AAB, Arkadiusz, ZARAŃSKA, Julia, KĘDRA, Kamila, MICHALIK, Izabela and BIELAK, Maciej. Physical Activity in Patients with IBD - Challenge, Opportunity, or Both? Journal of Education, Health and Sport. 2023;23(1):120-132. eISSN 2391-8306. DOI
http://dx.doi.org/10.12775/JEHS.2023.23.01.012
https://apcz.umk.pl/JEHS/article/view/44867
https://zenodo.org/record/8171736

The journal has had 40 points in Ministry of Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of December 21, 2021. No. 32343.
Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical Culture Sciences (Field of Medical sciences and health sciences); Health Sciences (Field of Medical Sciences and Health Sciences).
Punkty Ministerialne z 2019 - aktualny rok 40 punktów. Załącznik do komunikatu Ministra Edukacji i Nauki z dnia 21 grudnia 2021 r. Lp. 32343. Posiada Unikatowy Identyfikator Czasopisma: 201159.
Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 01.07.2023. Revised: 20.07.2023. Accepted: 20.07.2023. Published: 25.07.2023.

Physical Activity in Patients with IBD - Challenge, Opportunity, or Both?

Arkadiusz Aab

Clinical Regional Hospital No. 2 of St. Jadwiga The Queen in Rzeszów, ul. Lwowska 60, 35-301–Rzeszów

ORCID 0009-0002-3329-2620

https://orcid.org/0009-0002-3329-2620

arcziaab@gmail.com

Julia Zarańska

City Hospital of John Paul II in Rzeszów, ul. Rycerska 4, 35-241–Rzeszów

ORCID 0009-0004-4080-0472

https://orcid.org/0009-0004-4080-0472

zaranskaj@gmail.com

Kamila Kędra

Medical Center in Łańcut Sp. z o. o. - Hospital of St. Michael the Archangel, ul. Ignacego Paderewskiego 5, 37-100 Łańcut

ORCID 0000-0002-3072-4697

https://orcid.org/0000-0002-3072-4697

kedra.kamilaa@gmail.com

Izabela Michalik
Medical Center in Łańcut Sp. z o. o. - Hospital of St. Michael the Archangel, ul. Ignacego Paderewskiego 5, 37-100 Łańcut
ORCID 0009-0002-6238-1729
https://orcid.org/0009-0002-6238-1729
izkam20@gmail.com

Maciej Bielak
Medical Center in Łańcut Sp. z o. o. - Hospital of St. Michael the Archangel, ul. Ignacego Paderewskiego 5, 37-100 Łańcut
ORCID 0009-0005-4150-1869
https://orcid.org/0009-0005-4150-1869
bielakmj@gmail.com

ABSTRACT

Introduction: Inflammatory bowel diseases (IBD) are a global public health problem, and their incidence is continuously increasing. IBD is characterized by a relapsing nature and is associated with symptoms such as abdominal pain, diarrhoea, malabsorption, and nutritional deficiencies. Patients affected by this disease are typically young individuals, and physical activity plays a significant role in this age group. Understanding the role of exercise and sports activities in individuals with IBD can help consider potential therapeutic interventions for these patients.

Objective: The aim of this study is to summarize the knowledge regarding the role of physical activity in patients with IBD.

Materials and methods: A literature review was conducted using the PubMed and Google Scholar databases, using the following keywords: IBD, physical activity, stress and fatigue in individuals with IBD, anxiety in patients with IBD.

State of knowledge: The role of physical activity in promoting health and preventing various diseases is well-established. However, there is limited research on the association between exercise and IBD.

Conclusions: Physical activity, by reducing fatigue and stress, has a positive impact on the functioning of patients with IBD. There are reports suggesting a reduction in gastroenterological symptoms in patients after engaging in exercise. With appropriate control

of the underlying disease using pharmacological and other recommended methods, participating in sports activities does not pose a barrier for patients. Physicians should encourage patients to engage in exercise with tailored intensity due to its beneficial effects on various aspects of life for individuals with IBD. Further research is necessary to explore this topic more extensively.
Keywords: IBD, physical activity, stress in patients with IBD, fatigue.

