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The impact of diet on the inflammatory bowel disease course – a literature review

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Abstract

Introduction and Objective. Inflammatory bowel disease (IBD), including ulcerative colitis (UC) and Crohn's disease (CD), is a chronic gastrointestinal disorder marked by relapsing symptoms. Current treatments mainly involve immunosuppressive therapies, which are effective but may have significant side effects. Diet as an adjunctive treatment is appealing due to its accessibility, low cost, and minimal adverse effects. This review explores the role of diet in managing IBD, focusing on dietary strategies during both active disease and remission.

Methods. A literature review was conducted using PubMed and Google Scholar with search terms like "inflammatory bowel disease", "Crohn's disease", "ulcerative colitis", "diet", "IBD treatment", "anti-inflammatory food" and related variations. Articles published within the last five years were prioritized.

Brief description of the state of Knowledge. Ulcerative colitis and Crohn's disease cause gastrointestinal inflammation. Crohn's disease symptoms include abdominal pain, fistulas and

rectal lesions, while UC is characterized by diarrhea, severe discomfort, and blood in the stool. Certain foods often exacerbate IBD symptoms. Proper nutrition during disease stages can improve patients' quality of life. Diets high in processed foods, sugar, and red meat may increase IBD risk, while fiber and vitamin D3 are associated with fewer flare-ups. Regular malnutrition screening is essential for all IBD patients.

Conclusions. Understanding the dietary components that influence inflammation in IBD could lead to better treatment outcomes and longer-lasting symptom relief. Integrating nutrition into personalized treatment strategies should become standard practice for managing IBD.

Keywords: inflammatory bowel disease (IBD), Crohn's disease, ulcerative colitis, diet, IBD treatment, anti-inflammatory food

Introduction and objective

Ulcerative colitis (UC) and Crohn's disease (CD) are both categorized as chronic inflammatory bowel disease (IBD) that share similar symptoms and cause digestive disorders and inflammation within the gastrointestinal tract. The underlying causes of these conditions remain unclear [1]. However, a key environmental factor associated with the onset and progression of IBD is a diet. Increasing evidence suggests that gut dysbiosis, along with an abnormal immune response in susceptible individuals play a significant role. Certain dietary components influence the structure and function of the microbiota, which in turn affects immune activity. These dietary elements can modify the structure and permeability of the mucosal barrier [2, 3]. However, the precise interaction between these factors remains unclear. Nevertheless, it is believed that the western diet, rich in fat and sugar adjectives while being low in fruits and vegetables, contributes to the development of IBD [4]. It is important to remember that dietary restrictions, combined with the clinical complications of IBD, can lead to malnutrition, which is often under-recognized in this patient population. Several factors contribute to malnutrition in patients with IBD, including reduced oral intake, malabsorption, chronic loss of blood and proteins, and intestinal bacterial overgrowth [5]. Poor nutritional status, along with selective malnutrition or sarcopenia, is linked to adverse clinical outcomes, diminished therapeutic response, and a lower quality of life [6]. For this reason, nutrition in IBD patients plays a major role in the lives of IBD patients, but the role of diet in their course is often underestimated [5]. Given the growing societal concern over the increasing incidence of IBD, along with their chronic and relapsing nature, the role of an appropriate diet, which may influence symptom alleviation or exacerbation, becomes a crucial issue for patients, their

families, and the clinicians treating them. Therefore, the aim of this literature review is to analyze the available dietary strategies used in the management of IBD patients, including an assessment of recommendations for their practical application and the impact of the foods involved on both nutritional status and potential disease flare-ups.

Methods

The literature review was conducted through the electronic databases PubMed and Google Scholar, using key search terms such as "inflammatory bowel disease", "Crohn's disease", "ulcerative colitis", "diet", "IBD treatment", "anti-inflammatory food", and related variations. The focus was on clinical trials, double-blind randomized controlled trials, meta-analyses, systematic reviews, and other review articles, particularly those published in the past five years. Case reports were not included in the review. Additionally, the review integrates the guidelines from the European Society for Clinical Nutrition and Metabolism (ESPEN).

