JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Original Article

Fungal colonization and ASCA/p-ANCA positivity in inflammatory bowel disease: a cross-sectional study from Turkey

Zülal Aşçı Toraman[1], Pınar Öner[2], Meryem Erdoğan[1], Berçem Afşar Karatepe[3], Abdurrahman Şahin[4], Yasemin Üstündağ[1], Handan Akbulut[1]

[1] Firat University, Faculty of Medicine, Department of Microbiology, Elazig, Turkey
[2] University of Health Sciences, Fethi Sekin City Hospital, Department of Microbiology, Elazig, Turkey
[3] Fethi Sekin City Hospital, Department of Internal Medicine, Elazig, Turkey
[4] Gaziosmanpasa University, Faculty of Medicine, Department of Gastroenterology, Tokat, Turkey

Abstract

Introduction: Recent research indicates that individuals with inflammatory bowel disease (IBD) exhibit distinct intestinal fungal communities compared with healthy individuals. This study examined the relationship among anti-*Saccharomyces cerevisiae* antibodies (ASCA), perinuclear anti-neutrophil cytoplasmic antibodies (p-ANCA), and *Candida* spp. colonization to assess their utility in diagnosing IBD, differentiating subtypes, and predicting disease localization.

Methodology: Serum samples from 240 patients with IBD and 61 healthy controls were tested for ASCA and p-ANCA using indirect immunofluorescence assay (IIFA). Fecal samples were cultured to identify *Candida* species.

Results: ASCA positivity was significantly higher in Crohn's disease (CD) (61.7%), whereas p-ANCA positivity was more frequent in ulcerative colitis (UC) (51.6%) ($p = 0.005$ and $p = 0.002$, respectively). Fluorescence intensity showed stronger ASCA reactivity in CD and higher p-ANCA intensity in UC. *Candida* colonization (≥ 5 CFU) was detected in 64.2% of IBD patients, with *Candida albicans* the most common species. *Saccharomyces cerevisiae* was detected exclusively in IBD patients (3.7%, $p = 0.038$). Higher colonization rates were observed in UC with pancolitis (78.9%) and in CD with colonic involvement (80%). ASCA intensity inversely correlated with *Candida* load in CD ($p = 0.021$), whereas p-ANCA intensity positively correlated with *Candida* load in UC ($p = 0.038$). No significant differences in *Candida* species diversity were observed between subtypes.

Conclusions: These findings support the diagnostic value of ASCA and p-ANCA in distinguishing IBD subtypes and highlight their association with *Candida* colonization. Further studies are warranted to elucidate fungal antigen–antibody interactions and to refine subtype-specific diagnostic and therapeutic strategies.

Key words: Inflammatory bowel disease; ulcerative colitis; Crohn's disease; ASCA; p-ANCA; fungal colonization.

J Infect Dev Ctries 2026; 20(3):464-471. doi:10.3855/jidc.21755

(Received 21 April 2025 – Accepted 14 July 2025)

Introduction

Inflammatory bowel diseases (IBD) are chronic, relapsing inflammatory disorders of the gastrointestinal tract of uncertain etiopathogenesis, affecting different regions and layers of the gut wall [1,2]. Although the precise cause remains unknown, current evidence indicates that IBD arises from an inappropriate immune response against the intestinal mucosa, shaped by genetic susceptibility, environmental factors, and host–microbiota interactions [3]. The primary clinical subtypes are ulcerative colitis (UC), Crohn's disease (CD), and indeterminate colitis (IC) [4].

Serological markers, particularly anti-*Saccharomyces cerevisiae* antibodies (ASCA) and perinuclear anti-neutrophil cytoplasmic antibodies (p-ANCA), are frequently used to differentiate UC from CD. ASCA positivity is more common in CD, whereas p-ANCA is typically detected at higher rates in UC [2]. ASCA targets specific epitopes on the *S. cerevisiae* cell wall [5]. Although its exact role in CD remains unclear, ASCA has been associated with increased intestinal permeability—a feature present in 50-60% of patients with CD-and correlates with disease activity [6]. Despite their diagnostic value, approximately 10% of IBD cases are initially misclassified, and another 10% remain unclassified as IC until characteristic features of UC or CD emerge [7]. Serological markers, therefore, continue to play an important adjunctive role in distinguishing IBD subtypes [8]. In recent years, additional serological markers-such as anti-pancreatic antibodies (PAB), outer membrane porin C (OMP-C), bacterial antigens, and flagellin—have been identified to aid differentiation between CD and UC [9]. Nevertheless, their clinical utility remains limited, with substantial variability in reported positivity rates across patient populations [10]. Specifically, ASCA positivity

has been observed in 40-70% of CD and 5-15% of UC, whereas p-ANCA positivity ranges from 40–80% in UC and 2–20% in CD [11].