Introduction

Inflammatory bowel diseases (IBD) have become a global disease in recent years, with an increasing incidence, particularly in developing countries. IBD can be classified into two main entities: Crohn's disease (CD) and ulcerative colitis (UC). CD is characterized by transmural inflammation with granuloma formation and can affect any part of the gastrointestinal tract, most commonly the terminal ileum. Involved segments of the bowel are interspersed with healthy segments. The most common complications of CD include fistulas and abscesses. On the other hand, UC is limited to the mucosal layer of the colon or rectum. Common symptoms shared by CD and UC include abdominal pain, diarrhoea, weight loss, and nutritional deficiencies, with gastrointestinal bleeding being less common. IBD is characterized by a relapsing nature, with periods of exacerbation and remission [1, 2]. The pathophysiological basis of the disease involves an abnormal inflammatory response with excessive intensity. Recent studies shed light on the role of newly discovered Th-17 cells present in the intestinal mucosa, which produce Interleukin-17, in the development of IBD [3].

Diagnostic procedures for IBD primarily include gastrointestinal endoscopy. This examination allows for differentiation between CD and UC, assessment of disease activity, evaluation of treatment effectiveness, and monitoring for the development of colorectal cancer. The latest endoscopic techniques also enable minimally invasive treatment of complications (e.g., intestinal strictures) that previously required surgical intervention [4]. Treatment of IBD mainly involves pharmacological therapy (aminosalicylates, corticosteroids, immunomodulatory drugs, and biologics). However, achieving remission in patients often poses challenges for clinicians, despite seemingly optimal treatment. It should also be noted that IBD patients often experience stress, anxiety, depression, and other emotional disorders, which can negatively impact their disease management [5].

The estimated global prevalence of IBD is 0.3%. These data emphasize the need for research on IBD prevention and innovations in healthcare systems to effectively manage this

complex and costly condition [6]. In Poland, the highest prevalence of IBD is observed in the 30-44 age group, characterized by a generally high level of physical activity. Considering that cases of IBD most commonly occur at a young age, understanding the role of physical activity in the context of these patients is important [7].

Physical Activity and the Severity of IBD

According to the World Health Organization (WHO), physical activity refers to any bodily movement produced by skeletal muscles that requires energy expenditure. It encompasses all types of movement, including leisure-time activities and transportation to and from work. Regular moderate to vigorous physical activity improves health and prevents the development of many diseases, including heart disease, diabetes, and hypertension.

Various lifestyle factors, such as stress, sleep, and physical activity, can influence the development of IBD. Obesity, in turn, increases the risk of disease relapse and is associated with higher levels of anxiety, fatigue, and pain, which make coping with the underlying disease more challenging [8]. The role of physical exercise in reducing inflammation is widely known. Physical activity acts as an adjuvant to the immune system. Each training session during physical exercise enhances the anti-pathogenic capacity of immune cells and increases the recirculation of immunoglobulins and cytokines. Regular training has a general anti-inflammatory effect. Meta-analyses have shown that individuals who exercise regularly have reduced levels of inflammatory biomarkers [9].

A study conducted by Jones et al. on 1857 patients demonstrated that CD patients who engage in physical activity are significantly less prone to developing active disease. In the case of UC patients, a reduction in this risk was also observed, although it was not statistically significant. The observation period lasted for 6 months [10].

In their mouse model study, Saxena et al. demonstrate a decrease in the levels of certain pro-inflammatory cytokines. Physical training contributes to the alleviation of symptoms of acute colitis, as evidenced by the reduction in clinical symptoms and molecular markers in mice [11].

Furthermore, many articles address the issue of reduced bone mineral density (BMD) in individuals with IBD. In this case, osteoporosis occurs as a secondary condition to the underlying disease. Although the exact cause of bone metabolism disorders is not yet fully understood, it is postulated that it may be related to inflammation, corticosteroid use, or impaired absorption of nutrients. Physical exercise is an essential approach to preventing and treating bone loss [12].

Obesity is a significant problem for patients with IBD. Some studies indicate that the prevalence of obesity or overweight individuals among CD patients is 52%. For example, obesity in Crohn's disease is associated with more complications in the perianal region and increased disease activity, leading to more hospitalizations and reduced quality of life. Proper physical activity can reduce body mass index (BMI) and have a beneficial impact on the health of these individuals [13, 14].