State of knowledge

Differences between ulcerative colitis and Crohn's disease. Ulcerative colitis and Crohn's disease cause digestive disorders and inflammation in the gastrointestinal tract. Despite many differences, both conditions share bowel symptoms that occur in 25-40% of patients with IBD [7]. Some of the most common symptoms of Crohn's disease and ulcerative colitis include:

1. Diarrhea
2. Abdominal pain
3. Rectal bleeding
4. Weight loss

Crohn's disease is primarily associated with abdominal pain and complications such as fistulas and rectal lesions [8]. In contrast, individuals with ulcerative colitis typically experience intermittent pain that correlates with bowel movements [1]. UC is characterized by blood in the stool, severe pain, and diarrhea, whereas CD can lead to severe bleeding in selected cases. Rectal bleeding is less common in CD, while it is a frequent symptom of UC [8]. More than 50% of individuals with CD experience deficiencies in folate and vitamin D, while over 50% of those with UC suffer from iron deficiency [9]. According to the European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines, treatment of iron deficiency (parenterally, if necessary) is strongly recommended [10]. Crohn's disease often affects the ileum and a part of the large intestine, but it can involve any part of the

gastrointestinal tract, including the mouth, esophagus, stomach, small intestine, rectum, and anus. In CD, the small intestine often becomes inflamed. In contrast, ulcerative colitis is limited to the colon, primarily affecting certain areas of the large intestine, including colon and rectum [1,11]. In UC, the large intestine becomes inflamed while the small intestine functions normally. Symptoms can range from mild to severe and may pose a significant threat to life [12].

Malnutrition. Malnutrition is particularly prevalent in CD, as the small intestine, which is crucial for nutrient absorption, is often damaged by this disease [13]. Patients with inflammatory bowel disease may experience symptomatic intestinal stenosis, which makes it difficult for them to tolerate fibrous plant foods, such as raw fruits and vegetables, due to their texture. Processing these foods to a softer, less fibrous consistency can help individuals with inflammatory bowel disease and intestinal strictures incorporate a wider variety of plant foods and fiber into their diets [14]. Since relapsing inflammatory disorders of the digestive tract typically manifest during adolescence and early adulthood, all patients with inflammatory bowel disease should receive regular screening for malnutrition. Screening involves evaluating signs and symptoms such as unintended weight loss, edema, fluid retention, and loss of fat and muscle mass. If these signs are identified, a more thorough evaluation for malnutrition by a clinical dietitian is needed [5,10].

Nutrition in inflammatory bowel disease. IBD patients often experience discomfort from eating certain foods. The study of diet is complex because the diet consists of many foods and nutrients. Products consumed in different combinations and amounts can interact with each other [15]. Therefore, there is not just one recommendation, as most dietary studies are prone to bias [2]. During exacerbations, a low-fiber diet is generally recommended for most individuals [17,19]. Different types of diets potentially used in IBD are presented in Table 1.

Table 1. Types of diet potentially used in the treatment of IBS.

Type of diet	**Description**
GrAID - The Groningen Anti-Inflammatory Diet	GrAID Includes lean meats, eggs, fish, plain dairy (such as milk, yogurt, and hard cheeses), fruits, vegetables, wheat, coffee, tea, and honey. It is recommended to limit red meat, other dairy products, and sugar, while avoiding canned and processed foods, alcohol, and sweetened beverages [4].

Mediterranean	A Mediterranean diet contains high consumption of olive oil, legumes, grains, vegetables, fruits, nuts, and seeds. Moderate consumption of fish, poultry, dairy foods and low consumption of processed foods, red, and processed meats [17,23].
IBD-AID (Anti-Inflammatory Diet)	The Anti-Inflammatory Diet that restricts the intake of certain carbohydrates, emphasizes the consumption of pre- and probiotic foods, and modifies dietary fatty acids, showcasing its potential as an adjunct dietary therapy for the treatment of IBD [22].
SCD - Specific Carbohydrate Diet	In the Specific Carbohydrate Diet all grains, all sugars except honey, all dairy products except for hard cheese and yogurt fermented for over 24 hours, as well as most processed foods are excluded. It also limits the intake of complex carbohydrates [23].
CDED - Crohn's disease exclusive diet	CDED includes avoidance of foods negatively impacting the microbiome and barrier integrity, means that for example the meat, dairy products, wheat and gluten, processed food is not allowed. Whole foods diet in conjunction with partial enteral nutrition [24].
UCED - Ulcerative Colitis Exclusion Diet	UCED is a low-protein, low-fat, high-fiber, and additive-eliminating diet [18].
Low-FODMAP (FODMAPs - Fermentable, Oligo-, Di-, Mono -saccharides And Polyols)	Low-FODMAP is a diet with poorly absorbed, short-chain carbohydrates. FODMAPs can trigger gastrointestinal symptoms by rapidly fermenting in the gut, producing gas through bacterial activity, and by drawing additional fluid into the large intestine due to their osmotic effect [25,26].

