KAPLER, Marta, KOTULA, Jacek, MĄSIOR, Magdalena Natalia, ZINKOW, Karolina and GAWLIK, Łukasz Marek. The Role of Dietary Fiber in Gastrointestinal Health: Focus on Irritable Bowel Syndrome and Diverticular Disease. Quality in Sport. 2024;18:53478. eISSN 2450-3118.
https://dx.doi.org/10.12775/QS.2024.18.53478
https://apcz.umk.pl/QS/article/view/53478

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.
Has a Journal's Unique Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.
Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 15.07.2024. Revised: 10.08.2024. Accepted: 10.08.2024. Published: 12.08.2024.

The Role of Dietary Fiber in Gastrointestinal Health: Focus on Irritable Bowel Syndrome and Diverticular Disease

Marta Kapler,
Ludwik Rydygier Specialist Hospital in Kraków, Złotej Jesieni 1 Estate, 31-826 Kraków
https://orcid.org/0009-0008-4973-1396
martakapler@gmail.com

Jacek Kotuła,
St, Anne's Hospital in Miechów, Szpitalna 3, 32-200 Miechów https://orcid.org/0009-0005-5212-2362
jacekkoszat@gmail.com

Magdalena Natalia Mąsior,
Ludwik Rydygier Specialist Hospital in Kraków, Złotej Jesieni 1 Estate, 31-826 Kraków
https://orcid.org/0009-0006-4806-9949
masiormagdalena@gmail.com

Karolina Zinkow,
Gabriel Narutowicz Specialist City Hospital in Kraków, Prądnicka 35, 31-202 Kraków
https://orcid.org/0009-0006-6891-7984
karolina1316@autograf.pl

Łukasz Marek Gawlik
Ludwik Rydygier Specialist Hospital in Kraków, Złotej Jesieni 1 Estate, 31-826 Kraków
https://orcid.org/0009-0001-6485-3622
lgawlik@onet.pl

Corresponding Author
Magdalena Mąsior
Ludwik Rydygier Specialist Hospital in Kraków, Złotej Jesieni 1 Estate, 31-826 Kraków
masiormagdalena@gmail.com

Abstract

Dietary fiber (DF) encompasses a variety of plant-derived carbohydrates resistant to human digestive enzymes, significantly influencing gastrointestinal health. This study examines the role of DF in managing Irritable Bowel Syndrome (IBS) and Diverticular Disease (DD), utilizing comprehensive analysis from PubMed, Google Scholar, and Embase. IBS, affecting 10-20% globally, involves complex brain-gut interactions, motility issues, and microbiota changes. Soluble fiber like psyllium reduces IBS symptoms by improving stool consistency and regulating bowel movements. However, the role of DF in DD is more nuanced. While the reports on the impact on diverticulosis prevalence are contradictory, numerous moderate-quality studies confirmed the protective effect against recurrent diverticulitis and hospitalization. The effect of different fiber types on this matter was not widely explored which might explain the discordances between the studies. Further research is essential to fully understand the diverse effects of different types of DF on gastrointestinal (GI) health. This way, exhaustive guidelines specific to each fiber type and disease phenotype could be developed, allowing to tailor the dietary recommendations to each patient, optimizing the management of symptoms of IBS and DD, and improving the quality of life.

Keywords: Irritable Bowel Syndrome (IBS), dietary fiber, Diverticular Disease (DD), soluble fiber, insoluble fiber

Introduction

Dietary fiber (DF) constitutes a group of various plant-derived carbohydrates that are resistant to human digestive enzymes. The definition of DF has evolved significantly over the past century. Initially, DF was recognized primarily for its role in promoting gastrointestinal (GI) health through its mechanical effects on bowel movements. British physician Eban Hipsley formally introduced the term "dietary fiber" in 1953 to describe the indigestible components of plant cell walls [1, 2].

In the 1970s, Trowell and colleagues expanded this definition to include the non-starch polysaccharides (NSPs) that make up plant cell walls, such as cellulose, hemicellulose, and lignin, emphasizing their resistance to digestion by human enzymes [3, 4]. Modern definitions of DF are more comprehensive, considering both the chemical composition and physiological effects of these fibers. The Codex Alimentarius Commission has provided a definition that includes all digestion-resistant carbohydrates with a degree of polymerization (DP) of three or higher. This definition helps fill the "fiber gap" by including short-chain carbohydrates previously excluded due to their solubility characteristics [5].

