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The Impact of Physical Activity on the Course of Inflammatory Bowel Diseases

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Abstract
Inflammatory bowel diseases (IBD) including Crohn's disease (CD) and ulcerative colitis (UC), are chronic, immune-mediated conditions with increasing global prevalence. While the etiology of IBD is multifactorial—encompassing genetic, environmental, microbial, and immunological components—emerging evidence highlights the role of lifestyle factors, such as physical activity (PA), in modulating disease mechanisms and outcomes. This review explores the multifaceted impact of PA on IBD, focusing on gut microbiota composition, intestinal barrier integrity, and immune function. Moderate, regular exercise has been shown to beneficially influence gut microbial diversity, promote the production of anti-inflammatory metabolites, and support mucosal barrier function. Additionally, PA modulates systemic and

intestinal immune responses, potentially reducing pro-inflammatory cytokine activity. In CD, visceral adiposity and adipokine dysregulation further complicate disease progression, suggesting a specific relevance of PA in this patient group. While observational and interventional studies indicate that PA may reduce anxiety and improve quality of life in IBD patients, the evidence regarding its effects on somatic symptoms and disease course remains inconclusive. Future randomized controlled trials are essential to establish standardized exercise protocols and clarify the therapeutic potential of PA in IBD management. Nonetheless, current data support PA as a safe, promising adjunct to conventional therapies, with potential benefits for both physical and psychological health in IBD patients.

Introduction: Inflammatory bowel diseases (IBD), primarily Crohn's disease (CD) and ulcerative colitis (UC), are chronic, relapsing-remitting gastrointestinal conditions with multifactorial etiology involving genetic, environmental, microbial, and immunological factors. Although traditionally associated with malnutrition and weight loss, recent trends indicate a growing prevalence of overweight and obesity among IBD patients, particularly in CD, where visceral adiposity and altered adipokine profiles may exacerbate disease severity. Emerging evidence highlights the potential of non-pharmacological interventions, such as physical activity (PA), in modulating key pathophysiological processes in IBD, including gut microbiota composition, intestinal permeability, immune response, and systemic inflammation.

Methods: This narrative review synthesizes findings from clinical, experimental, and epidemiological studies examining the effects of physical activity on IBD. A systematic literature search was conducted using PubMed, Scopus, and Google Scholar databases for articles published between 2015 and 2024. Two high-quality studies from 2013 were included due to their relevance and foundational insights. Keywords used included "inflammatory bowel disease," "Crohn's disease," "ulcerative colitis," "physical activity," "exercise," "gut microbiota," "intestinal permeability," and "cytokines." The review included randomized controlled trials, cohort studies, case-control studies, experimental animal models, and systematic reviews published in English or Polish. Non-peer-reviewed publications and studies lacking full-text access were excluded.

Results: Moderate-intensity physical activity exerts multifaceted benefits on gastrointestinal and systemic physiology in individuals with IBD. Several studies demonstrate that regular exercise is associated with increased microbial richness and diversity, higher fecal concentrations of short-chain fatty acids (SCFAs), and enrichment of beneficial bacterial taxa such as *Akkermansia*, *Prevotella*, and *Veillonellaceae*. These microbial shifts correlate with improved metabolic and immune functions. Exercise has also been shown to reduce gastrointestinal transit time and enhance mucosal integrity by upregulating tight junction proteins, thereby protecting against intestinal hyperpermeability, which is a key feature in IBD pathogenesis.

However, the intensity and duration of exercise are critical. High-intensity or prolonged physical exertion may disrupt the gut barrier, promote oxidative stress, and contribute to dysbiosis. Animal studies have shown increased intestinal permeability, reduced claudin-1 expression, and elevated oxidative markers following intense exercise protocols. In humans, endurance athletes may experience gastrointestinal symptoms such as diarrhea, bloating, and fatigue, partially due to exercise-induced ischemic colitis.

PA also modulates immune function by lowering levels of pro-inflammatory cytokines (e.g., TNF-α, IL-1) and increasing anti-inflammatory myokines (e.g., IL-6, IL-10, IL-1ra), thus contributing to the restoration of immune homeostasis. Observational data suggest an inverse relationship between regular PA and the risk of developing CD, though similar evidence for UC is limited. Meta-analyses confirm that moderate exercise is safe for IBD patients, with potential benefits for mental health, particularly in reducing anxiety. The interplay between

PA, gut microbiota, adipokines, and mesenteric fat suggests a complex regulatory network influencing disease expression and progression.
Conclusions: Physical activity appears to be a safe, accessible, and cost-effective adjunct in the management of inflammatory bowel diseases. Through its effects on gut microbiota diversity, barrier integrity, immune regulation, and systemic inflammation, PA holds promise in mitigating disease severity, improving psychological well-being, and enhancing quality of life in affected individuals. Nevertheless, the heterogeneity of available studies highlights the need for further randomized, controlled trials to establish standardized exercise protocols tailored to disease subtype, activity level, and patient condition. Integrating PA into comprehensive treatment strategies could improve long-term outcomes and represent an essential component of holistic IBD care.