Chiba et al. demonstrated that a semi-vegetarian diet was more effective in maintaining remission in patients with Crohn's disease compared to an omnivorous diet. [16]. A diet low in red and processed meat (animal fat) may also help reduce exacerbations of ulcerative colitis [14]. Most scientific studies tend to support the Mediterranean diet, which includes moderate amounts of meat while being rich in plant-based foods and promoting health [14,17,18]. A Mediterranean diet that is rich in a variety of fresh fruits and vegetables, monounsaturated fats, complex carbohydrates, and lean proteins, while low in ultra-processed foods, added sugars and salt is recommended for overall health [18]. Several studies have been conducted on the Mediterranean diet. Papada et al. found that greater adherence to the Mediterranean diet was

associated with clinical remission, improved quality of life, and reduced disease activity in 86 patients with Crohn's disease [19]. Furthermore, Chicco et al. observed benefits of this diet in 142 adult patients with both Crohn's disease and ulcerative colitis. After following the diet for six months, significant improvements were shown in body mass index (BMI), waist circumference, liver steatosis, disease activity, CRP levels, fecal calprotectin, and overall quality of life [20]. Lewis et al. in their multicenter study compared the Mediterranean diet and SCD in patients in CD remission. There were no differences in symptomatic remission between SCD and MD, but both significantly improved from baseline. Although, objective evidence was lacking, the study concluded that the Mediterranean diet may be a more appealing option for achieving symptomatic remission in patients with Crohn's disease, as it is easier to follow and can be more readily integrated into existing dietary habits compared to the Specific Carbohydrate Diet (SCD) [23]. Appropriate nutrition during specific periods of the disease can improve patients' quality of life [19,20,23].

Table 2. Products and their impact on the condition of the disease in several known IBD diets [2,4,17,18,22,23,24,25].

Main products	**Impact on dietary component**	**Recommendations**
Meat (red and processed meat)	- Excellent source of protein, iron and vitamin B12. - Meat contains saturated fat. According to some studies a saturated fatty acid is associated with increased risk of a flare. - Meat and processed meat contain high levels of organic sulphur and sulphate additives, which has detrimental effects on the colonic microenvironment	- In the CDED diet, an exclusion diet given to patients with CD who have flares, red meat is not allowed. - In GrAID, Mediterranean, IBD-AID it should be limited. - In SCD and low-FODMAP consumption of meat is allowed.
Fish	- Fish oil is rich in long-chain n-3 polyunsaturated fatty acids (PUFAs), including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which have shown anti-	- Fish consumption is allowed in most diets.

	inflammatory effects in IBD.	
Dairy products	- An important source of protein, riboflavin, and the main dietary source of calcium. - If the patient has lactase deficiency, then the food may cause bloating and/or diarrhea.	- In the CDED, dairy products are prohibited, in the IBD-AID and Low FODMAP diet they are allowed in limited amounts. - The SCD eliminates all milk products except for hard cheeses and fermented yogurt.
Fruits	- Besides sugars, fresh fruits are typically high in fiber and vitamin C (an antioxidant). - Fruits also contain phenolic acids, which are absorbed through the intestinal wall and may offer potential antioxidant and anti-inflammatory benefits.	- Apples are not allowed to consume in low FODMAP diet, and in general in this type of diet fruits should be limited. - Fruits are allowed in other diets
Vegetables	- Vegetables contain dietary fibres and are an important source of antioxidant vitamins A, C and E, minerals, trace elements and phenolic compounds. - The anti-inflammatory properties of these phenolic compounds can serve as a natural means of preventing IBD.	- Vegetables are allowed in all diets except low-FODMAP, where they should be limited. - In addition, in the CDED diet, daily consumption of potatoes is mandatory.
Cereals (wheat)	- Wheat can trigger GI symptoms GI such as bloating, abdominal pain and diarrhoea	- In the IBD-AID, SCD diet and CDED diet wheat and gluten consumption is not allowed.