DF is now understood to play significant roles in human health, including the modulation of gut microbiota, enhancement of stool consistency, and regulation of metabolic functions [3, 4]. Therefore, its role in clinical outcomes in the most common GI diseases is worth exploring.

Aim of the Study

The aim of this study is to critically evaluate the role of DF in managing Irritable Bowel Syndrome (IBS) and Diverticular Disease (DD). By examining existing research, the study seeks to clarify the efficacy of different types of DF in improving symptoms and preventing complications associated with these GI disorders.

Methods

Comprehensive research and analysis of literature available on PubMed, Google Scholar, Scopus, and Embase were performed. These databases were searched using the following keywords: "dietary fiber," "Irritable Bowel Syndrome," "IBS," "Diverticular Disease," "diverticulosis," "diverticulitis," "soluble fiber," "insoluble fiber," and "gastrointestinal health." Peer-reviewed studies, including randomized controlled trials, systematic reviews, and observational studies, were included to ensure a high-quality evaluation. Statistical measures such as relative risk (RR) and confidence intervals (CI) were employed to assess the efficacy of fiber interventions.

Types and Classification of Dietary Fiber

Dietary fibers are broadly categorized based on their solubility in water, chemical structure, and functional properties, including prebiotic effects. Understanding these classifications helps explain their various roles and benefits in nutrition and health.

Solubility-Based Classification

Soluble Dietary Fiber dissolves in water to form viscous gels. Examples of soluble fibers include pectins found in fruits, inulin, beta-glucans in oats and barley, guar gum, mucilages, and some hemicelluloses.

Insoluble Dietary Fiber does not dissolve in water and primarily consists of cellulose, lignin, and certain hemicelluloses. Common sources of insoluble fiber include whole grains, vegetables, and the bran layer of cereals [6].

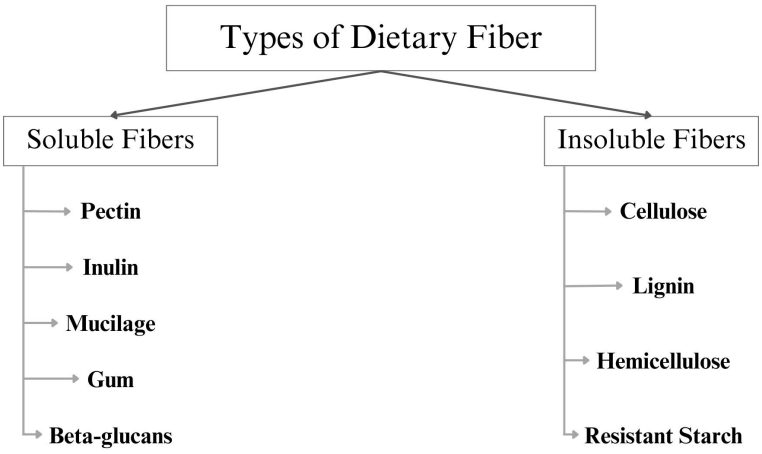

Figure 1. Types of dietary fiber (DF) classified by their solubility

Chemical Structure-Based Classification

Polysaccharides are the most prevalent form of DF, comprising long chains of monosaccharide units. This category includes molecules such as cellulose, hemicellulose, and inulin [7]. Cellulose, a linear polymer of glucose units, is a primary component of plant cell walls and an essential insoluble fiber. Hemicellulose, a heterogeneous group of polysaccharides, varies in its composition and can be either soluble or insoluble depending on its structure [8]. Inulin, a type of fructan and another polysaccharide that serves as a soluble fiber is one of the key examples of prebiotic fiber, with an important effect on the regulation of intestinal microbiota via stimulating the growth of beneficial bacteria. [9,10].

Oligosaccharides consist of shorter chains of monosaccharides, typically ranging from 3 to 10 units [11]. Despite their smaller size, oligosaccharides are classified as DF due to their beneficial physiological effects, particularly their high fermentability [6,12].

