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COMPARISON OF THE ROLES OF PROBIOTICS, PREBIOTICS, AND SYNBIOTICS IN THE MANAGEMENT OF IRRITABLE BOWEL SYNDROME: A REVIEW OF RECENT EVIDENCE

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ABSTRACT

Irritable bowel syndrome (IBS) is a chronic disorder characterized by recurrent abdominal pain and altered bowel habits. Its heterogeneity has intensified interest in microbiota targeted therapies. This review summarizes evidence published between 2020 and 2024 on the use of probiotics, prebiotics, and synbiotics for the treatment of IBS. The search was limited to English language, full-text studies in humans and used the terms “probiotics”, “prebiotics”, “synbiotics”, “irritable bowel syndrome” and “IBS”. Studies indicate that improvements are strain and formulation specific rather than a class effect. Treatment duration and dose appear critical. Benefits are more likely with interventions lasting at least four weeks and daily doses around $\geq 10^9$ CFU. Signals for global symptom relief have been reported for Escherichia strains and Lactobacillus plantarum 299V, while reductions in abdominal pain have been observed with Saccharomyces cerevisiae CNCM I-3856, Bifidobacterium strains, and Bacillus coagulans. Overall comparisons across studies suggest outcome specific efficacy, with L. acidophilus DDS-1 and B. coagulans strains frequently showing favorable effects on symptom severity, abdominal pain, and stool related outcomes in IBS D. Some data suggest prebiotics can improve defecation frequency in IBS C. In contrast, prebiotics and synbiotics show more variable and product dependent effects. Overall, probiotics appear safe and potentially effective when appropriately selected, but heterogeneity across studies underscores the need for standardized endpoints, subtype stratified analyses, and precise reporting of strain identity, dose, and viability to guide individualized recommendations.

KEYWORDS

Irritable Bowel Syndrome, IBS, Probiotics, Prebiotics, Synbiotics

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Introduction

Irritable bowel syndrome (IBS) is a chronic disorder of gut-brain interaction characterized by recurrent abdominal pain accompanied by alterations in bowel habits and stool form, in the absence of structural or biochemical abnormalities that fully explain the symptoms [1-3]. Clinically, IBS is associated with bloating, abdominal distension, urgency, straining, and a fluctuating symptom course marked by exacerbations and remissions [1]. It is among the most common functional gastrointestinal disorders and represents a substantial burden due to impaired quality of life, reduced work productivity, and increased healthcare utilization [4]. Current diagnostic approaches are symptom based, most aligned with Rome IV criteria, and emphasize a positive diagnosis supported by limited, targeted evaluation to exclude alarm features and alternative organic diseases [5].

IBS is a heterogeneous condition with multifactorial pathophysiology. Proposed mechanisms include altered gastrointestinal motility, visceral hypersensitivity, dysregulated central pain processing, impaired intestinal barrier function, immune activation with low grade inflammation, bile acid malabsorption in a subset of patients, and psychosocial factors such as stress and anxiety [6]. Increasing attention has been directed toward the intestinal microbiome and its metabolic outputs, which may influence mucosal immunity, gut permeability, motility patterns, and signaling along the gut-brain axis. This biological complexity contributes to variability in clinical presentation and treatment response and supports the need for individualized management strategies [5,6].

IBS is commonly subclassified according to the predominant stool pattern, typically using the Bristol Stool Form Scale (BSFS) [7]. The major subtypes include IBS with predominant constipation (IBS C), IBS with predominant diarrhea (IBS D), IBS with mixed bowel habits (IBS M), and unclassified IBS (IBS U) when stool patterns do not consistently meet criteria for the other categories [8,9]. This subtype framework is clinically relevant because symptom drivers and therapeutic priorities often differ across groups, for example, constipation severity and straining in IBS C, urgency, and loose stools in IBS D, or frequent switching between constipation and diarrhea in IBS M. Subtyping is therefore central both to interpreting clinical trial evidence and to selecting and evaluating interventions, including microbiota-targeted approaches such as probiotics, prebiotics, and synbiotics [8-11].

IBS prevalence vary by the specific iteration applied, ranging from 1.1% in studies using Rome I to 3.8% in analyses applying Rome IV [12,13]. Under Rome IV, IBS D emerges as the most frequently reported subtype, accounting for 31.5% of individuals with IBS. Across studies, IBS is also more common in women than in men, with prevalence estimates of 12.0% versus 8.6%, respectively [13].

Methodology

A literature search was conducted in PubMed using the terms “probiotics”, “prebiotics”, “synbiotics”, “irritable bowel syndrome” and “IBS.” The search was restricted to publications in English with full text available and published between 2020 and 2024. Titles and abstracts were screened to identify potentially relevant studies, followed by full-text assessment. Animal studies were excluded.