Key words: Crohn's disease, inflammatory bowel disease, physical activity, gut microbiota, cytokines, exercise therapy, intestinal barrier

Introduction

Inflammatory bowel diseases (IBD) comprise a group of chronic conditions, primarily including Crohn's disease (CD) and ulcerative colitis (UC). The highest incidence and prevalence rates of IBD globally have been reported in Canada and Europe, while Asia has shown lower rates. The incidence of IBD, particularly CD, has significantly increased in recent years in developed countries, likely due to changing dietary habits and decreasing physical activity levels [1]. Although epidemiological data from developing countries are limited, the incidence and prevalence of IBD are increasing over time and across different regions worldwide, indicating that this disease is becoming a global health concern. The etiology of IBD remains incompletely understood. Research has demonstrated that genetic susceptibility, the interaction of environmental factors, alterations in the gut microbiota, and a dysfunctional mucosal immune system can contribute to the development of IBD [2, 3, 4]. Changes in the composition and diversity of the gut microbiota, potentially induced by altered dietary patterns, appear to be of significant importance in the pathogenesis of IBD [5]. Historically, IBD patients were often considered malnourished, and overweight was relatively uncommon. However, recent studies have shown an increase in the prevalence of obesity in this population, suggesting a potential negative impact on disease course [6]. This is particularly relevant in Crohn's disease, where obese individuals have been found to have an

increased risk of complicated disease progression [7]. Recent findings highlight the specific role of visceral adipose tissue. Studies indicate that excessive expression of adipokines, such as leptin and adiponectin, occurs in the mesenteric adipose tissue of CD patients, which may influence inflammatory processes in this disease [8, 9]. Patients suffering from IBD typically complain of abdominal pain, bloating, watery and bloody diarrhea, and systemic symptoms such as anorexia, malaise, fatigue, weight loss, fever, and extraintestinal manifestations [10, 11]. Alterations in the structure and properties of mesenteric adipose tissue are also characteristic of CD, and recent research has shown that the mechanism of their formation is dependent on the gut microbiota [12]. While numerous advanced medical and surgical therapies are available for the treatment of IBD, adults with IBD may seek other complementary options to manage symptoms and improve their quality of life. Physical activity (PA) is one such alternative intervention [32]. This review will describe the impact of PA on gastrointestinal function and the course of inflammatory bowel diseases, with a particular emphasis on Crohn's disease.

Physical Activity and the Gut Microbiota

Exercise is considered one of the primary environmental factors that can influence the composition of the gut microbiota [13]. Several well-established effects of exercise on gut physiology exist. The duration and intensity of exercise have been shown to impact gastrointestinal health. For instance, physical activity shortens the transient time of stool in the gastrointestinal tract, reducing prolonged contact of pathogens with the gastrointestinal mucus layer and the circulatory system. Furthermore, moderate physical exertion is associated with a reduced incidence of colon cancer [14]. A case-control study demonstrated that microbial diversity was significantly higher in a group of professional rugby players compared to age-, sex-, and body composition-matched sedentary controls [15]. Another study showed that the microbiome of athletes also differed functionally, with an increased presence of genes related to carbohydrate and amino acid metabolism and the production of short-chain fatty acids (SCFAs) [16]. Fecal SCFA levels showed significantly higher levels of acetate ($p<0.001$), propionate ($p<0.001$), butyrate ($p<0.001$), and valerate ($p=0.011$) in athletes compared to the control group. One article stated that the microbiomes of athletes contain a specific composition. Microbiological studies have shown an increased abundance of *Veillonellaceae*, *Bacteroidetes*, *Prevotella*, *Methanobrevibacter*, and *Akkermansia* [20], while sedentary individuals have a predominance of *Bacteroides* and *Parabacteroides* [21]. Another study, involving 19 active and 21 sedentary women aged ≤40 years, showed that the abundance of several bacterial taxa was significantly correlated with the percentage of fat

mass or fat-free mass [17]. It is worth noting that the gut microbiome exhibits resilience to sudden changes in physical activity levels. In these studies [18, 19], it was observed in young men subjected to a period of forced inactivity that cessation of exercise led to a decrease in the number of bowel movements and a change in stool consistency, but the composition of the gut microbiota remained unchanged in the initial stages. On the other hand, it should be remembered that prolonged and extreme training can lead to dysbiosis of the gut microbiome, promoting inflammation and increasing the release of pro-inflammatory cytokines in tissues and plasma. Athletes engaging in exhaustive sports such as marathons and triathlons may suffer from so-called ischemic colitis, which manifests as bloody diarrhea, fatigue, and fever [21]. The above data indicate that physical activity has a significant impact on the composition of the gut microbiome and can have beneficial effects on the entire organism by modulating pathological processes, including IBD.