Resistant Starch (RS) is a form of starch that resists digestion in the small intestine undergoes fermentation in the large intestine and produces short-chain fatty acids. RS is divided into four types based on its source and structural properties: RS1 (physically inaccessible starch), RS2 (ungelatinized starch granules), RS3 (retrograded starch), and RS4 (chemically modified starch) [9]. RS is categorized as a functional dietary fiber, recently added to this classification by the Food and Nutrition Board of the Institute of Medicine of the National Academics [13,14].

Irritable Bowel Syndrome

IBS is a common functional GI disorder characterized by chronic abdominal pain, bloating, and altered bowel habits, including constipation, diarrhea, or both [15]. Globally, the prevalence of IBS varies between 10-20%, making it a significant health concern [16,17]. The exact pathophysiology of IBS remains unclear but is believed to involve a complex interplay between the brain-gut axis, gastrointestinal motility disturbances, intestinal permeability, visceral hypersensitivity, and alterations in the gut microbiota [18,19]. Psychological factors such as stress and anxiety can exacerbate symptoms, contributing to the chronic nature of the disorder [20].

Role of Different Fiber Types in Managing IBS Symptoms

DF plays a crucial role in managing IBS symptoms, although its impact varies depending on the type of fiber consumed. Beneath, the impact of the different types of DF is discussed and compared.

Soluble Fiber

Soluble fibers like psyllium, also referred to as ispaghula, oats, and pectins dissolve in water to form viscous gels, which can slow digestion and improve stool consistency, which has been shown to be particularly beneficial in reducing IBS symptoms. This type of fiber can make stools softer and easier to pass in cases of constipation, while also adding bulk and firmness in cases of diarrhea, thus normalizing intestinal motility, reducing bloating, and making stools more consistent and well-formed [21,22]. Soluble fibers are effective in both IBS with constipation (IBS-C) and IBS with diarrhea (IBS-D) by normalizing bowel movements and reducing discomfort [23]. A randomized placebo controlled trial demonstrated that psyllium significantly improved symptoms in patients with IBS, with 57% of patients reporting adequate symptom relief compared to 35% in the placebo group ($P < 0.05$) [24]. Another clinical trial showed that 82% of patients receiving ispaghula and 53% of the placebo group evaluated the treatment as satisfactory ($P < 0.02$) [25]. Furthermore, a systematic review and meta-analysis by Moayyedi et al. (2014) highlighted that soluble fiber, particularly psyllium, significantly reduced IBS symptoms compared to placebo (RR = 0.83; 95 %CI 0.73 – 0.94 with an NNT = 7; 95 % CI 4 – 25) [26].

Insoluble Fiber

In contrast, insoluble fiber, such as wheat bran, is generally not recommended for IBS management. Insoluble fibers can increase stool bulk and speed up transit time, which may exacerbate symptoms, particularly in patients with IBS-D. A study found that while insoluble fiber increased stool frequency, it did not significantly improve other IBS symptoms and could deteriorate bloating and abdominal pain [27]. According to a clinical trial by Bijkerk et al. (2009), psyllium improved global symptoms of IBS more effectively than bran or placebo, suggesting that soluble fiber, rather than insoluble fiber, should be the first line of dietary intervention for IBS patients [24].

Prebiotic Fiber

Prebiotic fiber, such as inulin and fructo-oligosaccharides, promotes the growth of beneficial gut bacteria, potentially improving gut health and reducing IBS symptoms. However, the fermentation of these fibers can produce gas and exacerbate bloating in some patients. A systematic review concluded that while prebiotics can benefit gut health, their use in IBS should be personalized due to variable tolerance among patients [28]

Diverticular Disease

DD includes a spectrum of conditions related to the formation of diverticula, small bulging pouches in the lining of the digestive tract, predominantly in the colon. This disease includes asymptomatic diverticulosis and diverticulitis, an inflammatory condition of the diverticula. This condition is one of the most common diagnoses of GI disorders in the United States [29]. DD is widely considered a disease of the elderly [30]. The prevalence of DD increases with age, affecting approximately 10% of people aged less than 40 years and increasing up to more than 70% in people aged more than 80 years in Western countries [31]. The pathophysiology of DD is not understood completely. Many factors have been considered to contribute to its pathogenesis including increased intraluminal pressure, often associated with a low-fiber diet, obesity, and physical inactivity as well as genetic predisposition, which leads to mucosal herniation through weak points in the colonic wall [32,33]. Risk factors include aging, arterial hypertension, alcohol use, low dietary fiber intake, obesity, and increased red meat intake [34,35,36].

