertension, and dyslipidemia — that substantially increases the risk of cardiovascular disease and type 2 diabetes (3). Although classically associated with sedentary and obese populations, emerging evidence suggests a significant MetS prevalence among IBD patients, ranging from 15% to over 40% across studies, driven by shared pathophysiological mechanisms including chronic systemic inflammation, immunometabolic dysregulation, and gut microbiota alterations (4, 5).

Despite the growing attention to the problem, the epidemiological data concerning the prevalence of MetS in IBD patients still vary from study to study, with great geographical variation and a lack of information on the issue among Africans and North Africans. (4) Furthermore, the medical significance of MetS among IBD patients is understudied.

This study aimed to: (1) determine the prevalence of MetS in a Tunisian IBD cohort; (2) identify independent factors associated with MetS in this population; and (3) examine the relationship between MetS and IBD clinical outcomes, including hospitalization, corticosteroid dependency, and treatment escalation.

2. Materials and Methods

a. Study Design and Setting

We performed a single-center, analytical cross-sectional study with retrospective data collection. Patients with IBD followed at the Gastroenterology Department of CHU Taher Sfar, Mahdia, Tunisia, between January 1998 and December 2025 were eligible.

b. Participants

Inclusion criteria

(1) confirmed diagnosis of CD or UC based on clinical, biological, endoscopic, radiological, and histological criteria; (2) age ≥ 18 years; (3) at least two documented annual follow-up consultations.

Exclusion criteria

(1) uncontrolled endocrine disorders; (2) conditions interfering with metabolism or inflammation (chronic kidney disease with eGFR < 60 mL/min/1.73 m², active or recent systemic autoimmune diseases, active malignancy or remission < 5 years); (3) incomplete medical records; (4) follow-up duration < 1 year.

c.Data Collection

Data were retrospectively extracted from paper medical records by the principal investigator over a 9-month period using a standardized data collection form (Appendix 1). Variables included: (1) sociodemographic characteristics (age, sex, smoking, alcohol); (2) comorbidities (diabetes, hypertension, dyslipidemia); (3) clinical parameters (weight, height, BMI, waist circumference); (4) biological parameters (fasting glucose, HbA1c, lipid panel, ferritin, albumin, calcium, CRP); (5) abdominal ultrasound findings (hepatic steatosis); and (6) IBD-specific data (type, phenotype per Montreal classification [10], disease activity indices, treatment history, surgical history).

d. Disease Activity Assessment

For CD, disease activity was assessed using the Harvey-Bradshaw Index (HBI) (6); for UC, the partial Mayo score (PMS) was applied (7, 8). Remission was defined as HBI < 5 for CD and PMS ≤ 2 for UC.

e. MetS Definition

MetS was defined according to the modified NCEP ATP III criteria (9), requiring ≥ 3 of the following 5 components:

1. Waist circumference: ≥ 102 cm (men) or ≥ 88 cm (women)
2. Blood pressure: SBP ≥ 130 mmHg and/or DBP ≥ 85 mmHg, or antihypertensive therapy
3. Fasting glucose: ≥ 5.5 mmol/L or ≥ 1 g/L, or insulin/oral antidiabetic use
4. Triglycerides: ≥ 1.7 mmol/L or ≥ 1.5 g/L
5. HDL-cholesterol: < 1.03 mmol/L (men) or < 1.29 mmol/L (women)

f. Statistical Analysis

Analyses were performed using SPSS v28.0. Normally distributed continuous variables are reported as mean ± SD and compared using Student's t-test; non-normally distributed variables as median [IQR]. Categorical variables are reported as frequencies and percentages and compared by chi-square or Fisher's exact test. Binary logistic regression (univariable followed by multivariable backward stepwise) was used to identify factors independently associated with MetS. Statistical significance was set at $p < 0.05$.

g. Ethics

The study was conducted in accordance with the Declaration of Helsinki and with Tunisian Organic Law No. 2004-63 of 27 July 2004 on the protection of personal data, and was approved by the Ethics Committee of CHU Taher Sfar Mahdia (Certificate No. CEM-2025-03-02; issued 17/03/2025). Patient confidentiality and data anonymization were strictly maintained throughout.

3. Results

3.1 Study population

A total of 161 patients with inflammatory bowel disease were included in the study. The mean age was 46.8 ± 16.9 years and 82 patients (50.9%) were female. Ulcerative colitis accounted for 56.5% of cases and Crohn's disease for 43.5%. The mean disease duration was 8.1 ± 7.5 years. At inclusion, 145 patients (90.1%) were in clinical remission. However, previous disease-related complications remained common. Baseline characteristics are summarized in Table 1.

