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THE IMPACT OF PHYSICAL ACTIVITY ON THE GUT MICROBIOME AND CLINICAL COURSE OF INFLAMMATORY BOWEL DISEASE

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ABSTRACT

Inflammatory bowel diseases (IBD), including ulcerative colitis and Crohn's disease, are chronic disorders of complex and not yet fully understood etiology, involving genetic, immunological, and environmental factors. Increasing attention has been directed toward the role of the gut microbiome, whose disturbances play a significant role in the pathogenesis of these diseases. Concurrently, growing interest has been directed toward therapeutic strategies that support pharmacological treatment, including non-pharmacological interventions capable of modulating disease activity.

Physical activity is recognized as one of the key determinants of overall health, and its role in inflammatory bowel diseases is of particular importance. Regular and moderate exercise promotes the maintenance of intestinal barrier function, exerts a beneficial effect on the composition and diversity of the gut microbiota, reduces inflammatory processes, and supports patients' mental well-being. These effects may contribute to longer remission periods, improved treatment tolerance, and enhanced quality of life.

Conversely, intensive and prolonged physical activity may act as a burden, potentially leading to destabilization of the intestinal barrier and exacerbation of disease symptoms. Therefore, proper adjustment of the type and intensity of physical activity represents an important component of supportive management.

The aim of this paper is to present the current state of knowledge regarding the impact of physical activity on the gut microbiome, immune system function, and the clinical course of inflammatory bowel diseases, as well as to discuss its potential role in the prevention of extraintestinal complications and in the comprehensive improvement of patients' quality of life.

KEYWORDS

Physical Activity, Gut Microbiome, Inflammatory Bowel Diseases, Crohn's Disease, Ulcerative Colitis, Short-Chain Fatty Acids (SCFA)

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1. Introduction

Inflammatory bowel diseases (IBD) are a group of chronic inflammatory disorders of the gastrointestinal tract, encompassing Crohn's disease and ulcerative colitis, with a complex pathogenesis involving genetic, environmental, immunological, and microbial factors [1,2].

Ulcerative colitis (UC) is a chronic inflammatory condition of the colonic mucosa, primarily affecting the colon and rectum. Although the exact etiology remains unclear, the disease is considered multifactorial. Genetic, immunological, and environmental factors play a pivotal role in its pathogenesis. UC affects individuals across all age groups, including children and the elderly, but is most commonly diagnosed between the ages of 20 and 40. The disease is characterized by continuous mucosal inflammation mediated by pro-inflammatory cytokines. Clinical manifestations typically include diarrhea with blood and mucus, painful urgency to defecate, and abdominal pain, often accompanied by low-grade fever, weight loss, and general fatigue [3].

Crohn's disease (CD), unlike UC, can affect any segment of the gastrointestinal tract, from the oral cavity to the anus, *with a discontinuous distribution of inflammatory lesions*. The terminal ileum and cecum are the most commonly affected sites, while lesions in the upper gastrointestinal tract are reported in only about 3% of cases. Symptoms include abdominal pain, watery or mucoid diarrhea, bloating, colicky pain, perianal lesions, and aphthous stomatitis [3].

The etiology of IBD is not fully understood. These disorders are more likely to develop in genetically predisposed individuals under the influence of environmental, infectious (viral, bacterial), and dietary factors. Potential dietary triggers include plant proteins, gluten, UHT-treated milk, yeasts, and artificial food additives such as colorants, preservatives, and sweeteners. Studies have shown that eliminating some of these dietary components may prolong remission in CD [3]. Research findings also indicate a strong association between the rising incidence of IBD and lifestyle factors, particularly diets rich in highly processed foods such as fast food, especially among adolescents [1,4]. Additional risk factors that may exacerbate symptoms include smoking, vitamin D deficiency, and sleep disturbances [5].

In recent years, increasing attention has been devoted to the role of the gut microbiome in the pathogenesis and clinical course of IBD. The balance of intestinal microbiota is essential for maintaining the integrity of the intestinal barrier and modulating immune responses. Disruption of this balance, known as dysbiosis, leads to excessive activation of inflammatory pathways and disease progression [6,7]. Within this context, the influence of physical activity on the gut microbiome is of particular interest. Evidence indicates that regular exercise promotes microbial diversity, enhances the production of short-chain fatty acids (SCFA), improves intestinal barrier integrity, and modulates inflammatory processes [8,9,10,11,12,13]. These effects may be clinically relevant in alleviating the course of IBD and prolonging remission.

Given the increasing incidence of IBD and the proven importance of the gut microbiome in the development and course of these diseases, the present study aims to summarize the current knowledge on the impact of physical activity on the gut microbiome and its possible role in UC and CD progression.