Role of Different Fiber Types in Managing Diverticular Disease

Historically, a high-fiber diet, particularly rich in insoluble fiber, was believed to lower the risk of DD by increasing stool bulk and decreasing intraluminal pressure [37,38]. Recent studies indicate that these benefits might be overestimated [39]. Many studies support this view, indicating that high fiber intake is associated with a lower risk of symptomatic DD [40]. For example, Crowe et al, 2011 found in their prospective cohort study that participants with the highest DF intake (≥25.5 g/day for women and ≥26.1 g/day for men) had a 38% lower risk (RR: 0.62, 95% CI: 0.47-0.82, P<0.001) compared to those with the lowest intake (<14 g/day for both women and men) [41]. However, the reliability of the benefit of fiber intake is still discussed. The systematic review performed by Ünlü et al. in 2011 concluded that fiber intake is protective against recurrent diverticulitis, however, the evidence is of moderate quality, and higher-quality studies are required. The review also emphasized the significance of the placebo effect [42]. Nevertheless, a recent review reported a persistent lack of high-quality data, while still confirming the protective effect of DF against diverticulitis [43]. However, a trial by Peery et al. found that high fiber intake did not reduce the prevalence of diverticulosis; in fact, those with the highest fiber intake had a greater prevalence of diverticulosis compared to those with the lowest intake (PR = 1.30; 95% CI 1.13-1.50) [44].

Insoluble Fiber

Insoluble fiber, such as wheat bran, has traditionally been recommended to increase stool bulk. However, some studies have found limited benefits. For example, a controlled clinical trial by Ornstein and Littlewood showed a significant increase in stool frequency and improved consistency for all fiber types including bran (insoluble fiber). However, there were no significant differences between the active treatment and placebo [45].

Soluble Fiber

Soluble fiber, such as psyllium is recommended for preventing future flare-ups once the acute period resolves [46]. In the previously mentioned study by Ornstein and Littlewood, Ispaghula husk has been shown to improve symptoms in patients with DD to a greater degree than insoluble fiber [45], although its pharmacological mechanism remains unclear. Thorburn et al. discovered using radiotelemetry that ispaghula husk reduces the transit time from mouth to rectum [47].

Prebiotic Fiber

Prebiotic fibers, such as inulin and fructo-oligosaccharides, have shown promise in managing diverticular disease by selectively stimulating the growth of beneficial gut bacteria, such as Bifidobacterium, which play an important role in maintaining intestinal integrity and reducing inflammation. By enhancing the gut microbiota composition, prebiotic fibers can help improve symptoms associated with diverticulitis and prevent the recurrence of diverticulosis [48].

Sources of Fiber

The effectiveness of fiber in managing DD symptoms also depends on the type and source of fiber. The prospective study of UK women by Crowe et al. showed a statistically significant reduced risk of DD with increasing intake of DF, with notable diversity by the main sources of fiber. Significant reductions in risk were only associated with intakes of fruit and cereal fiber, with relative risks, adjusted for each of the other sources of DF: for cereal, it reached 0.84 (0.81 to 0.88) per 5 g/day, for fruit 0.81 (0.77 to 0.86) per 5 g/day [49].

There is ongoing debate about whether nuts and seeds should be excluded from the diet to prevent symptoms or complications of DD. Traditionally, clinicians have advised against consuming nuts, seeds, corn, hulls, and popcorn [50]. However, there is no scientific evidence to support this advice. In fact, recent studies indicate that these dietary restrictions may not be necessary. The Health Professionals Follow-up Study is a cohort of US men by Strate et al. found no link between corn consumption and diverticulitis, nor between the intake of nuts, corn, or popcorn and diverticular hemorrhage or uncomplicated diverticulitis. Interestingly, an inverse relationship was observed, indicating that consuming nuts ([HR 0.80; 95% CI, 0.63-1.01) and popcorn (HR 0.72; 95% CI, 0.56-0.92) may actually reduce the risk of developing diverticulitis, suggesting a protective effect [51].