The impact of physical activity on the mental well-being of patients with IBD

Physical activity can have a significant and beneficial impact on the mental well-being of patients with inflammatory bowel disease (IBD). Regular participation in sports can contribute to improved emotional well-being and reduction of stress symptoms. Nowadays, stress seems to be pervasive, and for chronically ill patients, there is a heightened experience of stress due to concerns about the complete loss of health, ability to work, or family. The relationship between stress and IBD symptoms is bidirectional. Symptomatic patients tend to experience higher levels of perceived stress, whereas patients with IBD in remission or without symptoms have significantly lower stress levels [8].

Based on a study conducted by Bernstein et al. on 704 patients with IBD, it was demonstrated that high levels of perceived stress correlate with an increased risk of exacerbations. The conclusions drawn were that psychological factors contribute to the increased intensity of gastrointestinal symptoms in these patients [15].

Levenstein et al. in their analysis of 62 patients with ulcerative colitis report that long-term, high-intensity stress triples the risk of exacerbation within the subsequent 8 months of observation. The same study also observed that short-term stress does not lead to exacerbations [16].

In summary, the role of stress in the exacerbation of gastrointestinal symptoms in patients with IBD is not yet clear. It is uncertain whether symptoms are primarily a result of increased inflammatory response and impact on the immune system's function or whether they affect gastrointestinal motility. Stress, by directly influencing the nervous system that controls intestinal peristalsis, may exacerbate abdominal pain, bloating, or irregular bowel movements. Simultaneously, stress intensifies immune system activity, leading to increased levels of pro-inflammatory cytokines. Furthermore, stress can disrupt intestinal barrier function, increasing gut permeability and allowing pro-inflammatory substances to penetrate intestinal tissue. However, it is important to note that the response to stress is highly individual, and therefore, it is not entirely possible to determine definitively which pathways

are affected by stress in patients with IBD [17]. Regular physical exercise leads to a reduction in stress levels, which, in turn, increases the likelihood of remission in patients with IBD. Exercise activates the release of endorphins, which can provide relief from symptoms in patients. Additionally, physical activity can help build a positive attitude towards the disease and increase self-worth [18].

Physical activity in pediatric patients with IBD

Childhood is a period of intense growth and development, both mentally and physically. Children grow rapidly, their physique becomes slimmer and taller. Around the age of 6, there is a phenomenon known as "obesity rebound," in which there is a sudden increase in BMI. This is one of the most critical moments when children are at risk of developing obesity. It has been shown that physical activity in preschool-age children is inversely proportional to obesity [19, 20].

Physical exertion can reduce fatigue, which is a common and burdensome symptom experienced by individuals with inflammatory bowel diseases. Fatigue can significantly limit children's ability to engage in daily activities such as school, sports, and social events, and it can also affect mood and quality of life. Exercise can improve overall physical fitness, endurance, and well-being. Maintaining good fitness and appropriate weight contributes to improved functioning in pediatric patients with IBD [21, 22].

The diagnosis of IBD in children can significantly affect their physical activity for several reasons. Firstly, symptoms such as diarrhea, abdominal pain, or fatigue can greatly limit the ability to engage in physical exercise. Children may experience anxiety and fear associated with these symptoms, which can effectively deter them from participating in sports activities [23]. A study by Calsbeek et al. found that school absenteeism due to illness can contribute to a lower social position for children with IBD [24]. Among these patients, chronic fatigue is often reported as a significant factor negatively affecting their educational achievements, ability to concentrate, and physical fitness. Abdominal pain is a common symptom in patients, even in those without active disease in clinical studies [25]. An analysis by Giannakopoulos et al. indicated a link between reported life events with a stressful nature in the past year by parents of children with IBD and disease activity. Furthermore, a relationship was found between parents' reported anxiety symptoms in children and symptoms related to mental health and disease activity [26]. Reigada et al. demonstrated that 30% of pediatric patients with IBD reported significant anxiety symptoms, with half of them scoring above the established threshold in at least one area related to anxiety, with school-related

anxiety, general anxiety, and separation anxiety being the most commonly mentioned symptoms. There was a statistically significant association between increased school-related anxiety and worsened well-being, more severe abdominal pain, more frequent loose stools, and extraintestinal manifestations. The authors suggest that implementing a short screening test for anxiety in specialized centers for pediatric patients with IBD could be one of the potential tools for identifying children in difficult situations. Healthcare professionals should also consider regular monitoring of school-related anxiety in adolescents with IBD [27]. Increased susceptibility to psychological disorders can simultaneously induce problems at school, avoidance of recreational activities, and impairment of peer relationships. Undoubtedly, children with IBD should be screened for depression, as the unpleasant events caused by the disease can increase the likelihood of developing this condition [28, 29].