Chronic, recurrent inflammation-a hallmark of IBD-likely results from a dysregulated immune response to the commensal gut microbiota [12]. Inflammation in IBD disrupts microbial equilibrium and alters host–microbe interactions, thereby exacerbating mucosal injury and facilitating high-level fungal colonization [1]. Patients with IBD are particularly susceptible to opportunistic fungal infections owing to compromised mucosal barrier integrity and frequent exposure to immunosuppressive therapies (e.g., corticosteroids and immune-modulating agents) [13]. Among fungal pathogens, *Candida* spp.-particularly *Candida albicans* (*C. albicans*)-are most frequently isolated in this population, whereas *Saccharomyces cerevisiae* also represents a major component of the human gut mycobiota [14]. Recent studies underscore the role of fungal communities in regulating innate and adaptive immune responses, suggesting that fungal dysbiosis may contribute to IBD pathogenesis. Notably, *Candida* colonization has been shown to increase during the early phases of immunosuppressive therapy [13]. Furthermore, the IBD-associated intestinal environment-characterized by dysbiosis and immune dysregulation-provides favorable conditions for *Candida* overgrowth, which is increasingly recognized as a clinical indicator of disease severity and microbial imbalance [15].

This study aimed to evaluate the presence and positivity rates of ASCA and p-ANCA in serum samples from patients with IBD and healthy controls. In addition, we sought to identify *Candida* species from fecal samples and analyze their relationship with IBD. Furthermore, we aimed to investigate the association between ASCA and p-ANCA positivity and the intensity of *Candida* colonization, as well as to explore the correlation between fungal burden and disease location.

Methodology

Study Population

The study included a total of 300 participants: 240 patients with inflammatory bowel disease (153 with ulcerative colitis, 81 with Crohn's disease, and 6 with indeterminate colitis) who were followed at the hospital's Gastroenterology Clinic, and 61 healthy controls. Diagnoses, medical records, and colonoscopy reports were retrospectively reviewed to document disease location, age, and sex. Individuals with concomitant autoimmune disease, diabetes, recent gastrointestinal infection, antibiotic use within the previous month, antifungal treatment, or prior gastrointestinal surgery were excluded. None of the participants had used yeast-based probiotics in the three months preceding fecal sample collection.

Sample Collection and Blood Analyses

Three milliliters (mL) of blood were collected from patients with IBD and healthy controls into labeled serum separator tubes. After centrifugation at 4,000 rpm for 5 minutes, the serum was aliquoted into labeled Eppendorf tubes and stored at -80 °C until a sufficient number of samples were available for batch analysis.

ASCA and p-ANCA were detected using an indirect immunofluorescence assay (IIFA), considered the gold standard for autoantibody detection. This method allows simultaneous evaluation of multiple test antigens via BIOCHIP technology. The Titerplane® technique provided by the manufacturer was used.

The CIBD Profile (BIOCHIP) kit was employed. The kit includes slides containing pancreatic antigens (rPAg1 and rPAg2), intestinal goblet cells, transfer cells, ethanol-fixed granulocytes, and *Saccharomyces cerevisiae* cultures. It also provides a fluorescein isothiocyanate (FITC)-conjugated anti-human IgG antibody, positive and negative controls, PBS/Tween 20, and glycerol with cover glasses. The BIOCHIP substrates comprise primate pancreatic tissue for acinar cells, primate intestinal tissue for goblet cells, primate liver tissue, and *S. cerevisiae* cultures.

Fluorescence evaluations were conducted using a Euroimmun EUROStar-1 microscope with fluorescein isothiocyanate (FITC), a green-fluorescing dye. The microscope was equipped with an excitation filter of 450–490 nm, a 510 nm beam splitter, and either a 100 W mercury vapor lamp or a EUROIMMUN LED light source, as recommended by the manufacturer. Slides were examined at 40× magnification in a dark environment. Both negative and positive controls were included. Fluorescence intensity in patient samples was compared with that of the positive control. Samples lacking apple-green fluorescence were considered negative, whereas those exhibiting fluorescence were considered positive. Antibody positivity and titers were determined according to the manufacturer's fluorescence intensity standards.

Collection and Assessment of Stool Samples for Candida spp. Colonization Using Mycological Methods

In this study, stool samples were subjected to macroscopic, microscopic, and culture-based examinations, as well as yeast species identification.

Macroscopic analysis assessed the quantity, color, shape, and consistency of the samples, and the presence of blood, mucus, pus, food remnants, or potential parasites was recorded. Microscopic examination for fungal structures was performed on both unstained and Gram-stained preparations using objectives at ×10 and ×40 magnification (without immersion) and ×100 magnification (with immersion).