Table 1. Summary of beneficial and harmful effects of different DF types on IBS and DD

	Insoluble Fiber	Soluble Fiber	Prebiotic Fiber
IBS	−/+ Increases stool bulk and frequency but may worsen bloating and abdominal pain. − Can exacerbate symptoms, particularly in IBS-D; usually not recommended.	+ Reduces symptoms by improving stool consistency and regulating bowel movements in IBS-C and IBS-D.	+ Promotes growth of beneficial gut bacteria, potentially improving gut health and symptoms. − Fermentation may cause gas and bloating in some patients.
DD	−/+ Historically recommended to increase stool bulk, but benefits are moderate. − Some studies show limited improvement in symptoms.	+ Helps prevent flare-ups post the acute phase. + Reduces transit time through GI tract.	+ Enhances gut microbiota composition; can improves symptoms and prevents recurrence of diverticulosis.

IBS = Irritable Bowel Syndrome; DD = Diverticular Disease; GI = Gastrointestinal; DF = Dietary Fiber

Conclusion

The role of DF in GI health is both significant and complex, particularly concerning IBS and DD. Soluble fiber like psyllium has shown consistent benefits regarding IBS symptoms, by improving stool consistency and regulating bowel movements. This makes soluble fiber a key component in dietary strategies for IBS, helping to improve both constipation and diarrhea.

In contrast, the role of fiber in DD is more nuanced. While previously considered beneficial in diverticulosis, the effects vary in terms of the different aspects of the disease. The available data indicates benefits regarding recurrent diverticulitis and the likelihood of hospitalization. Multiple moderate-quality studies have confirmed its role in reducing the recurrence of diverticulitis, although findings on its impact on diverticulosis prevalence are inconsistent. The differences in these findings may be due to the limited exploration of the effects of different types of DF, which could account for the discordances observed across various studies.

Detailed and high-quality research on specific DF types and their effects on individual clinical outcomes is essential. This will facilitate the development of comprehensive, up-to-

date guidelines that take into consideration the unique characteristics of DF components and DD and IBS phenotypes. Consequently, revised dietary recommendations would enable healthcare providers to offer personalized dietary recommendations, ultimately optimizing symptom management and improving the quality of life for patients.

Disclosures:

Author's contribution:

Conceptualization: Marta Kapler, Magdalena N. Mąsior

Methodology: Łukasz Gawlik, Jacek Kotuła, Marta Kapler

Formal analysis: Karolina Zinkow, Magdalena N. Mąsior

Investigation: Jacek Kotuła, Łukasz Gawlik, Karolina Zinkow

Resources: Magdalena N. Mąsior, Marta Kapler, Łukasz Gawlik

Data Curation: Jacek Kotuła, Karolina Zinkow

Writing - rough preparation: Marta Kapler, Magdalena N. Mąsior

Writing - review and editing: Jacek Kotuła, Łukasz Gawlik, Karolina Zinkow

Visualization: Marta Kapler

Supervision: Magdalena N. Mąsior, Marta Kapler, Łukasz Gawlik, Jacek Kotuła, Karolina Zinkow

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

Funding statement:

The study did not receive special funding.

Institutional review board statement:

Not applicable.

Informed consent statement:

Not applicable.

Data availability statement:

Not applicable.

Conflict of interest:

The authors declare no conflict of interest.