Canned and processed food	- Apart from added sugar and salt, processed foods often contain emulsifiers. - Most of them potentially have detrimental effects within the whole gastrointestinal tract.	- The SCD eliminates most processed foods. - Processed foods are also not allowed in the CDED, IBD-AID and low FODMAP diet.

Diet during disease exacerbation and remission. IBD comprises chronic conditions with an etiology that is not yet fully understood, characterized by cycles of exacerbation and remission. During periods of IBD exacerbations, when the severity of diarrhea is high, a liquid diet is used, followed by a semi-liquid diet [17,18]. Exclusive enteral nutrition, employing liquid nutrition formulations, is an effective treatment for inducing clinical remission and endoscopic response in Crohn's disease, with stronger evidence supporting its use in children compared to adults. Additionally, exclusive enteral nutrition may be considered a steroid-sparing bridge therapy for patients with Crohn's disease [14]. However, dietary recommendations for patients in IBD remission remain unclear. Based on scientific publications on a variety of diets, it seems that the use of diets with “anti-inflammatory properties” can be considered in maintaining remission [17,19,22]. According to Zallot et al, as many as two-thirds of patients with IBD follow elimination diets during remission to avoid disease exacerbations, which affects their lives [27]. Nevertheless, patients do not have clear guidelines on what they should eliminate from their diets. The National Clinical Guideline Center recommends a varied and well-balanced diet for patients with CD but it does not provide specific details regarding the composition of the diet [28]. What has been shown to be significant is that a deficiency in vitamin D may exacerbate the progression of IBD and is also linked to an elevated mortality rate [19,29,30,31]. Given the increasing popularity of vitamin D in recent years in studies not only related to IBS and CD, but also assessing its potential role in the pathophysiology of other immune-mediated diseases, further research may be necessary to definitively establish its function [32,33].

Conclusions

Despite the increasing awareness among patients and doctors regarding the significance of diet as a therapeutic approach for inflammatory bowel disease, there is still a need to highlight its importance. Understanding the specific dietary components that may have pro-

inflammatory or anti-inflammatory effects in the context of IBD could potentially lead to improved treatment outcomes and prolonged symptom reduction.

A diet high in sugar, red meat, and processed foods may elevate the risk of developing IBD. On the other hand, dietary factors such as fiber and vitamin D3 have been associated with reduced risk of disease flares. Regular screening for malnutrition is crucial for all individuals with IBD, especially given that these conditions often arise in adolescence and early adulthood.

Research shows that integrating diet as both a preventative and therapeutic measure in personalized treatment plans for patients with IBD should be a standard consideration. Individualized characteristics play a key role in achieving optimal disease management and limiting adverse effects. A multidisciplinary approach to evaluating and managing patients with IBD is recommended, with nutritional strategies tailored to each individual. Given the growing issue of increased incidence of IBD, selecting an appropriate diet for patients to ensure not only symptom stabilization but also adequate nutritional support has become one of the key challenges for clinicians managing conditions such as Crohn's disease and ulcerative colitis. Due to varying opinions within the scientific community regarding the optimal diet for individuals with IBD, there remains a need for further multidisciplinary research, including double-blind trials, to definitively determine the most beneficial treatment approach for the patients.

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Conceptualization: MZ, AN, MK