Yeast identification at the species level was carried out using conventional methods and advanced systems, including the VITEK® 2 Compact system (bioMérieux, Marcy-l'Étoile, France) and matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) mass spectrometry. For quantitative cultures, 200 mg of stool was weighed on an analytical balance (6110, Balance-International PBI) and suspended in 300 µL of sterile saline. The suspension was homogenized by vortexing, allowed to stand at room temperature for several minutes, and then 50 µL was inoculated onto culture media. Sabouraud Dextrose Agar (SDA; RTA Laboratories, Istanbul, Turkey) was used for mycological cultures, while SDA supplemented with chloramphenicol and gentamicin (SDA+CG; RTA Laboratories, Istanbul, Turkey) was used for selective yeast isolation. Each sample was cultured on both media types. Plates containing single-colony cultures were incubated aerobically at 37 °C for 24-48 hours and at 29 ± 2 °C for at least five days in a humidified incubator. Extended incubation was applied to SDA+CG because of its more stringent growth requirements. After incubation, colonies were counted, and results were expressed as colony-forming units (CFU) per gram of stool by multiplying the observed counts by 50. In both control and patient groups, colony counts of five or six were considered insufficient to indicate infection and were therefore not subjected to species-level identification.

Statistical Analysis

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS for Windows, Version 26.0; IBM Corp., Armonk, NY, USA). Descriptive statistics for variables including age, sex, diagnosis, site of involvement, serological test results, *Candida* species, and colony counts were reported as frequencies and percentages. The chi-square (χ^2) test was applied to compare categorical variables. A $p < 0.05$ was considered statistically significant.

Results

Among the 240 patients with inflammatory bowel disease (IBD), 146 (60.8%) were male and 94 (39.2%) were female, with a mean age of 43.12 ± 13.65 years. In the control group, 38 (62.3%) were male and 23 (37.7%) were female, with a mean age of 40.81 ± 10.24 years. No significant difference was observed in sex distribution among patients with ulcerative colitis (UC), Crohn's disease (CD), and indeterminate colitis (IC) ($p = 0.580$). However, a significant age difference was detected between the subgroups ($p = 0.012$). Most UC patients were 40–58 years old (41%), whereas the majority of CD patients and all IC patients were 22–41 years old.

All 240 IBD patients were evaluated by disease localization. A statistically significant difference was found in the distribution of disease involvement across UC, CD, and IC patients ($p = 0.001$). In UC, the most frequently affected site was the left colon (28%), followed by the rectosigmoid region (21.2%) and pancolitis (20.7%). In CD, the terminal ileum (36.9%) and pancolitis (30.6%) were predominant. Among IC patients, 65.8% presented with pancolitis.

Serological profiles of ASCA ($p = 0.005$) and p-ANCA ($p = 0.002$) differed significantly across IBD subtypes. ASCA positivity was highest in CD, with 61.7% (50/81) testing positive, compared with 33.4% (51/153) in UC and none in IC. Conversely, p-ANCA positivity was more frequent in UC (51.6%, 79/153), but much lower in CD (9.9%, 8/81) and 50% (3/6) in IC. These findings highlight the diagnostic value of ASCA in CD and p-ANCA in UC.

Fluorescence intensity scores further supported these serological patterns. Higher ASCA intensities (++ to ++++) were significantly more common in CD patients ($p = 0.005$). Eighteen CD patients demonstrated the highest (++++) ASCA intensity, whereas most UC patients showed negative or weak staining, with only three reaching the highest level. None of the IC patients were ASCA-positive. In contrast, p-ANCA fluorescence was predominantly observed in UC patients. Forty UC patients exhibited the highest (++++) p-ANCA intensity ($p = 0.002$), and many others showed moderate intensities (+ to +++). CD patients were mostly negative or weakly positive, and none displayed strong fluorescence. Notably, three of the six IC patients showed high (++++) p-ANCA intensity, all of whom were also seropositive, suggesting serological overlap with UC.

According to the Montreal classification, no significant association was observed between p-ANCA positivity and disease location (pancolitis, left colon, rectosigmoid) in UC patients ($p = 0.816$). Similarly, ASCA positivity did not vary significantly with disease localization (ileum, colon, ileocolon) in CD patients (*p*

Figure 1. The distribution of *Candida* species in patients with Inflammatory Bowel Disease (IBD) and the control group. p = 0.038* colony counts fewer than five.