Results

Goodoory et al. (2023), in an analysis including 10,332 participants, concluded that selected probiotic preparations may be beneficial for IBS symptom management [14]. Reported benefits for global IBS symptoms were strain and formulation specific, with evidence suggesting potential effects for Escherichia strains and Lactobacillus plantarum 299V. For abdominal pain, beneficial effects were reported for Saccharomyces cerevisiae I-3856 and Bifidobacterium strains. Overall, findings varied across strains and multispecies formulations, and no significant safety concerns were reported.

In a meta-analysis of 5,531 patients, Zhang et al. (2022) reported that Bacillus coagulans administered for eight weeks had the highest probability of being the most effective probiotic species for improving IBS symptom remission and reducing overall symptom severity, abdominal pain, bloating ($p = 0.035$), and straining during defecation ($p = 0.020$) [15]. The greatest improvement in quality of life (QOL) was observed with L. plantarum, while L. acidophilus was associated with the lowest incidence of adverse events.

Zhang et al. (2023) emphasized the importance of treatment duration and dose. [16] In an analysis including 6,289 participants, an effective treatment duration of at least four weeks was suggested ($p < 0.00001$), with effective doses starting at approximately 10^9 CFU/day ($p < 0.0001$). Symptom improvement was reported for strains from the genera Bifidobacterium, Lactobacillus, and Saccharomyces. Probiotic mixtures and combinations of Lactobacillus and Bifidobacterium were also associated with higher rates of subjective symptom relief. Across preparations, abdominal pain was reduced.

The benefits of probiotics were also supported by van der Schoot et al. (2022), who reported improvement in more than half of participants receiving probiotics (57%, $p = 0.007$) [17]. Probiotics increased bowel movement frequency ($p < 0.00001$), with a notable effect for Bifidobacterium lactis. No significant effects were observed for certain probiotic mixtures, B. coagulans Unique IS2, or Lactobacillus casei Shirota ($p = 0.008$). Probiotics did not significantly affect stool consistency ($p = 0.08$). In contrast, synbiotics did not show comparable benefits versus controls.

Chao et al. (2024) investigated probiotic supplementation over six weeks and evaluated the additional role of physical activity [18]. Participants were allocated to probiotics alone, exercise alone, or a combined intervention. The combined intervention yielded the most favorable overall outcomes. The probiotics only group demonstrated improved cardiovascular fitness ($p < 0.001$) and a reduction in Klebsiella abundance ($p < 0.05$). Improvements in QOL were observed in both the combined group ($p < 0.001$) and the exercise-only group ($p < 0.05$).

Similarly, Wu et al. (2024) reported the most consistent effects for preparations containing Bacillus, Bifidobacterium, and Lactobacillus, with Bifidobacterium and Lactobacillus showing comparatively stronger effects among single strain interventions [19]. No significant adverse effects were noted. In contrast, prebiotic and synbiotic therapies were not associated with clinically meaningful improvements.

A direct comparison of probiotic and prebiotic interventions was reported by Janssen Duijghuijsen et al. (2024) in a double blind, randomized controlled trial including 180 participants meeting Rome IV criteria for IBS C. [20] Following a 4-week observation period, participants received either 10 g/day of acacia fiber (AF), 4 g/day of the probiotic BLa80 (2×10^{11} CFU/g), or placebo (10 g/day maltodextrin) for four weeks. Defecation frequency improved significantly in both the AF and probiotic groups compared with placebo ($p < 0.001$ and $p = 0.02$, respectively). The probiotic BLa80 significantly reduced overall IBS symptom severity ($p = 0.03$), whereas AF reduced constipation symptom severity without reaching statistical significance ($p = 0.10$). No significant differences were found between groups in stool consistency, stool weight, or QOL.

A trial conducted by Skrzydło-Radomańska et al. (2020) evaluated a multi-strain synbiotic containing Lactobacillus rhamnosus 19070-2, Lactobacillus acidophilus DSMZ 32418, Bifidobacterium lactis DSMZ 32269, Bifidobacterium longum DSMZ 32946, Bifidobacterium bifidum DSMZ 32403, and fructooligosaccharides in adults with IBS D [21]. Eighty patients with moderate to- evere IBS D were randomized to receive either synbiotic therapy or placebo for eight weeks, and 68 participants completed the study. Primary outcomes included changes in symptom severity assessed by the IBS Symptom Severity Scale (IBS-SSS), global improvement measured with the IBS Global Improvement Scale (IBS-GIS), and adequate relief at weeks 4 and 8. Secondary outcomes were collected three times per week and included individual symptom ratings and adverse events. Compared with placebo, synbiotic treatment significantly improved IBS-GIS ($p = 0.043$) and reduced total IBS-SSS scores ($p = 0.042$). Domain-specific improvements were observed for flatulence ($p = 0.028$) and bowel habit-related scores ($p = 0.028$) at both week 4 and week 8. Weekly assessments also indicated significant reductions in the feeling of incomplete evacuation, flatulence, abdominal

pain, stool pressure, and diarrheal stools versus placebo. No between group differences in adverse events were reported, indicating good tolerability of the intervention.