Methodology: MZA, GB

Software: GB, AN

Check: PN, WP, MZA

Formal analysis: WP, MZ, MK

Investigation: AN, MZ, GB

Resources: AN, PN, KJ

Data curation: WP, AN, KJ

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References

1. Seyedian SS, Nokhostin F, Malamir MD. A review of the diagnosis, prevention, and treatment methods of inflammatory bowel disease. *J Med Life*. 2019;12(2):113-122. doi:10.25122/jml-2018-0075
2. Wark G, Samocha-Bonet D, Ghaly S, Danta M. The Role of Diet in the Pathogenesis and Management of Inflammatory Bowel Disease: A Review. *Nutrients*. 2020;13(1):135. Published 2020 Dec 31. doi:10.3390/nu13010135
3. Gentschew L, Ferguson LR. Role of nutrition and microbiota in susceptibility to inflammatory bowel diseases. *Mol Nutr Food Res*. 2012;56(4):524-535. doi:10.1002/mnfr.201100630
4. Campmans-Kuijpers MJE, Dijkstra G. Food and Food Groups in Inflammatory Bowel Disease (IBD): The Design of the Groningen Anti-Inflammatory Diet (GrAID). *Nutrients*. 2021;13(4):1067. Published 2021 Mar 25. doi:10.3390/nu13041067
5. Balestrieri P, Ribolsi M, Guarino MPL, Emerenziani S, Altomare A, Cicala M. Nutritional Aspects in Inflammatory Bowel Diseases. *Nutrients*. 2020;12(2):372. Published 2020 Jan 31. doi:10.3390/nu12020372
6. Einav L, Hirsch A, Ron Y, et al. Risk Factors for Malnutrition among IBD Patients. *Nutrients*. 2021;13(11):4098. Published 2021 Nov 16. doi:10.3390/nu13114098
7. Bernstein CN. Extraintestinal manifestations of inflammatory bowel disease. *Curr Gastroenterol Rep*. 2001;3(6):477-483. doi:10.1007/s11894-001-0068-6
8. Veauthier B, Hornecker JR. Crohn's Disease: Diagnosis and Management. *Am Fam Physician*. 2018;98(11):661-669.
9. Burgmann T, Clara I, Graff L, et al. The Manitoba Inflammatory Bowel Disease Cohort Study: prolonged symptoms before diagnosis--how much is irritable bowel

syndrome? *Clin Gastroenterol Hepatol*. 2006;4(5):614-620. doi:10.1016/j.cgh.2006.03.003

10. Bischoff SC, Escher J, Hébuterne X, et al. Guía ESPEN: Nutrición clínica en la enfermedad inflamatoria intestinal [ESPEN guideline: Clinical nutrition in inflammatory bowel disease]. *Nutr Hosp*. 2022;39(3):678-703. doi:10.20960/nh.03857
11. Guan Q. A Comprehensive Review and Update on the Pathogenesis of Inflammatory Bowel Disease. *J Immunol Res*. 2019;2019:7247238. Published 2019 Dec 1. doi:10.1155/2019/7247238
12. Baumgart DC, Sandborn WJ. Inflammatory bowel disease: clinical aspects and established and evolving therapies. *Lancet*. 2007;369(9573):1641-1657. doi:10.1016/S0140-6736(07)60751-X
13. Hugot JP, Alberti C, Berrebi D, Bingen E, Cézard JP. Crohn's disease: the cold chain hypothesis. *Lancet*. 2003;362(9400):2012-2015. doi:10.1016/S0140-6736(03)15024-6
14. Hashash JG, Elkins J, Lewis JD, Binion DG. AGA Clinical Practice Update on Diet and Nutritional Therapies in Patients With Inflammatory Bowel Disease: Expert Review. *Gastroenterology*. 2024;166(3):521-532. doi:10.1053/j.gastro.2023.11.303
15. Christensen C, Knudsen A, Arnesen EK, Hatlebakk JG, Sletten IS, Fadnes LT. Diet, Food, and Nutritional Exposures and Inflammatory Bowel Disease or Progression of Disease: an Umbrella Review. *Adv Nutr*. 2024;15(5):100219. doi:10.1016/j.advnut.2024.100219
16. Chiba M, Abe T, Tsuda H, et al. Lifestyle-related disease in Crohn's disease: relapse prevention by a semi-vegetarian diet. *World J Gastroenterol*. 2010;16(20):2484-2495. doi:10.3748/wjg.v16.i20.2484
17. Owczarek D, Rodacki T, Domagała-Rodacka R, Cibor D, Mach T. Diet and nutritional factors in inflammatory bowel diseases. *World J Gastroenterol*. 2016;22(3):895-905. doi:10.3748/wjg.v22.i3.895
18. Radziszewska M, Smarkusz-Zarzecka J, Ostrowska L, Pogodziński D. Nutrition and Supplementation in Ulcerative Colitis. *Nutrients*. 2022;14(12):2469. Published 2022 Jun 14. doi:10.3390/nu14122469
19. Papada E, Amerikanou C, Forbes A, Kaliora AC. Adherence to Mediterranean diet in Crohn's disease. *Eur J Nutr*. 2020;59(3):1115-1121. doi:10.1007/s00394-019-01972-z
20. Chicco F, Magrì S, Cingolani A, et al. Multidimensional Impact of Mediterranean Diet on IBD Patients. *Inflamm Bowel Dis*. 2021;27(1):1-9. doi:10.1093/ibd/izaa097