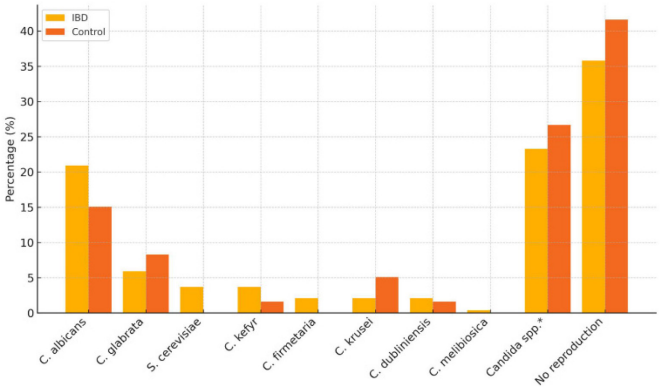
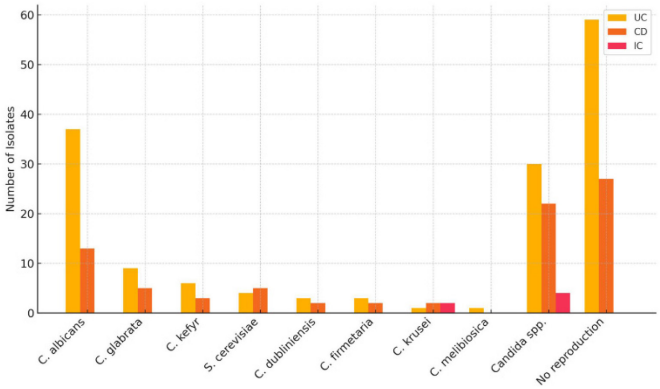


Figure 2. Distribution of *Candida* species isolated from stool samples of patients with Ulcerative Colitis (UC), Crohn's Disease (CD), and Indeterminate Colitis (IC). p = 0.378.



= 0.263). These results indicate that seropositivity is not significantly influenced by disease site in either UC or CD.

Yeast growth was detected in 154 of 240 stool samples from IBD patients (64.2%). Of these, 98 samples with colony counts ≥ 5 CFU were subjected to species-level identification. In the control group, yeast growth was observed in 36 of 61 individuals (58.3%), with 20 samples meeting the colony count threshold for species identification. A statistically significant difference in *Candida* species distribution between IBD and control groups was observed (p = 0.038). *Candida albicans* was the most frequently isolated species in both groups, followed by *C. glabrata*, *C. kefyr*, *Saccharomyces cerevisiae*, and other non-*albicans* *Candida* species. Notably, *S. cerevisiae* was exclusively isolated from IBD patients (3.7%, 9/240) and was not detected in controls, suggesting a potential association with IBD-specific intestinal dysbiosis (Figure 1). No significant difference in *Candida* species distribution was found among UC, CD, and IC patients (p = 0.378) (Figure 2).

In this study, gastrointestinal *Candida* colonization was defined as ≥ 5 CFU, categorized as 1–4, 5–100, and

Figure 3. Distribution of *Candida* species according to intestinal involvement sites in Inflammatory Bowel Disease (IBD) patients.