The Impact of Exercise on the Intestinal Barrier

The intestine plays a crucial role as a barrier protecting the body against the penetration of harmful external factors. However, its function can be disrupted due to oxidative damage and weakening of the mucus layer. Intense physical exertion can lead to an increase in oxidative stress in intestinal tissue, although the precise impact of this process on intestinal permeability is not fully understood. This study [23] analyzed the role of oxidative stress in the functioning of the intestinal barrier in mice subjected to intense exercise. Twelve-week-old male ICR mice were used for the experiment and divided into a control (sedentary) group and an exercise group. Mice in the active group underwent a single bout of treadmill running, after which their ileum was collected for histological and biochemical analyses. After oral administration of FITC-dextran, the level of plasma fluorescence gradually increased for 30 minutes post-exercise, proportional to the intensity of the exercise. The active group showed higher levels of oxidative proteins and a reduced level of claudin-1, an essential component of tight junctions in the intestinal epithelium. Additionally, inhibition of xanthine oxidase activity limited the exercise-induced increase in intestinal permeability. Regular, excessive physical activity for two weeks resulted in elevated resting intestinal permeability. Histological examination also revealed that the thickness of the intestinal wall was smaller in mice from the exercise group compared to the control group. The obtained results suggest that intense physical exertion can increase intestinal permeability and damage tight junctions, which may be associated with increased oxidative stress. Similar conclusions were reached in these studies. In this study [24], the threshold inducing increased intestinal permeability, the so-called "leaky gut," was ≥70% of maximum capacity during ≥60 minutes of intense

endurance training. These results are confirmed by another study [25], which observed a significant increase in intestinal permeability during high-intensity exercise, such as running for 60 minutes at 80% VO2 max. The analyzed literature indicates that the effect of physical activity on the intestinal barrier largely depends on the intensity and duration of exercise. Some studies clearly show that intense physical exertion causes an increase in intestinal permeability.

Physical Exercise and the Immune System

Abnormalities in the functioning of the intestinal immune system can initiate the development of inflammation characteristic of inflammatory bowel diseases (IBD). The anti-inflammatory properties of physical activity, which include the regulation of pro-inflammatory cytokine levels within the intestine, are extensively described in the scientific literature. In healthy individuals, the intestinal immune system typically remains in a state of balance between pro- and anti-inflammatory factors. However, disturbances in this homeostasis can result in excessive immune activation and the development of chronic inflammation, as seen in IBD [26]. Animal studies have shown that moderate physical activity can reduce the expression of pro-inflammatory mediators such as interleukin 1 (IL-1) and tumor necrosis factor-alpha (TNF-α), leading to the alleviation of the inflammatory process [27]. Moreover, physical exercise stimulates the production of muscle-derived myokines – including IL-6, IL-10, and IL-1ra – which play a significant role in inhibiting TNF-α synthesis, thereby supporting protection against excessive inflammation in the gastrointestinal tract [28, 29].

The Impact of Physical Activity on Inflammatory Bowel Diseases – Crohn's Disease and Ulcerative Colitis

Most available studies confirm the beneficial effects of systematic physical exercise of moderate intensity in adult patients with inflammatory bowel diseases (IBD) [33]. In many articles, walking was the most commonly performed activity (57% of respondents), while running/jogging was most frequently avoided (34%). [30,]. In contrast, the results of a large, prospective cohort study, the Nurses' Health Study, involving 194,711 women observed for an average of 17 years, suggest that higher physical activity may be associated with a lower risk of developing Crohn's disease. Women in the most physically active group had a 44% lower risk of developing the disease compared to the least active. However, such an association was not demonstrated for ulcerative colitis [31, 33]. A meta-analysis of eight studies conducted between 2011 and 2023, involving nearly 400 patients, showed that physical activity is safe for individuals with IBD and may contribute to the reduction of

anxiety levels. However, the impact of exercise on other symptoms, such as abdominal pain, fatigue, or quality of life, remains inconclusive and requires further high-quality research [34].

Conclusions

Available data indicate that moderate, regular physical activity may favorably influence the pathophysiology of inflammatory bowel diseases (IBD) by modulating the gut microbiota, supporting intestinal barrier function, and limiting the activation of the mucosal immune system. Despite promising results, particularly in the context of Crohn's disease, the heterogeneity of research designs, exercise protocols, and methods for assessing the effectiveness of interventions makes it difficult to draw definitive conclusions. However, it is significant that physical activity appears to be a safe form of therapeutic support for IBD patients, with a potential impact on alleviating disease symptoms and improving psychological well-being – especially in terms of reducing anxiety levels. The effect of exercise on somatic symptoms, such as abdominal pain, fatigue, or the overall course of the disease, remains inconclusive and requires further well-designed clinical studies. Future research should focus on randomized, placebo-controlled trials that will allow for the standardization of exercise interventions and a more detailed understanding of the mechanisms of action of physical activity in the context of IBD. Incorporating regular physical activity into comprehensive treatment may constitute an effective, non-pharmacological adjunct to therapy, improving the quality of life and long-term prognosis of patients.

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