References

1. Dai, F.-J., & Chau, C.-F. (2017). Classification and regulatory perspectives of dietary fiber. *Journal of Food and Drug Analysis*, 25(1), 37-42. doi: 10.1016/j.jfda.2016.09.006.
2. Definitions, regulations, and new frontiers for dietary fiber and whole grains. (2020). *Nutrition Reviews*, 78(Supplement_1), 6-12. doi: 10.1093/nutrit/nuz085.
3. Evolution of a Definition for Dietary Fiber and Methodology to Service This Definition. (2017). *FAO/WHO Codex Alimentarius*. Available from: FAO.
4. Stephen, A. M., Champ, M. M., Cloran, S. J., Fleith, M., van Lieshout, L., Mejborn, H., & Burley, V. J. (2017). Dietary fibre in Europe: current state of knowledge on definitions, sources, recommendations, intakes and relationships to health. *Nutrition Research Reviews*, 30(2), 149-190. doi: 10.1017/S095442241700004X.
5. Jones, J. M. (2014). CODEX-aligned dietary fiber definitions help to bridge the 'fiber gap'. *Nutrition Journal*, 13(34). doi: 10.1186/1475-2891-13-34.
6. Holesh, J. E., Aslam, S., & Martin, A. (2021). Carbohydrates. In *StatPearls*. StatPearls Publishing. Available from: StatPearls.
7. Li, Y. O., & Komarek, A. R. (2017). Dietary fibre basics: Health, nutrition, analysis, and applications. *Food Quality and Safety*, 1(1), 47-59. doi: 10.1093/fqsafe/fyx007.
8. Fuentes-Zaragoza, E., Riquelme-Navarrete, M. J., Sánchez-Zapata, E., & Pérez-Álvarez, J. A. (2010). Resistant starch as functional ingredient: A review. Food Research International, 43(4), 931–942. doi:10.1016/j.foodres.2010.02.004
9. Chawla, R., & Patil, G. R. (2010). Soluble dietary fiber. *Comprehensive Reviews in Food Science and Food Safety*, 9(2), 178-196. doi: 10.1111/j.1541-4337.2009.00099.x.
10. Qin YQ, Wang LY, Yang XY, Xu YJ, Fan G, Fan YG, Ren JN, An Q, Li X. Inulin: properties and health benefits. Food Funct. 2023 Apr 3;14(7):2948-2968. doi: 10.1039/d2fo01096h.
11. Blackwood AD, Salter J, Dettmar PW, Chaplin MF. Dietary fibre, physicochemical properties and their relationship to health. J R Soc Promot Health. 2000 Dec;120(4):242-7. doi: 10.1177/146642400012000412.
12. Brownlee, I. A. (2011). The impact of dietary fibre intake on the physiology and health of the gut. *Food Hydrocolloids*, 25(2), 238-250. doi: 10.1016/j.foodhyd.2009.11.013.

13. DeVries, J. W. (2003). On defining dietary fibre. Proceedings of the Nutrition Society, 62(01), 37–43. doi:10.1079/pns2002234
14. Trumbo, P., Schlicker, S., Yates, A. A., & Poos, M. (2002). Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein and Amino Acids. Journal of the American Dietetic Association, 102(11), 1621–1630. doi:10.1016/s0002-8223(02)90346-9
15. Bijkerk CJ, de Wit NJ, Stalman WA, Knottnerus JA, Hoes AW, Muris JW. Irritable bowel syndrome in primary care: the patients' and doctors' views on symptoms, etiology and management. Can J Gastroenterol. 2003 Jun;17(6):363-8; quiz 405-6. doi: 10.1155/2003/532138.
16. Schmulson, M. J., & Drossman, D. A. (2017). What Is New in Rome IV. Journal of Neurogastroenterology and Motility, 23(2), 151–163. doi: 10.5056/jnm16214.
17. Lovell, R. M., & Ford, A. C. (2012). Global prevalence of and risk factors for irritable bowel syndrome: a meta-analysis. *Clinical Gastroenterology and Hepatology*, 10(7), 712-721. doi: 10.1016/j.cgh.2012.02.029.
18. Camilleri, M., et al. (2012). Intestinal barrier function in health and gastrointestinal disease. *Neurogastroenterology & Motility*, 24(6), 503-512. doi: 10.1111/j.1365-2982.2012.01921.x.
19. Blackwood AD, Salter J, Dettmar PW, Chaplin MF. Dietary fibre, physicochemical properties and their relationship to health. J R Soc Promot Health. 2000 Dec;120(4):242-7. doi: 10.1177/146642400012000412.
20. Lovell, R. M., & Ford, A. C. (2012). Prevalence of and risk factors for irritable bowel syndrome. *Clinical Gastroenterology and Hepatology*, 10(7), 712-721. doi: 10.1016/j.cgh.2012.02.029.
21. Eswaran, S., Muir, J., & Chey, W. D. (2013). Fiber and Functional Gastrointestinal Disorders. The American Journal of Gastroenterology, 108(5), 718–727. doi: 10.1038/ajg.2013.63.
22. Mehmood MH, Aziz N, Ghayur MN, Gilani AH. Pharmacological basis for the medicinal use of psyllium husk (Ispaghula) in constipation and diarrhea. Dig Dis Sci. 2011 May;56(5):1460-71. doi: 10.1007/s10620-010-1466-0. Epub 2010 Nov 17.
23. Anderson JW, Baird P, Davis RH Jr, Ferreri S, Knudtson M, Koraym A, Waters V, Williams CL. Health benefits of dietary fiber. Nutr Rev. 2009 Apr;67(4):188-205. doi: 10.1111/j.1753-4887.2009.00189.x.