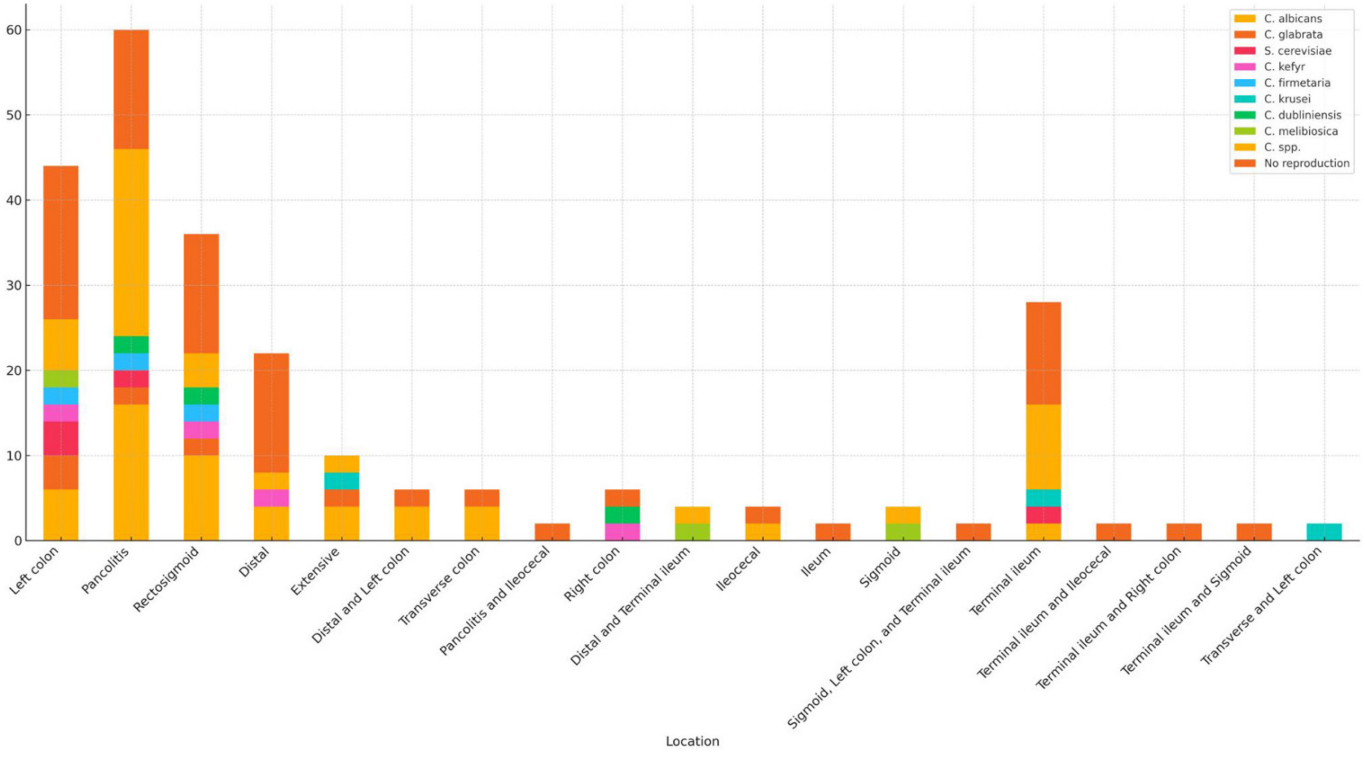


Table 1. Relationship between pANCA and ASCA seropositivity and *Candida* colonization in patients with Ulcerative Colitis and Crohn's Disease.

UC (p = 0.073)	**Colonization n (%)**	**Colonization (-) n (%)**	**Total n (%)**
pANCA (+)	53 (67.0)	26 (33.0)	79 (100)
pANCA (-)	36 (48.7)	38 (51.3)	74 (100)
Total	89 (58.2)	64 (41.8)	153 (100)
CD (p = 0.065)			
ASCA (+)	31 (62.0)	19 (38.0)	50 (100)
ASCA (-)	22 (70.0)	9 (30.0)	31 (100)
Total	53 (65.5)	28 (34.5)	81 (100)

> 100 CFU. Using the Montreal classification, the relationship between *Candida* colonization and disease location was assessed in UC (left colon, pancolitis, rectosigmoid) and CD (ileum, colon, ileocolon). No significant differences were observed in UC (p = 0.124) or CD (p = 0.132). However, higher colonization rates were noted in UC patients with pancolitis (78.9%) and CD patients with colonic involvement (80%). The distribution of *Candida* species by disease site in IBD patients is shown in Figure 3.

We also examined the relationship between ASCA and p-ANCA positivity and *Candida* colonization. No statistically significant associations were found in UC (p = 0.073) or CD (p = 0.065). Nonetheless, colonization was more frequent in ASCA- and p-ANCA-positive patients than in seronegative individuals (Table 1).

In CD patients with colony counts ≥ 5 CFU, ASCA fluorescence intensity showed a statistically significant inverse correlation with *Candida* colony numbers (p = 0.021). Conversely, in UC patients with ≥ 5 colonies, higher p-ANCA fluorescence intensity was associated with increased *Candida* colony numbers (p = 0.038) (Table 2).

Discussion

One of the key findings of this study is that *Candida* species diversity in IBD patients did not vary significantly with inflammatory status or site of intestinal involvement. Another important observation was that, among patients with ≥ 5 *Candida* colonies, higher ASCA fluorescence intensity was associated with lower colony counts. Conversely, in patients with ≥ 5 colonies, higher p-ANCA fluorescence intensity was positively correlated with colony numbers. According to the Montreal classification, elevated *Candida* colonization rates were observed in UC patients with pancolitis and in CD patients with colonic involvement, with *C. albicans* being the most frequently identified species. Moreover, *Candida* colonization was more common in ASCA- and p-ANCA-positive patients than in seronegative individuals. The prevalence of *C. albicans* was also higher in UC patients compared with those with CD or indeterminate colitis (IC).

The reported prevalence of ASCA and p-ANCA in IBD patients varies across studies, likely due to environmental and ethnic differences. Several investigations have confirmed the influence of such population-specific factors on serologic expression in IBD [1]. Riis *et al.* [16] conducted a large prevalence study of genetic and serologic markers in a European cohort spanning Norway to Israel and Greece. They reported ASCA positivity rates of 28.5% in CD, 7.1% in UC, and 7.2% in healthy individuals. These relatively low rates were attributed to the high specificity but low sensitivity of the ASCA detection method employed. The prevalence of p-ANCA was 25.3% in UC, 8.2% in CD, and 8.4% in healthy controls. By contrast, our study demonstrated higher positivity rates: 61.7% for

Table 2. The relationship between the fluorescence intensity of ASCA and p-ANCA and the number of cultured *Candida* colonies in patients with Inflammatory Bowel Disease.