Regular exercise can help alleviate low-grade chronic inflammation, which is characteristic of IBD, by influencing the regulation of the immune system. Additionally, physical activity can have a positive impact on the body's ability to fight infections, which is essential for patients with IBD who may experience various types of infections due to dysregulated immune system [30].

The Canadian research team conducted a study on a group of patients with inactive or mildly active Crohn's disease. The aim of the study was to assess the impact of low-intensity physical activity on the exacerbation of symptoms related to inflammatory bowel disease and the quality of life of patients. A group of 12 patients was asked to go for walks three times a week for 12 weeks. Each walking session lasted an average of 32 minutes and covered approximately 3.5 km. At the end of the study, patients showed reduced stress, improved quality of life, and decreased body mass index (BMI). No disease exacerbation was observed as a result of exercise in any of the participants [31].

Martin Meller conducted research at a rehabilitation center in Bad Neuenahr regarding the use of sports therapy in chronic inflammatory bowel diseases. He proposed moderate physical training tailored individually to each patient in a group of IBD patients. The training included various sports such as stationary cycling, water jogging, and walking. Relaxation techniques were used only in the control group. Meller was able to demonstrate that the sports group had a significantly reduced need for medication (e.g., cortisone), improved body awareness and overall condition. They experienced less anxiety and depression, and their work capacity increased [32].

According to researchers, the disease can limit physical activity due to weakness, fatigue, and abdominal pain. Physical exercise can have a beneficial impact on the regression

of IBD symptoms [33, 34]. Beery et al., in their scientific work, considered 149 patients whom they asked to complete surveys regarding the impact of IBD on physical activity. In 45% of cases, IBD negatively affected physical fitness and performance, but in 44%, it had no such impact. Proper pharmacological treatment and appropriate disease activity control contribute to a greater willingness to participate in sports activities. Only 18% of the respondents stated that IBD prevented them from engaging in their desired sport, and for some, there was a shift in interests towards other types of sports that may seem more suitable for these patients. Additionally, a similar level of physical activity was observed compared to healthy American youth, and the decrease in participation in physical activities was minimal after an IBD diagnosis. Anemia and poor absorption lead to weight loss due to insufficient energy intake, which in turn can exacerbate fatigue and decrease motivation for exercise. Extra-intestinal symptoms such as enteropathic arthritis or osteoporosis unfortunately correlate with limitations in safely performing certain physical exercises. Consultation with experts in physiotherapy and physical activities seems necessary to determine which type of exercise would be optimal and safe for these specific patients [35]. It is also important to address the issue of body acceptance in pediatric patients with IBD. Previous surgeries, wasting, presence of surgical wounds, or stomas may hinder participation in sports, although some meta-analyses suggest that the impact may not be as significant as it may seem [36, 35].

Summary

Engaging in moderate physical activity, taking into account the individual disease condition of the patient, can have many positive effects. Physical activity can help reduce stress, improve mood, and strengthen the cardiovascular system. Coordination training can make movements smoother and enhance concentration. Light strength training can improve daily life performance and prevent osteoporosis. Exercise stimulates blood circulation and intestinal movements, which promotes the healing of inflammatory processes in the intestines. Additionally, the processes occurring in the human body during moderate exercise lead to a regression of overall inflammation.

In summary, the beneficial impact of physical activity on the mental state and quality of life of IBD patients should be acknowledged. Therefore, doctors should promote engaging in exercises of appropriate intensity.

Author Contributions

Conceptualization: Aab A., Zarańska J.; Methodology: Aab A., Zarańska J.; Software: Bielak M.; Check: Kędra K., Michalik I.; Formal analysis: Michalik I.; Investigation: Aab A.; Resources: Zarańska J.; Data curation: Zarańska J.; Writing - rough preparation: Bielak M., Kędra K.; Writing - review and editing: Zarańska J., Michalik I., Kędra K..; Visualization: Kędra K.; Supervision: Aab A.; Project administration: Aab A., Bielak M.