Physical activity plays a crucial role in maintaining overall health and preventing numerous chronic diseases. According to the World Health Organization (WHO), physical activity is defined as "any bodily movement produced by skeletal muscles that requires energy expenditure" [14]. It encompasses various forms, including aerobic exercise, strength training, swimming, and daily household activities. Regular physical activity has demonstrated beneficial effects not only on cardiovascular and metabolic health but also on the immune system and the gut microbiome [15].

An increasing body of research highlights the critical role of the gut microbiota in maintaining immune homeostasis and modulating inflammatory processes. Dysbiosis is strongly associated with the pathogenesis of IBD [16]. Physical activity, by enhancing bacterial diversity and promoting the production of metabolites such as SCFA, may modulate the clinical course of UC and CD [8].

Considering the role of the gut microbiome and physical activity in the context of IBD is of great importance due to the potential impact of these factors both in disease prevention and in improving patients' quality of life. The purpose of this paper is to evaluate the influence of physical activity on the gut microbiome and the course of inflammatory bowel diseases.

2. Materials and Methods

A literature review was conducted in PubMed, Scopus, and ResearchGate to identify studies investigating the relationship between physical activity, the gut microbiome, and the clinical course of inflammatory bowel disease (IBD), including Crohn's disease and ulcerative colitis. Publications from 2001 to 2025 were eligible for inclusion.

The search strategy combined the following terms: inflammatory bowel disease, Crohn's disease, ulcerative colitis, physical activity, exercise, gut microbiome, short-chain fatty acids, intestinal barrier, permeability, calprotectin, C-reactive protein (CRP), quality of life. Eligible studies included original research articles, clinical trials, observational studies, and systematic reviews. Conference abstracts and case reports were excluded.

3. Results

3.1. Physical Activity and the Risk of Developing Inflammatory Bowel Diseases

Large cohort studies, such as the Nurses' Health Study, have demonstrated that higher levels of physical activity (PA) are associated with a lower risk of developing Crohn's disease (CD), while this relationship appears less consistent in the case of ulcerative colitis (UC) [2]. Individuals with the highest levels of PA exhibited a 40–44% lower risk of CD compared to the least active participants [2,17]. These findings suggest that regular, moderate physical activity may play a role in the prevention of inflammatory bowel diseases, although the relationship may differ depending on the disease phenotype.

Protective mechanisms include improved intestinal barrier function, reduced oxidative stress, and favorable alterations in the gut microbiome, resulting from increased microbial diversity and the enrichment of bacteria producing short-chain fatty acids (SCFA) [8,12,18,19]. Regular PA has also been linked to a reduction in inflammatory markers, which may suppress the initiation of intestinal inflammation [19]. Moreover, moderate exercise enhances immune function by stimulating regulatory T-cell activity and increasing the production of anti-inflammatory cytokines such as IL-10, thereby contributing to the maintenance of immunological balance[21,23].

From an epidemiological perspective, it has also been noted that physically active individuals are more likely to adhere to healthier lifestyle behaviors, which may further reduce the risk of IBD. Higher-quality diets, lower body mass index (BMI), better psychological well-being, and reduced exposure to oxidative stress represent factors that may act synergistically with PA to mitigate disease risk[2].

However, not all studies consistently confirm the protective role of physical activity. Discrepancies may arise from population heterogeneity, differences in methods used to assess physical activity, and the influence of coexisting factors such as diet, smoking, or genetic predisposition[25]. Furthermore, there remains a lack of sufficiently powered prospective studies to definitively determine the relationship between the type and intensity of physical activity and the risk of developing UC and CD[32].

Available evidence suggests that regular physical activity, particularly of moderate intensity, may represent an important protective factor against the development of inflammatory bowel diseases, especially Crohn's disease[18,23]. Nevertheless, further research is required to fully elucidate this relationship and to define the optimal forms and levels of activity in the context of IBD prevention.

3.2. Immunomodulatory Effects of Physical Exercise in Patients with Crohn's Disease and Ulcerative Colitis

Regular physical activity (PA) may modulate the immune response in patients with inflammatory bowel diseases (IBD), including Crohn's disease (CD) and ulcerative colitis (UC). IBD is characterized by chronic immune system activation with excessive secretion of pro-inflammatory cytokines such as TNF-α, IL-6, and IL-1β [20]. Studies have shown that moderate PA reduces the concentrations of these inflammatory mediators while enhancing the production of anti-inflammatory cytokines, including IL-10, which supports the maintenance of remission [18,21].

Moderate-intensity exercise influences the activity of immune cells, particularly regulatory T lymphocytes (Treg), which suppress excessive inflammatory responses in the intestinal mucosa [22]. Experimental studies in animal models have demonstrated that PA decreases inflammatory infiltrates, limits the expression of adhesion molecules, and reduces epithelial injury within the intestine [19,23].