ASCA	**Negative**	**(+)**	**+**	**++**	**+++**	**++++**	**Total**
No reproduction	55	15	7	0	0	11	88
1-4	30	4	8	3	5	5	54
5-100	33	6	5	0	3	3	50
> 100	21	19	0	5	0	2	48
Total	139	44	20	8	8	21	240
p = 0.021							
p-ANCA	**Negative**	**(+)**	**+**	**++**	**+++**	**++++**	**Total**
No reproduction	62	2	7	6	0	10	88
1-4	38	2	2	2	4	6	54
5-10	3	2	0	2	0	8	14
> 100	47	5	6	6	0	20	84
Total	150	11	15	16	4	44	240
p = 0.038							

ASCA in CD and 51.6% for p-ANCA in UC. This variability across studies underscores the impact of geographic and demographic factors on serologic expression in IBD and highlights the importance of population-specific diagnostic algorithms. The higher rates observed in our cohort may also reflect increased antigenic stimulation, potentially resulting from differences in microbial exposure or host immune response characteristics unique to our population.

A recent meta-analysis evaluating noninvasive tests—including C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), platelet count, hemoglobin, albumin, ASCA, ANCA, fecal calprotectin, and fecal lactoferrin-for the assessment of IBD identified fecal calprotectin as the most sensitive marker (sensitivity: 0.99), while ANCA showed the highest specificity (0.971) in distinguishing IBD from non-IBD cases [17]. ASCA was the most sensitive and specific marker for differentiating CD from UC (sensitivity: 0.53, specificity: 0.89), whereas ANCA was most effective in distinguishing UC from CD (sensitivity: 0.55, specificity: 0.88). In clinical practice, these two serological markers are widely used to differentiate IBD subtypes, particularly in unclassified cases, and to predict disease course. In the same meta-analysis, alongside radiological methods, fecal calprotectin was also considered the most reliable biomarker for monitoring disease activity and recurrence [17]. However, because our study was not longitudinal in design, our findings are insufficient to assess the role of ASCA and p-ANCA in predicting disease activity or flares.

Several studies have demonstrated that ASCA positivity is more frequently observed in CD patients with ileal involvement [12]. Reese *et al.* [18] and Vasiliauskas *et al.* [19] reported lower ASCA positivity rates in CD patients with isolated colonic disease compared with those with ileal or ileocolonic involvement. In our study, ASCA positivity was more frequent in CD patients with ileocolonic disease than in those with isolated colonic or ileal involvement. Interestingly, some studies have reported higher ASCA positivity in colonic and ileocolonic disease compared with ileal disease alone [19]. With respect to p-ANCA, previous studies have shown higher positivity rates in UC patients with pancolitis than in those with left-sided or distal colitis [18]. Consistent with these findings, our results also demonstrated increased p-ANCA positivity in UC patients with pancolitis compared with those with left colon or rectosigmoid involvement. These distribution patterns suggest that more extensive mucosal involvement may be associated with heightened immune activation, potentially contributing to increased antibody production.

Previous studies have shown that ASCA is independently associated with stricturing or penetrating phenotypes and the need for surgical resection in Crohn's disease (CD) [20]. In contrast, p-ANCA has been linked to a lower risk of developing stricturing or penetrating complications and requiring surgery in CD, as well as to a more severe disease course in ulcerative colitis (UC) [21]. Because our study did not include long-term follow-up, our findings are insufficient to draw conclusions regarding disease progression or clinical outcomes.

Culture-based studies have estimated fungal loads in the oral cavity at approximately 10^2 colonies/mL, while concentrations in fecal samples may reach up to 10^6 colonies/mL. Within the gastrointestinal tract, fungal density appears to increase progressively from the ileum to the colon, reaching its highest levels in the distal colon [22]. In our study, the diversity of *Candida* species in the gastrointestinal tracts of IBD patients closely resembled that of healthy individuals. This suggests that the range of *Candida* species colonizing the gut does not differ significantly in the context of IBD, regardless of the site of inflammation. Similarly, Imai *et al*. [23] reported no significant differences in *Candida* species diversity between IBD patients and healthy controls, attributing this similarity to shared environmental exposures-particularly dietary habits-among individuals in the same geographic region. These findings imply that factors beyond species diversity-such as fungal load, virulence characteristics, or host immune reactivity may play a more critical role in IBD pathogenesis.

Candida albicans is the most frequently isolated yeast species in the human gastrointestinal tract, followed by *C. tropicalis*, *C. parapsilosis*, and *C. glabrata* [24]. Under normal conditions, it colonizes approximately 50% of healthy adults. Its prevalence, however, increases markedly in hospitalized individuals, likely due to factors such as antibiotic exposure, immunosuppressive therapies, and environmental conditions that promote fungal overgrowth in healthcare settings [24]. In our study, *C. albicans* was detected in only 15.1% of healthy controls, a rate substantially lower than those reported in the literature. These findings support the hypothesis that although *C. albicans* colonization is common in healthy individuals, its expansion in IBD patients may represent dysbiosis-driven overgrowth rather than simple commensal presence.