All authors have read and agreed with the published version of the manuscript.

Funding

This research received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Abraham C, Cho JH. Inflammatory bowel disease. N Engl J Med. 2009 Nov 19;361(21):2066-78. doi: 10.1056/NEJMra0804647. PMID: 19923578; PMCID: PMC3491806.

2. Lee SH, Kwon JE, Cho ML. Immunological pathogenesis of inflammatory bowel disease. Intest Res. 2018 Jan;16(1):26-42. doi: 10.5217/ir.2018.16.1.26. Epub 2018 Jan 18. PMID: 29422795; PMCID: PMC5797268.

3. Raza A, Yousaf W, Giannella R, Shata MT. Th17 cells: interactions with predisposing factors in the immunopathogenesis of inflammatory bowel disease. Expert Rev Clin Immunol. 2012 Feb;8(2):161-8. doi: 10.1586/eci.11.96. PMID: 22288454; PMCID: PMC3937806.

4. Spiceland CM, Lodhia N. Endoscopy in inflammatory bowel disease: Role in diagnosis, management, and treatment. World J Gastroenterol. 2018 Sep 21;24(35):4014-4020. doi: 10.3748/wjg.v24.i35.4014. PMID: 30254405; PMCID: PMC6148432.

5. Cai Z, Wang S, Li J. Treatment of Inflammatory Bowel Disease: A Comprehensive Review. Front Med (Lausanne). 2021 Dec 20;8:765474. doi: 10.3389/fmed.2021.765474. PMID: 34988090; PMCID: PMC8720971.

6. Ng SC, Shi HY, Hamidi N, Underwood FE, Tang W, Benchimol EI, Panaccione R, Ghosh S, Wu JCY, Chan FKL, Sung JJY, Kaplan GG. Worldwide incidence and prevalence of inflammatory bowel disease in the 21st century: a systematic review of population-based studies. Lancet. 2017 Dec 23;390(10114):2769-2778. doi: 10.1016/S0140-6736(17)32448-0. Epub 2017 Oct 16. Erratum in: Lancet. 2020 Oct 3;396(10256):e56. PMID: 29050646.

7. Zagórowicz E, Walkiewicz D, Kucha P, et al. Nationwide data on epidemiology of inflammatory bowel disease in Poland between 2009 and 2020. Pol Arch Intern Med. 2022; 132: 16194. doi:10.20452/pamw.16194

8. Rozich JJ, Holmer A, Singh S. Effect of Lifestyle Factors on Outcomes in Patients With Inflammatory Bowel Diseases. Am J Gastroenterol. 2020 Jun;115(6):832-840. doi: 10.14309/ajg.0000000000000608. PMID: 32224703; PMCID: PMC7274876.

9. Nieman DC, Wentz LM. The compelling link between physical activity and the body's defense system. J Sport Health Sci. 2019 May;8(3):201-217. doi: 10.1016/j.jshs.2018.09.009. Epub 2018 Nov 16. PMID: 31193280; PMCID: PMC6523821.

10. Jones PD, Kappelman MD, Martin CF, Chen W, Sandler RS, Long MD. Exercise decreases risk of future active disease in patients with inflammatory bowel disease in remission. Inflamm Bowel Dis. 2015 May;21(5):1063-71. doi: 10.1097/MIB.0000000000000333. PMID: 25723616; PMCID: PMC4402239.

11. Saxena A, Fletcher E, Larsen B, Baliga MS, Durstine JL, Fayad R. Effect of exercise on chemically-induced colitis in adiponectin deficient mice. J Inflamm (Lond). 2012 Aug 21;9(1):30. doi: 10.1186/1476-9255-9-30. PMID: 22909126; PMCID: PMC3490765.

12. Lee N, Radford-Smith G, Taaffe DR. Bone loss in Crohn's disease: exercise as a potential countermeasure. Inflamm Bowel Dis. 2005 Dec;11(12):1108-18. doi:10.1097/01.mib.0000192325. 28168.08. PMID: 16306774.