Table 1
Baseline characteristics of the study population

Variable	Value
-Age (years)	46.8 ± 16.9
- Female sex	82 (50.9%)
- BMI (kg/m²)	26.4 ± 5.3
- Current smoking	24 (22%)
- Diabetes mellitus	36 (22.4%)
- Hypertension	31 (19.3%)
- Dyslipidemia	47 (29.2%)
- Ulcerative colitis	91 (56.5%)
- Crohn's disease	70 (43.5%)
- Disease duration (years)	8.1 ± 7.5
- Clinical remission	145 (90.1%)
- Previous IBD-related surgery	25 (15.5%)
- Biologic therapy	63 (39.1%)
- Elevated CRP	34 (21.1%)
- Anemia	63 (39.1%)

3.2 IBD characteristics

The mean age at diagnosis was 38.4 ± 15.5 years. In Crohn's disease, ileocolonic involvement (L3) was the predominant location, while inflammatory behavior (B1) represented the most frequent phenotype. In ulcerative colitis, extensive colitis (E3) was the most common disease extent. Disease characteristics according to IBD subtype are presented in Table 2.

Table 2
Disease characteristics according to IBD subtype

Variable	CD (n = 70)	UC (n = 91)
Age at diagnosis (years)	38.1 ± 15.8	38.7 ± 15.1
L3 location	52 (74.3%)	-
B1 phenotype	42 (60.0%)	-
Perianal disease	10 (14.3%)	-
E2 extent	-	38 (41.8%)
E3 extent		44 (48.4%)

3.3 Prevalence of metabolic syndrome

Metabolic syndrome was diagnosed in 52 patients, corresponding to a prevalence of 32.3%.

The prevalence was similar between Crohn's disease and ulcerative colitis (34.3% vs. 30.8%, p = 0.64).

3.4 Comparison between patients with and without metabolic syndrome

Patients with metabolic syndrome were significantly older and exhibited higher BMI, fasting glucose and triglyceride levels. Hepatic steatosis was markedly more frequent among MetS patients. Conversely, anemia and nutritional deficiency were less common in this subgroup, as detailed in Table 3.

Table 3
Factors associated with metabolic syndrome

Variable	MetS− (n = 109)	MetS+ (n = 52)	p-value
- Age (years)	40.9 ± 15.8	59.2 ± 11.5	< 0.001
- Female sex	49 (45.0%)	33 (63.5%)	0.027
- BMI (kg/m²)	24.6 ± 3.9	32.1 ± 4.2	< 0.001
- Triglycerides (mmol/L)	1.08 ± 0.37	1.71 ± 0.58	< 0.001
- Fasting glucose (mmol/L	5.42 ± 1.32	7.01 ± 2.11	< 0.001
- Ferritin (µg/L)	27 ± 24	44 ± 30	0.004
- Anemia	53 (48.6%)	10 (19.2%)	< 0.001
- Hepatic steatosis	12 (11.0%)	18 (34.6%)	< 0.001

3.5 Impact of metabolic syndrome on IBD outcomes

During follow-up, patients with metabolic syndrome experienced a less favorable disease course. They required hospitalization more frequently, showed higher rates of corticosteroid dependency, and underwent treatment escalation more often than patients without metabolic syndrome, as shown in Table 4.

Table 4
IBD outcomes according to metabolic syndrome status

	MetS− (n = 109)	MetS+ (n = 52)	p-value
≥ 1 IBD-related hospitalization	18 (16.5%)	17 (32.7%)	0.017
- Corticosteroid dependency	12 (11.0%)	13 (25.0%)	0.021
- Treatment escalation	16 (14.7%)	14 (26.9%)	0.047
- IBD-related surgery	11 (10.1%)	9 (17.3%)	0.17
- Active disease at inclusion	8 (7.3%)	8 (15.4%)	0.08

3.6 Multivariable analysis

Variables showing significant associations in univariable analyses and considered clinically relevant were entered into a multivariable logistic regression model. Independent factors associated with metabolic syndrome are presented in Table 5.

Table 5
Independent factors associated with metabolic syndrome

Variable	Adjusted OR	95% CI	p-value
Age (per year)	1.07	1.03–1.11	< 0.001
BMI (per kg/m²)	1.29	1.16–1.44	< 0.001
Female sex	1.89	1.02–3.49	0.042
Hepatic steatosis	3.12	1.34–7.27	0.008

3.7 Multivariable predictors of adverse IBD outcomes

A second multivariable model was performed using hospitalization, corticosteroid dependency, treatment escalation, or surgery as a composite adverse outcome. Metabolic syndrome remained independently associated with unfavorable disease outcomes, as shown in Table 6.