In addition to previous findings linking *C. albicans*

with ASCA seropositivity in Crohn's disease (CD), another study reported a correlation between *C. tropicalis* and ASCA levels [25], suggesting that multiple fungal species may contribute to antigenic stimulation. In our study, the concurrent detection of increased *Candida* colonization and seropositivity in ASCA-positive CD patients and p-ANCA-positive UC patients further supports the role of fungal–host immune interactions in IBD pathogenesis and underscores the need for focused research on species-specific immune responses.

In conclusion, while IIFA-based serological tests such as ASCA and p-ANCA remain valuable tools in the differential diagnosis of IBD, their specificity may be compromised by immunological cross-reactions with microbial antigens, particularly those of fungal origin. Our findings highlight the potential role of *Candida* colonization and fungal antigen–antibody interactions in shaping serological responses in IBD. Further studies exploring fungal–host immune dynamics may enhance diagnostic precision for distinguishing IBD subtypes and predicting disease localization, thereby contributing to more individualized management strategies.

Acknowledgements
The authors would like to thank the clinical staff and laboratory team at Fethi Sekin City Hospital for their support and cooperation during the course of this study.

Ethical Approval
Our study was approved by the Firat University Clinical Research Ethics Committee (No: 2024/12-43).

Authors' contributions
Zülal Aşçı Toraman conceived and designed the study, supervised the entire research process, interpreted the microbiological findings, and critically revised the manuscript. Pınar Öner performed laboratory analyses, contributed to data interpretation, and drafted the manuscript. Berçem Afşar Karatepe and Abdurrahman Şahin contributed to patient recruitment, clinical data evaluation, and provided constructive clinical insight. Yasemin Üstündağ conducted statistical analysis and contributed to the creation of tables and final proofreading. Meryem Erdoğan contributed to the literature review and assisted in laboratory procedures. Handan Akbulut supported data organization and manuscript formatting. All authors have read and approved the submitted version. All authors contributed to the article and approved the submitted version.

Corresponding Author
Professor Dr. Zülal Aşçı Toraman,
Firat University, Faculty of Medicine,
Department of Microbiology, Elazig, Turkey
Tel: +904242370000/6404
Email: zulalasci@gmail.com

Conflict of interest
No conflict of interest is declared.

References
1. Sakurai T, Saruta M (2023) Positioning and usefulness of biomarkers in inflammatory bowel disease. Digestion 104: 30-41. doi: 10.1159/000527846.
2. Bodecker-Zingmark L, Widbom L, Hultdin J, Eriksson C, Karling P (2023) Anti-saccharomyces cerevisiae antibodies are only modestly more common in subjects later developing Crohn's disease. Dig Dis Sci 68: 608-615. doi: 10.1007/s10620-022-07630-5.
3. Chang JT (2020) Pathophysiology of inflammatory bowel diseases. N Engl J Med 383 2652-2664. doi: 10.1056/NEJMra2002697.
4. Imdad A, Pandit NG, Zaman M, Minkoff NZ, Tanner-Smith EE, Gomez-Duarte OG, Acra S, Nicholson MR (2023) Fecal transplantation for treatment of inflammatory bowel disease. Cochrane Database Syst Rev 4: CD012774. doi: 10.1002/14651858.CD012774.pub3.
5. Kaur H, Kasapoglu M, Yadavalli R, Nawaz S, Althwanay A, Aledani EM, Yu AK (2024) Inflammatory bowel disease and its association with perinuclear antineutrophil cytoplasmic antibodies: a systematic review. Cureus 16: e57872. doi: 10.7759/cureus.57872.
6. Barta Z, Csípõ I, Szabó GG, Szegedi G (2003) Seroreactivity against saccharomyces cerevisiae in patients with Crohn's disease and celiac disease. World J Gastroenterol 9: 2308-2312. doi: 10.3748/wjg.v9.i10.2308.
7. Jung SA (2012) Differential diagnosis of inflammatory bowel disease: what is the role of colonoscopy? Clin Endosc 45: 254-262. doi: 10.5946/ce.2012.45.3.254.
8. Yao F, Fan Y, Lv B, Ji C, Xu L (2018) Diagnostic utility of serological biomarkers in patients with Crohn's disease: a case-control study. Medicine (Baltimore) 97: e11772. doi: 10.1097/MD.0000000000011772.
9. Shanahan F (1997) Antibody 'markers' in Crohn's disease: opportunity or overstatement? Gut 40: 557-558. doi: 10.1136/gut.40.4.557.
10. Ordille AJ, Phadtare S (2023) Intensity-specific considerations for exercise for patients with inflammatory bowel disease. Gastroenterol Rep 11: goad004. doi: 10.1093/gastro/goad004.
11. Kovács M, Müller KE, Papp M, Lakatos PL, Csöndes M, Veres G (2014) New serological markers in pediatric patients with inflammatory bowel disease. World J Gastroenterol 20: 4873-4882. doi: 10.3748/wjg.v20.i17.4873.
12. Di Paola M, Rizzetto L, Stefanini I, Vitali F, Massi-Benedetti C, Tocci N, Romani L, Ramazzotti M, Lionetti P, Di Filippo C, Cavalieri D (2020) Comparative immunophenotyping of saccharomyces cerevisiae and *Candida* spp. strains from Crohn's disease patients and their interactions with the gut microbiome. J Transl Autoimmun 3: 100036. doi: 10.1016/j.jtauto.2020.100036.
13. Stamatiades GA, Ioannou P, Petrikkos G, Tsioutis C (2018) Fungal infections in patients with inflammatory bowel disease:

a systematic review. Mycoses 61: 366-376. doi: 10.1111/myc.12753.
14. Botschuijver S, Roeselers G, Levin E, Jonkers DM, Welting O, Heinsbroek SEM, Weerd HH, Boekhout T, Fornai M, Masclee AA, Schuren FHJ, Jonge WJ, Seppen J, van den Wijngaard RM (2017) Intestinal fungal dysbiosis is associated with visceral hypersensitivity in patients with irritable bowel syndrome and rats. Gastroenterology 153: 1026-1039. doi: 10.1053/j.gastro.2017.06.004.
15. Carlson SL, Mathew L, Savage M, Kok K, Lindsay JO, Munro CA, McCarthy NE (2023) Mucosal immunity to gut fungi in health and inflammatory bowel disease. J Fungi 9: 1105. doi: 10.3390/jof9111105.
16. Riis L, Vind I, Vermeire S, Wolters F, Katsanos K, Politi P, Freitas J, Mouzas IA, O'Morain C, Ruiz-Ochoa V, Odes S, Binder V, Munkholm P, Moum B, Stockbrügger R, Langholz E (2007) The prevalence of genetic and serologic markers in an unselected European population-based cohort of IBD patients. Inflamm Bowel Dis 13: 24-32. doi: 10.1002/ibd.20047.
17. Shi JT, Zhang Y, She Y, Goyal H, Wu ZQ, Xu HG (2022) Diagnostic utility of non-invasive tests for inflammatory bowel disease: an umbrella review. Front Med 9: 920732. doi: 10.3389/fmed.2022.920732.
18. Reese GE, Constantinides VA, Simillis C, Darzi AW, Orchard TR, Fazio VW, Tekkis PP (2006) Diagnostic precision of anti-saccharomyces cerevisiae antibodies and perinuclear antineutrophil cytoplasmic antibodies in inflammatory bowel disease. Am J Gastroenterol 101: 2410-2422. doi: 10.1111/j.1572-0241.2006.00840.x.
19. Vasiliauskas E, Kam L, Karp L, Gaiennie J, Yang H, Targan S (2000) Marker antibody expression stratifies Crohn's disease into immunologically homogeneous subgroups with distinct clinical characteristics. Gut 47: 487-496. doi: 10.1136/gut.47.4.487.
20. Sendid B, Cornu M, Cordier C, Bouckaert J, Colombel JF, Poulain D (2023) From ASCA breakthrough in Crohn's disease and candida albicans research to thirty years of investigations about their meaning in human health. Autoimmun Rev 22: 103486. doi: 10.1016/j.autrev.2023.103486.
21. Zeng Z, Jiang M, Li X, Yuan J, Zhang H (2023) Precision medicine in inflammatory bowel disease. Precis Clin Med 6: pbad033. doi: 10.1093/pcmedi/pbad033.
22. Bernhardt H (1996) *Candida* in the ecosystem of the orointestinal tract. Mycoses 39: 44-47. [Article in German].
23. Imai T, Inoue R, Kawada Y, Morita Y, Inatomi O, Nishida A, Bamba S, Kawahara M, Andoh A (2019) Characterization of fungal dysbiosis in Japanese patients with inflammatory bowel disease. J Gastroenterol 54: 149-159. doi: 10.1007/s00535-018-1530-7.
24. Brandquist ND, Lampman C, Smith EJ, Basilio L, Almansob A, Iwen PC, Blankenship JR (2023) Significant variation of filamentation phenotypes in clinical candida albicans strains. Front Cell Infect Microbiol 13: 1207083. doi: 10.3389/fcimb.2023.1207083.
25. Hoarau G, Mukherjee P, Gower-Rousseau C, Hager C, Chandra J, Retuerto MA, Neut C, Vermeire S, Clemente J, Colombel JF, Fujioka H, Poulain D, Sendid B, Ghannoum MA (2016) Bacteriome and mycobiome interactions underscore microbial dysbiosis in familial Crohn's disease. mBio 7: e01250-16. doi: 10.1128/mBio.01250-16.