24. Bijkerk, C. J., et al. (2009). Soluble or insoluble fibre in irritable bowel syndrome in primary care? Randomised placebo controlled trial. *BMJ*, 339, b3154. doi: 10.1136/bmj.b3154.
25. Prior A, Whorwell PJ. Double blind study of ispaghula in irritable bowel syndrome. Gut. 1987 Nov;28(11):1510-3. doi: 10.1136/gut.28.11.1510.
26. Moayyedi, P., et al. (2014). The efficacy of fiber in the treatment of irritable bowel syndrome: a systematic review and meta-analysis. *American Journal of Gastroenterology*, 109(9), 1365-1374. doi: 10.1038/ajg.2014.195.
27. Francis CY, Whorwell PJ. Bran and irritable bowel syndrome: time for reappraisal. Lancet. 1994 Jul 2;344(8914):39-40. doi: 10.1016/s0140-6736(94)91055-3.
28. Whelan K. Probiotics and prebiotics in the management of irritable bowel syndrome: a review of recent clinical trials and systematic reviews. Curr Opin Clin Nutr Metab Care. 2011 Nov;14(6):581-7. doi: 10.1097/MCO.0b013e32834b8082.
29. Peery, A. F., et al. (2013). Burden of gastrointestinal disease in the United States: 2012 update. Gastroenterology, 143(5), 1179-1187.e3. doi: 10.1053/j.gastro.2012.08.002.
30. Everhart, J. E., & Ruhl, C. E. (2009). Burden of Digestive Diseases in the United States Part II: Lower Gastrointestinal Diseases. Gastroenterology, 136(3), 741–754. doi:10.1053/j.gastro.2009.01.015
31. Piscopo N, Ellul P. Diverticular Disease: A Review on Pathophysiology and Recent Evidence. Ulster Med J. 2020 Sep;89(2):83-88. Epub 2020 Oct 21.
32. Tursi, A. (2016). Diverticulosis today: unfashionable and still under-researched. Therapeutic Advances in Gastroenterology, 9(1), 213-228. doi: 10.1177/1756283X15621228.
33. Rezapour M, Ali S, Stollman N. Diverticular Disease: An Update on Pathogenesis and Management. Gut Liver. 2018 Mar 15;12(2):125-132. doi: 10.5009/gnl16552.
34. Strate LL. Lifestyle factors and the course of diverticular disease. Dig Dis. 2012;30(1):35-45. doi: 10.1159/000335707. Epub 2012 May 3.
35. Wlodarczyk JR, Yoon D, Owens J, Ershadi S, Lee SW, Cologne KG, Koller SE. Prevalence of and Risk Factors for Incidental Colonic Diverticulosis. J Surg Res. 2022 Dec;280:348-354. doi: 10.1016/j.jss.2022.07.021. Epub 2022 Aug 26.
36. Völkerer A, Wernly S, Semmler G, Flamm M, Aigner E, Datz C, Wernly B. Diverticulosis and cardiometabolic risk factors: a systematic literature review. Int J Colorectal Dis. 2023 Sep 19;38(1):236. doi: 10.1007/s00384-023-04532-4.