13. Steed H, Walsh S, Reynolds N. A brief report of the epidemiology of obesity in the inflammatory bowel disease population of Tayside, Scotland. Obes Facts. 2009;2(6):370-2. doi: 10.1159/000262276. Epub 2009 Dec 17. PMID: 20090388; PMCID: PMC6515793.

14. Blain A, Cattan S, Beaugerie L, Carbonnel F, Gendre JP, Cosnes J. Crohn's disease clinical course and severity in obese patients. Clin Nutr. 2002 Feb;21(1):51-7. doi: 10.1054/clnu.2001.0503. PMID: 11884013.

15. Bernstein CN, Singh S, Graff LA, Walker JR, Miller N, Cheang M. A prospective population-based study of triggers of symptomatic flares in IBD. Am J Gastroenterol. 2010 Sep;105(9):1994-2002. doi: 10.1038/ajg.2010.140. Epub 2010 Apr 6. PMID: 20372115.

16. Levenstein S, Prantera C, Varvo V, Scribano ML, Andreoli A, Luzi C, Arcà M, Berto E, Milite G, Marcheggiano A. Stress and exacerbation in ulcerative colitis: a prospective study of patients enrolled in remission. Am J Gastroenterol. 2000 May;95(5):1213-20. doi: 10.1111/j.1572-0241.2000.02012.x. PMID: 10811330.

17. Targownik LE, Sexton KA, Bernstein MT, Beatie B, Sargent M, Walker JR, Graff LA. The Relationship Among Perceived Stress, Symptoms, and Inflammation in Persons With Inflammatory Bowel Disease. Am J Gastroenterol. 2015 Jul;110(7):1001-12; quiz 1013. doi: 10.1038/ajg.2015.147. Epub 2015 Jun 16. PMID: 26077178.

18. Eckert KG, Abbasi-Neureither I, Köppel M, Huber G. Structured physical activity interventions as a complementary therapy for patients with inflammatory bowel disease - a scoping review and practical implications. BMC Gastroenterol. 2019 Jul 2;19(1):115. doi: 10.1186/s12876-019-1034-9. PMID: 31266461; PMCID: PMC6604412.

19. Butte NF, Puyau MR, Wilson TA, Liu Y, Wong WW, Adolph AL, Zakeri IF. Role of physical activity and sleep duration in growth and body composition of preschool-aged children. Obesity (Silver Spring). 2016 Jun;24(6):1328-35. doi: 10.1002/oby.21489. Epub 2016 Apr 18. PMID: 27087679; PMCID: PMC4882246.

20. Raman M, Rajagopalan V, Kaur S, Reimer RA, Ma C, Ghosh S, Vallance J. Physical Activity in Patients With Inflammatory Bowel Disease: A Narrative Review. Inflamm Bowel Dis. 2022 Jul 1;28(7):1100-1111. doi: 10.1093/ibd/izab218. PMID: 34605548.

21. McNelly, A., Nathan, I., Monti, M., Grimble, G., Norton, C., Bredin, F., ... & Forbes, A. (2016). Inflammatory bowel disease and fatigue: the effect of physical activity and/or omega-3 supplementation.

22. Farrell D, Artom M, Czuber-Dochan W, Jelsness-Jørgensen LP, Norton C, Savage E. Interventions for fatigue in inflammatory bowel disease. Cochrane Database Syst Rev. 2020 Apr 16;4(4):CD012005. doi: 10.1002/14651858.CD012005.pub2. PMID: 32297974; PMCID: PMC7161727.

23. Silva LC, Seixas RBPM, de Carvalho E. Quality of Life in Children and Adolescents with Inflammatory Bowel Disease: Impact and Predictive Factors. Pediatr Gastroenterol Hepatol Nutr. 2020 May;23(3):286-296. doi: 10.5223/pghn.2020.23.3.286. Epub 2020 May 8. PMID: 32483550; PMCID: PMC7231741.

24. Calsbeek H, Rijken M, Bekkers MJ, Kerssens JJ, Dekker J, van Berge Henegouwen GP. Social position of adolescents with chronic digestive disorders. Eur J Gastroenterol Hepatol. 2002 May;14(5):543-9. doi: 10.1097/00042737-200205000-00012. PMID: 11984153.