Table 6
Predictors of adverse IBD outcomes

Variable	Adjusted OR	95% CI	p-value
- Metabolic syndrome	2.40	1.25–4.66	0.009
- Active smoking	1.97	1.01–3.89	0.046
- Extensive disease	1.79	1.01–3.31	0.044
- Age	1.01	0.99–1.03	0.27

4. Discussion

Our research revealed that 32.3% of individuals with inflammatory bowel disease (IBD) were affected by metabolic syndrome. This figure sits at the higher end of what has been documented in existing studies, underscoring the significant impact of metabolic conditions in our patient group. The occurrence of metabolic syndrome in IBD patients seems to differ greatly depending on the region. In a meta-analysis conducted by Shen et al. (2024), which included 11 studies with a total of 2,501 patients, the overall prevalence was found to be 19.4%(4). However, various studies have reported significantly different rates, with figures ranging from 10.6% in a Korean sample,(10) 25.4% in Turkey, (11) to 32.7% in Serbia. (12) These variations are likely due to differing diagnostic criteria, lifestyle influences, ethnic diversity, and the distribution of IBD phenotypes. Within our group, the rates of metabolic syndrome were comparable between patients with Crohn's disease and those with ulcerative colitis, at 34.3% and 30.8%, respectively (p = 0.64). This contrasts with the findings from Shen et al., who noted a significantly higher prevalence in ulcerative colitis compared to Crohn's disease (38.2% versus 13.5%)(4). This discrepancy might be attributable to the younger age and lower rates of obesity in our cohort compared to those observed in Western populations.

our predictors that were significantly related to the MetS through multivariable analysis included age, high BMI, being female, and hepatic steatosis. Both age and BMI being significant risk factors for the MetS have already been reported in literature and can be explained by a gradual effect of metabolic risk factors on the body with time (4, 10). The significance of the female gender can be explained by sex-specific differences in metabolism and body fat distribution in chronic inflammatory diseases (11). Strong relation of MetS and hepatic steatosis (OR = 3.12) was explained by the connection between non-alcoholic fatty liver disease, insulin resistance, and metabolic disturbances. Neither disease activity, flares, medication therapy nor surgeries had any influence on the occurrence of MetS which means that the latter is more dependent on patient characteristics rather than IBD.(13)

This study revealed an independent association between MetS and adverse IBD outcomes. Patients with MetS were at a significantly increased risk of hospitalization, corticosteroid dependency, and treatment escalation. MetS proved to remain an independent predictor of this composite poor outcome only in the multivariable analysis (OR = 2.41;95% CI [1.25–4.66]; p = 0.009), along with active smoking, extensive

disease and disease activity. These clinically meaningful findings support the hypothesis that MetS is not just comorbidity but a modifier of IBD disease.

This is in line with recent data indicating the severe impact of MetS on hospital course and higher health-care usage among IBD patients. A retrospective study of 241,772 hospitalized IBD patients included in the National Inpatient Sample (2016–2020) found that MetS was independently associated with an increased length of stay, more frequent use of intensive care procedures and poorer discharge outcomes(14). In addition, the effect of biologic and immunomodulator therapy is reduced in obese IBD patients with metabolic disorders because of changes in pharmacokinetics with lower drug trough levels leading to lower steroid-free remission rates(15).

Strengths and limitations

The present study has a number of strengths. For instance, to the best of our knowledge, this is one of the few studies to have assessed the prevalence of MetS and its clinical relevance in a North African IBD population, which was an important gap in the current literature. This was made possible by the application of standardized diagnostic criteria for the whole study sample (modified NCEP ATP III).

A number of limitations must be pointed out. There is an inherent risk associated with the retrospective study design of lacking data and biased selection. The sample was drawn from one single center, which raises doubts about the applicability of findings in relation to the larger population of patients with IBD in Tunisia and North Africa. Additionally, diet, physical activity, and social class factors, important predictors of metabolic risk, were not included.

Declarations

Ethics approval: This study was conducted in accordance with the Declaration of Helsinki and with Tunisian Organic Law No. 2004-63 of 27 July 2004 on the protection of personal data, and was approved by the Ethics Committee of CHU Taher Sfar Mahdia (Certificate CEM-2025-03-02; 17/03/2025).

Consent to participate: Patient confidentiality and data anonymization were ensured throughout.

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Competing interests: None declared.

Author Contribution

H.S. conceived and designed the study, collected and analyzed the data, and drafted the main manuscript text. O.G., T.M., and B.A.S. critically reviewed and revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

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