Additionally, it has been shown that PA can improve the integrity of the intestinal barrier, thereby reducing the translocation of bacterial antigens into the lamina propria and attenuating immune activation [24]. Clinical studies have further reported that IBD patients participating in moderate exercise programs (e.g., resistance and aerobic training) experienced reductions in serum CRP levels and fecal calprotectin, both of which indicate decreased inflammatory activity [18,25].

In conclusion, moderate PA may exert immunomodulatory effects in IBD patients by reducing inflammatory markers, stimulating anti-inflammatory mechanisms, and improving intestinal barrier integrity, thus serving as a valuable adjunct to conventional therapy.

3.3. Impact of Physical Activity on the Gut Microbiome and Intestinal Barrier Integrity

The gut microbiome plays a crucial role in maintaining gastrointestinal homeostasis, and its disturbances (dysbiosis) represent a key element in the pathogenesis of inflammatory bowel diseases (IBD) [16]. Regular physical activity (PA) can modulate the composition and function of the microbiome, potentially influencing the course of IBD. Both human and animal studies have demonstrated that moderate exercise increases microbial diversity and promotes the growth of bacteria that produce short-chain fatty acids (SCFA), such as *Faecalibacterium prausnitzii* and *Roseburia* spp. [8,12]. SCFAs, particularly butyrate, exert strong anti-inflammatory effects, serve as the primary energy source for colonocytes, and strengthen tight junctions between enterocytes [26,27].

PA may also reduce the abundance of pro-inflammatory bacteria, such as adherent-invasive *Escherichia coli* (AIEC), which play a role in the pathogenesis of Crohn's disease [28]. These changes contribute to improved intestinal barrier integrity. Experimental studies have shown that moderate-intensity exercise decreases intestinal permeability, limits bacterial translocation, and lowers circulating endotoxin levels [24,29].

In the context of IBD, maintaining proper structure and function of tight junctions is particularly important. Patients who regularly engage in PA demonstrate higher levels of tight junction proteins, such as occludin and claudin-1, which are associated with improved control of bacterial antigen translocation into the lamina propria [27,30].

Thus, moderate PA may beneficially affect the gut microbiome and intestinal barrier integrity by enhancing microbial diversity, increasing SCFA production, reducing dysbiosis, and strengthening tight junctions, thereby representing an important adjunctive element in IBD management.

3.4. Role of Moderate Physical Activity in Alleviating Symptoms and Improving Quality of Life in Patients with IBD

Moderate physical activity (PA) represents an important supportive strategy in the management of patients with inflammatory bowel diseases (IBD), including Crohn's disease (CD) and ulcerative colitis (UC). Clinical studies indicate that regular, moderate aerobic and resistance exercise may contribute to the reduction of gastrointestinal symptoms, decreased fatigue, and improved quality of life as measured by the Inflammatory Bowel Disease Questionnaire (IBDQ) [18,25]. PA has also been associated with a lower frequency of self-reported disease flares [31].

In patients in remission, moderate PA is linked to reduced levels of inflammatory markers such as C-reactive protein (CRP) and fecal calprotectin, which may reflect decreased disease activity [23,32]. Furthermore, physical exercise supports mental health by reducing symptoms of depression and anxiety, which commonly coexist with IBD and negatively affect disease course [33].

From a physiological perspective, PA may improve intestinal barrier integrity, modulate the gut microbiome, and exert anti-inflammatory effects, thereby contributing to fewer disease flares and a more stable clinical course [19,22]. Interventions involving moderate-intensity exercises such as walking, cycling, swimming, or yoga are well tolerated by patients and can be safely incorporated into daily therapeutic plans [31].

3.5. Potential Risks: Intensive Physical Exercise in the Exacerbation of Disease Course

Although moderate physical activity (PA) is considered beneficial in inflammatory bowel diseases (IBD), intensive and prolonged exercise may have adverse effects, particularly in patients during disease exacerbation. High-intensity training, especially endurance exercise, has been associated with increased intestinal barrier permeability, enhanced bacterial translocation, and elevated circulating endotoxin levels, which may induce or exacerbate intestinal inflammation [34,35].

The mechanisms underlying this phenomenon include redistribution of blood flow from the gastrointestinal tract to skeletal muscles during exercise, leading to transient ischemia and subsequent reperfusion injury of the intestinal epithelium [36]. In addition, elevated body temperature and oxidative stress generated during intense exercise can destabilize tight junctions, thereby increasing intestinal wall permeability [37,38].