25. Mackner LM, Greenley RN, Szigethy E, Herzer M, Deer K, Hommel KA. Psychosocial issues in pediatric inflammatory bowel disease: report of the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition. J Pediatr Gastroenterol Nutr. 2013 Apr;56(4):449-58. doi: 10.1097/MPG.0b013e3182841263. PMID: 23287808; PMCID: PMC3609923.

26. Giannakopoulos G, Chouliaras G, Margoni D, Korlou S, Hantzara V, Panayotou I, Roma E, Liakopoulou M, Anagnostopoulos DC. Stressful life events and psychosocial correlates of pediatric inflammatory bowel disease activity. World J Psychiatry. 2016 Sep 22;6(3):322-8. doi: 10.5498/wjp.v6.i3.322. PMID: 27679771; PMCID: PMC5031932.

27. Reigada LC, Hoogendoorn CJ, Walsh LC, Lai J, Szigethy E, Cohen BH, Bao R, Isola K, Benkov KJ. Anxiety symptoms and disease severity in children and adolescents with Crohn disease. J Pediatr Gastroenterol Nutr. 2015 Jan;60(1):30-5. doi: 10.1097/MPG.0000000000000552. PMID: 25187105.

28. Däbritz J, Gerner P, Enninger A, Claßen M, Radke M. Inflammatory Bowel Disease in Childhood and Adolescence. Dtsch Arztebl Int. 2017 May 12;114(19):331-338. doi: 10.3238/arztebl.2017.0331. PMID: 28597827; PMCID: PMC5470346.

29. Szigethy E, Levy-Warren A, Whitton S, Bousvaros A, Gauvreau K, Leichtner AM, Beardslee WR. Depressive symptoms and inflammatory bowel disease in children and adolescents: a cross-sectional study. J Pediatr Gastroenterol Nutr. 2004 Oct;39(4):395-403. doi: 10.1097/00005176-200410000-00017. PMID: 15448431.

30. Calcaterra V, Vandoni M, Rossi V, Berardo C, Grazi R, Cordaro E, Tranfaglia V, Carnevale Pellino V, Cereda C, Zuccotti G. Use of Physical Activity and Exercise to Reduce Inflammation in Children and Adolescents with Obesity. Int J Environ Res Public Health. 2022 Jun 5;19(11):6908. doi: 10.3390/ijerph19116908. PMID: 35682490; PMCID: PMC9180584.

31. Ng V, Millard W, Lebrun C, Howard J. Low-intensity exercise improves quality of life in patients with Crohn's disease. Clin J Sport Med. 2007 Sep;17(5):384-8. doi: 10.1097/JSM.0b013e31802b4fda. PMID: 17873551.

32.Meller, M. (2001) Sporttherapeutische Maßnahmen bei chronisch entzündlichen Darmerkrankungen. 1-448; Dissertation Deutsche Sporthochschule Köln.

33. Chan D, Robbins H, Rogers S, Clark S, Poullis A. Inflammatory bowel disease and exercise: results of a Crohn's and Colitis UK survey. Frontline Gastroenterol. 2014 Jan;5(1):44-48. doi: 10.1136/flgastro-2013-100339. Epub 2013 Jul 31. PMID: 28839750; PMCID: PMC5369708.

34. Narula N, Fedorak RN. Exercise and inflammatory bowel disease. Can J Gastroenterol. 2008 May;22(5):497-504. doi: 10.1155/2008/785953. PMID: 18478136; PMCID: PMC2660805.

35. Marchioni Beery RM, Li E, Fishman LN. Impact of pediatric inflammatory bowel disease diagnosis on exercise and sports participation: Patient and parent perspectives. World J Gastroenterol. 2019 Aug 21;25(31):4493-4501. doi: 10.3748/wjg.v25.i31.4493. PMID: 31496627; PMCID: PMC6710172.

36. Plevinsky JM, Wojtowicz AA, Poulopoulos N, Schneider KL, Greenley RN. Perceived Impairment in Sports Participation in Adolescents With Inflammatory Bowel Diseases: A Preliminary Examination. J Pediatr Gastroenterol Nutr. 2018 Jan;66(1):79-83. doi: 10.1097/MPG.0000000000001633. PMID: 28505049.