21. Lewis JD, Abreu MT. Diet as a Trigger or Therapy for Inflammatory Bowel Diseases. *Gastroenterology*. 2017;152(2):398-414.e6. doi:10.1053/j.gastro.2016.10.019
22. Olendzki BC, Silverstein TD, Persuitte GM, Ma Y, Baldwin KR, Cave D. An anti-inflammatory diet as treatment for inflammatory bowel disease: a case series report. *Nutr J*. 2014;13:5. Published 2014 Jan 16. doi:10.1186/1475-2891-13-5
23. Lewis JD, Sandler RS, Brotherton C, et al. A Randomized Trial Comparing the Specific Carbohydrate Diet to a Mediterranean Diet in Adults With Crohn's Disease [published correction appears in Gastroenterology. 2022 Nov;163(5):1473. doi: 10.1053/j.gastro.2022.07.058]. *Gastroenterology*. 2021;161(3):837-852.e9. doi:10.1053/j.gastro.2021.05.047
24. Sigall Boneh R, Westoby C, Oseran I, et al. The Crohn's Disease Exclusion Diet: A Comprehensive Review of Evidence, Implementation Strategies, Practical Guidance, and Future Directions. *Inflamm Bowel Dis*. 2024;30(10):1888-1902. doi:10.1093/ibd/izad255
25. Gearry RB, Irving PM, Barrett JS, Nathan DM, Shepherd SJ, Gibson PR. Reduction of dietary poorly absorbed short-chain carbohydrates (FODMAPs) improves abdominal symptoms in patients with inflammatory bowel disease-a pilot study. *J Crohns Colitis*. 2009;3(1):8-14. doi:10.1016/j.crohns.2008.09.004
26. Pedersen N, Ankersen DV, Felding M, et al. Low-FODMAP diet reduces irritable bowel symptoms in patients with inflammatory bowel disease. *World J Gastroenterol*. 2017;23(18):3356-3366. doi:10.3748/wjg.v23.i18.3356
27. Zallot C, Quilliot D, Chevaux JB, et al. Dietary beliefs and behavior among inflammatory bowel disease patients. Inflamm Bowel Dis. 2013;19(1):66-72. doi:10.1002/ibd.22965
28. Tun GS, Cripps S, Lobo AJ. Crohn's disease: management in adults, children and young people - concise guidance. Clin Med (Lond). 2018;18(3):231-236. doi:10.7861/clinmedicine.18-3-231
29. Jørgensen SP, Hvas CL, Agnholt J, Christensen LA, Heickendorff L, Dahlerup JF. Active Crohn's disease is associated with low vitamin D levels. *J Crohns Colitis*. 2013;7(10):e407-e413. doi:10.1016/j.crohns.2013.01.012
30. Vernia F, Valvano M, Longo S, Cesaro N, Viscido A, Latella G. Vitamin D in Inflammatory Bowel Diseases. Mechanisms of Action and Therapeutic Implications. *Nutrients*. 2022;14(2):269. Published 2022 Jan 9. doi:10.3390/nu14020269

31. Wu Z, Liu D, Deng F. The Role of Vitamin D in Immune System and Inflammatory Bowel Disease. J Inflamm Res. 2022;15:3167-3185. Published 2022 May 28. doi:10.2147/JIR.S363840
32. Murdaca G, Tonacci A, Negrini S, et al. Emerging role of vitamin D in autoimmune diseases: An update on evidence and therapeutic implications. *Autoimmun Rev*. 2019;18(9):102350. doi:10.1016/j.autrev.2019.102350
33. Zheng Y, Li ZB, Wu ZY, et al. Vitamin D levels in the assessment of Crohn's disease activity and their relation to nutritional status and inflammation. *J Hum Nutr Diet*. 2023;36(4):1159-1169. doi:10.1111/jhn.13139