In patients with IBD, in whom the intestinal barrier is already compromised, such changes may result in worsening symptoms, including diarrhea, abdominal pain, or gastrointestinal bleeding [39]. Clinical and observational studies have reported greater severity of gastrointestinal symptoms in individuals engaging in exercise exceeding 70% VO_2max for periods longer than 60 minutes [40].

Taken together, these findings indicate that intensive physical exercise may represent a risk factor for exacerbation of IBD, particularly during periods of unstable remission or active disease. Therefore, individualized adjustment of exercise intensity is recommended, with a preference for moderate forms of activity in the IBD population.

Table 1. Summary of clinical and experimental evidence on physical activity in IBD

Type of Exercise	Intensity	Duration/Frequency	Population	Outcome
Walking, cycling	Moderate (50-65% VO_2max)	30–45 min, 3–5 times/week	Patients with IBD in remission	Reduction in CRP and fecal calprotectin; improvement in quality of life (IBDQ)
Aerobic training	Moderate–high	10 weeks, 3 times/week	Patients with UC and CD	Improvement in quality of life; reduction of gastrointestinal symptoms
Resistance training	Moderate	8–12 weeks, 2–3 times/week	Patients with CD	Increase in muscle mass and strength; reduction of fatigue;
Yoga	Low–moderate	60 min, 2–3 times/week, 12 weeks	Patients with UC	Reduction in stress; improved quality of life; better symptom control
Intensive endurance exercise (running >60 min)	High (>70% VO_2max)	≥60 min, several times/week	Healthy volunteers and patients with IBD	Increased intestinal permeability; risk of gastrointestinal symptoms

Aerobic exercise (cycling, treadmill)	Moderate	6–8 weeks, 3 times/week	Healthy adults	Increased microbial diversity; higher abundance of SCFA-producing bacteria (e.g., Faecalibacterium prausnitzii)
Recreational activity (walking, dancing)	Light–moderate	Regular, ≥150 min/week	General population, elderly	Lower risk of Crohn's disease; no clear effect in UC

Authors' compilation based on [2,8,18,23,25,49].

3.6. Role of Physical Activity in the Prevention of Extraintestinal Complications of Inflammatory Bowel Diseases

Inflammatory bowel diseases (IBD), including Crohn's disease (CD) and ulcerative colitis (UC), are systemic disorders in which the inflammatory process extends beyond the gastrointestinal tract. Extraintestinal complications occur in 25–40% of patients and include osteoporosis, sarcopenia, cardiovascular diseases, and metabolic complications [41,42].

Regular physical activity (PA) may play an important role in the prevention of these complications. In the case of osteoporosis, which is more prevalent in IBD due to chronic inflammation, malnutrition, and corticosteroid use, PA—particularly resistance and weight-bearing exercises—stimulates bone remodeling and increases bone mineral density (BMD) [43,44]. Observational studies have shown that IBD patients with higher levels of PA demonstrate significantly higher BMD compared to inactive individuals [45].

PA also counteracts sarcopenia, which is common in IBD as a result of chronic inflammation and muscle catabolism. Resistance and endurance training increase muscle mass and strength, improve physical performance, and reduce the risk of disability [46,47].

With regard to cardiovascular diseases, to which IBD patients are predisposed due to chronic inflammation and coexisting metabolic disturbances, PA lowers blood pressure, improves lipid profiles, and enhances insulin sensitivity [48,49]. Moreover, exercise reduces symptoms of depression and anxiety, which are frequent psychological complications of IBD and negatively influence disease progression [32].

Taken together, the available evidence indicates that moderate and regular PA is an effective tool in the prevention and alleviation of extraintestinal complications of IBD, and its implementation should be considered an integral component of comprehensive patient care.

4. Conclusions

Physical activity represents an important adjunct in the management of inflammatory bowel diseases (IBD). Based on the available evidence, regular and moderate exercise may beneficially influence disease course by reducing inflammatory markers, improving intestinal barrier integrity, and modulating the gut microbiome, including enhancing microbial diversity and stimulating the production of short-chain fatty acids. Moreover, physical activity contributes to improved quality of life in patients by reducing fatigue and alleviating psychological symptoms such as depression and anxiety, which frequently coexist with IBD.

In the context of extraintestinal complications, physical activity supports musculoskeletal and cardiovascular health, counteracting osteoporosis, sarcopenia, and metabolic disorders.

Conversely, intensive and prolonged exercise may increase intestinal permeability and enhance bacterial translocation, thereby exacerbating disease symptoms. Therefore, optimal benefits are achieved with moderate-intensity activity, tailored individually to the clinical condition of the patient.

In summary, the available evidence indicates that physical activity should be regarded as an essential component of comprehensive care in IBD patients, both in terms of supportive therapy and the prevention of systemic complications.

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Disclosure

The authors declare they have no conflicts of interest.
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