A study conducted in 4,321 participants by Asha et al. (2020) evaluated the efficacy and safety of probiotics, prebiotics, and synbiotics for IBS by assessing global symptoms and/or abdominal pain, secondary symptoms, and adverse events [22]. Overall, probiotics significantly improved global IBS symptoms compared with placebo ($p < 0.001$), although substantial heterogeneity was observed ($p < 0.001$). Beneficial effects were also apparent across both single and multi-strain probiotic interventions as well as synbiotic formulations, whereas evidence for prebiotics remained limited. No significant between group differences were found in adverse event rates, highlighting an overall favorable safety profile.

Study by Matsuura et al. (2024) evaluated whether personalized prebiotic and probiotic supplementation tailored to intestinal microbiota profiles and IBS subtype can improve symptom severity [23]. A total of 120 patients were enrolled, including IBS D, IBS C, and IBS M and received subtype and microbiota guided supplements for 4 weeks. The primary endpoint was the change in the IBS-SSS from baseline to week 4. IBS-SSS significantly decreased in the overall cohort ($p < 0.001$), with significant improvements in IBS D ($p = 0.004$) and IBS C ($p = 0.002$), but not in IBS M ($p = 0.47$). No serious undesirable effects were reported.

An improvement in IBS-SSS following synbiotic supplementation was also observed in the study by Sommermeyer et al. (2024) [24]. In this trial, 202 adults with moderate to severe IBS received a multi-strain synbiotic or placebo for 12 weeks. IBS-GIS also improved significantly in the synbiotic group. Secondary outcomes including adequate relief (IBS-AR), BSFS, bowel movement frequency, abdominal pain, bloating, stool pressure, and the feeling of incomplete **e**vacuation, also favored the synbiotic group, with 70% of patients achieving adequate relief at the end of treatment. The intervention was well tolerated, with only two transient headaches reported in the synbiotic group.

Sixty-seven IBS patients aged ≥60 years were included in the study and received either placebo (n=34) or a synbiotic containing Lactobacillus paracasei DKGF1 and Opuntia humifusa extracts (n=33) for 4 weeks [25]. Oh et al. assessed patients using the Subject Global Assessment, a visual analog scale, and the BSFS. The overall responder rate after 4 weeks was significantly higher with the synbiotic than with placebo (51.5% vs 23.5%; p=0.017). Abdominal pain and psychological well-being improved significantly in the synbiotic group, whereas gas and bloating showed no significant differences. In patients with IBS C and IBS D (n=16), the synbiotic significantly improved abdominal pain and defecation symptoms, and no adverse events were reported in either group.

A meta-analysis conducted by Xie et al. (2023) compared and ranked the outcome-specific efficacy of probiotic strains and mixtures for treating IBS in adults [26]. They stated that several single strains and mixtures were superior to placebo for improving IBS-SSS, with Lactobacillus acidophilus DDS-1 ranking highest. A five-strain mixture ranked first for improving IBS related QOL while Bacillus coagulans MTCC 5856 and Unique IS2 were among the top options for reducing abdominal pain and improving stool form in IBS D.

Statistically significant findings were also observed by Srivastava et al. (2024) [27]. A trial in 200 adults with IBS D evaluated the probiotic Bifidobacterium longum CECT 7347 (ES1) and its heat treated postbiotic form (HT-ES1) versus placebo. Participants took two capsules once daily for 12 weeks and the primary endpoint was the change in total IBS-SSS score compared with placebo. Both ES1 and HT-ES1 produced significantly greater reductions in IBS-SSS than placebo at days 28, 56, and 84 ($p < 0.0001$). Secondary outcomes including IBS QOL, abdominal pain severity, BSFS, and anxiety (STAI) scores, also improved significantly in the ES1 and HT-ES1 groups compared with placebo. Overall, both the probiotic and the heat treated postbiotic were safe and led to reductions in IBS D symptoms.