37. Everhart, J. E., & Ruhl, C. E. (2009). Burden of Digestive Diseases in the United States Part II: Lower Gastrointestinal Diseases. Gastroenterology, 136(3), 741–754. doi:10.1053/j.gastro.2009.01.015
38. Herrera AF. Medical therapy of colonic diverticular disease. Postgrad Med. 1976 Dec;60(6):107-9. doi: 10.1080/00325481.1976.11708409.
39. Carabotti, M., Annibale, B., Severi, C., & Lahner, E. (2017). Role of Fiber in Symptomatic Uncomplicated Diverticular Disease: A Systematic Review. Nutrients, 9(2), 161. doi:10.3390/nu9020161
40. Hawkins AT, Wise PE, Chan T, Lee JT, Glyn T, Wood V, Eglinton T, Frizelle F, Khan A, Hall J, Ilyas MIM, Michailidou M, Nfonsam VN, Cowan ML, Williams J, Steele SR, Alavi K, Ellis CT, Collins D, Winter DC, Zaghiyan K, Gallo G, Carvello M, Spinelli A, Lightner AL. Diverticulitis: An Update From the Age Old Paradigm. Curr Probl Surg. 2020 Oct;57(10):100862. doi: 10.1016/j.cpsurg.2020.100862. Epub 2020 Jul 18.
41. Crowe, F. L., Appleby, P. N., Allen, N. E., & Key, T. J. (2011). Diet and risk of diverticular disease in Oxford cohort of European Prospective Investigation into Cancer and Nutrition (EPIC): prospective study of British vegetarians and non-vegetarians. BMJ, 343(jul19 4), d4131–d4131. doi:10.1136/bmj.d4131
42. Ünlü, C., Daniels, L., Vrouenraets, B. C., & Boermeester, M. A. (2011). A systematic review of high-fibre dietary therapy in diverticular disease. International Journal of Colorectal Disease, 27(4), 419–427. doi:10.1007/s00384-011-1308-3
43. Carabotti M, Falangone F, Cuomo R, Annibale B. Role of Dietary Habits in the Prevention of Diverticular Disease Complications: A Systematic Review. Nutrients. 2021; 13(4):1288. https://doi.org/10.3390/nu13041288
44. Peery, A. F., Barrett, P. R., Park, D., Rogers, A. J., Galanko, J. A., Martin, C. F., & Sandler, R. S. (2012). A high-fiber diet does not protect against asymptomatic diverticulosis. Gastroenterology, 142(2), 266-272. doi: 10.1053/j.gastro.2011.10.035.
45. Ornstein, M. H., Littlewood, E. R., Baird, I. M., Fowler, J., North, W. R., & Cox, A. G. (1981). Are fibre supplements really necessary in diverticular disease of the colon? A controlled clinical trial. BMJ, 282(6273), 1353–1356. doi:10.1136/bmj.282.6273.1353
46. Wick, J. Y. (2012). Diverticular Disease: Eat Your Fiber! The Consultant Pharmacist, 27(9), 613–618. doi:10.4140/tcp.n.2012.613

47. Thorburn, H. A., Carter, K. B., Goldberg, J. A., & Finlay, I. G. (1992). Does ispaghula husk stimulate the entire colon in diverticular disease? Gut, 33(3), 352–356. doi:10.1136/gut.33.3.352
48. Slavin, J. (2013). Fiber and Prebiotics: Mechanisms and Health Benefits. Nutrients, 5(4), 1417–1435. doi:10.3390/nu5041417
49. Crowe, F. L., Balkwill, A., Cairns, B. J., Appleby, P. N., Green, J., Reeves, G. K., … Beral, V. (2014). Source of dietary fibre and diverticular disease incidence: a prospective study of UK women. Gut, 63(9), 1450–1456. doi:10.1136/gutjnl-2013-304644
50. Schechter S, Mulvey J, Eisenstat TE. Management of uncomplicated acute diverticulitis: results of a survey. Dis Colon Rectum. 1999 Apr;42(4):470-5; discussion 475-6. doi: 10.1007/BF02234169.
51. Strate LL, Liu YL, Syngal S, Aldoori WH, Giovannucci EL. Nut, corn, and popcorn consumption and the incidence of diverticular disease. JAMA. 2008 Aug 27;300(8):907-14. doi: 10.1001/jama.300.8.907.