Lewis et al. (2020) stated that Lactobacillus paracasei HA-196 or Bifidobacterium longum R0175 could improve gastrointestinal and psychological symptoms in adults with IBS [28]. A total of 251 participants with IBS C, IBS D, or IBS M completed a 2 week trial in and were randomized to L. paracasei (n=84), B. longum (n=83), or placebo (n=81). Overall changes from baseline in IBS symptom severity at 4 and 8 weeks were similar across all groups. After randomization, participants were classified by Rome III subtype, and subtype specific effects were observed. In the L. paracasei group, bowel movement frequency increased in IBS C (n=10) and decreased in IBS D (n=10) after 8 weeks. Both probiotic groups showed improvements from baseline in QOL suggesting potential psychological benefits in certain IBS subtypes.

Martoni et al. (2020) assessed two probiotic strains for improving abdominal pain and overall symptoms in adults with IBS (Rome IV) [29]. A total of 330 participants (18-70 years) were randomized to placebo, Lactobacillus acidophilus DDS-1 (1×10^{10} CFU/day), or Bifidobacterium animalis subsp. lactis UABla-12

(1×10^{10} CFU/day) for six weeks. The primary outcome improved significantly versus placebo in both probiotic groups, with a larger absolute reduction and higher responder rate for DDS-1 than UABla-12. Both probiotics also produced significant reductions in IBS-SSS total scores compared with placebo, including improvements in pain, distension, bowel habits, and QOL. Stool consistency normalized over time in both probiotic groups, supporting clinically meaningful benefits for pain and bowel symptoms in IBS.

QOL and BSFS after probiotic therapy were also assessed by Gupta et al. (2021) [30]. Forty participants were randomized to receive either placebo or B. coagulans LBSC for 80 days, with 38 completing the study. Compared with placebo, the probiotic group showed significant improvements across multiple symptoms including bloating, abdominal pain, diarrhea, constipation, and anxiety, along with better stool consistency based on IBS-SSS and the BSFS. The intervention was well tolerated, showed no concerning endoscopic mucosal changes, and no serious adverse events were reported.

Discussion

This review indicates that probiotics are the microbiota targeted intervention with the most consistent evidence for symptomatic benefit in IBS, whereas prebiotics and synbiotics show more variable and formulation dependent effects. Across meta-analyses and randomized trials, improvements were most frequently observed for global IBS symptoms, abdominal pain, bloating, and selected bowel-habit outcomes, with an overall favorable safety profile.

A central theme across the included evidence is strain specificity. Large meta-analyses suggest that symptom response is not a class effect of probiotics but depends on the organism. Reported signals for global symptom improvement included Escherichia strains and Lactobacillus plantarum 299V, while reductions in abdominal pain were noted with Saccharomyces cerevisiae I-3856 and Bifidobacterium strains. Other articles further suggested that Bacillus coagulans may have a high probability of improving symptom remission and reducing overall symptom severity, including bloating and straining, while L. plantarum showed a comparatively stronger association with QOL improvement and L. acidophilus with fewer adverse events. These findings reinforce the clinical implication that probiotic recommendations should be product and strain informed, rather than generic.

The review also highlights dose and duration as critical determinants of response. Evidence synthesized across thousands of participants suggests that clinically meaningful benefits are more likely when treatment lasts at least four weeks, with effective doses beginning around 10^9 CFU/day. Short interventions or subtherapeutic dosing may therefore contribute to negative or equivocal trial results.

Importantly, IBS subtype appears to influence therapeutic priorities and measurable outcomes. In IBS C, a head-to-head randomized trial demonstrated that both acacia fiber (prebiotic) and a Bifidobacterium based probiotic (BLa80) increased defecation frequency versus placebo, but only the probiotic significantly reduced overall IBS symptom severity, while the prebiotic's reduction in constipation severity did not reach statistical significance. In IBS D, an 8-week multi-strain synbiotic improved global improvement scores and reduced IBS symptom severity, with notable reductions in flatulence and bowel habit related complaints and good tolerability.

The evidence for synbiotics is mixed. Some analyses concluded that synbiotics do not outperform controls overall, yet recent longer duration randomized trials reported meaningful improvements in IBS-SSS, global improvement, and adequate relief, including favorable changes in pain, bloating, stool pressure, and incomplete evacuation. This discrepancy likely reflects heterogeneity in synbiotic composition (different strains and prebiotic substrates), study duration (e.g., 8–12 weeks), baseline severity, and IBS subtype enrollment.

Emerging findings support a broader move toward multimodal and personalized strategies.

Conclusions

Given substantial heterogeneity in study designs, patient populations, IBS subtypes, and outcome measures, future work should prioritize well powered, rigorously designed trials that clearly define strain identity and viability, standardize endpoints (e.g., IBS-SSS, adequate relief), and perform subtype stratified and responder analyses. The emerging signals from microbiota and subtype guided supplementation and from combined lifestyle interventions (e.g., physical activity plus probiotics) suggest that individualized and multimodal strategies may enhance clinical benefit, but these approaches require further validation.

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