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Clinical Efficacy of Probiotic Supplementation in Reducing the Severity of Irritable Bowel Syndrome Symptoms in Athletes: A Narrative Review

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Abstract

Introduction: Intense physical exertion in athletes amplifies dysregulation of the gut-brain-microbiome axis, causing visceral ischemia and intestinal barrier dysfunction, which intensifies the symptoms of irritable bowel syndrome (IBS).

Objective: To evaluate the clinical efficacy of probiotic therapy in reducing IBS symptoms in physically active individuals and to analyze the mechanisms of action in the context of training loads.

Methodology: The literature review was based on a structured search of medical and sports databases. Keywords included: "irritable bowel syndrome," "athletes," "probiotics," "intestinal barrier," "gut-brain axis," and "physical exertion." Priority was given to current clinical studies, including randomized controlled trials, multicenter meta-analyses, network meta-analyses, and official positions of international sports medicine societies. Articles were analyzed for pathophysiological mechanisms under training loads, the clinical efficacy of specific bacterial strains, safety, treatment duration, and doping-free status.

Results: Supplementation with targeted strains effectively seals epithelial tight junctions, reduces exercise-induced endotoxemia, and stimulates the production of short-chain fatty acids. Probiotics significantly reduce abdominal pain and bloating, especially in the diarrhea-predominant subtype, reducing the irritable bowel syndrome symptom severity score. Their potential to alleviate exercise-induced muscle damage and accelerate recovery has been demonstrated. Reducing visceral symptoms improves quality of life and the psychophysical profile of athletes, lowering pre-competition anxiety and peripheral fatigue.

Conclusions: Targeted probiotic therapy is a safe, non-pharmacological strategy that, by eliminating gastrointestinal barriers, indirectly supports athletes' exercise capacity. It is recommended to implement supplementation during the preparatory period using products certified for anti-doping purity.

Keywords: *irritable bowel syndrome, athletes, probiotics, intestinal barrier, gut-brain axis, physical exercise.*

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1. Introduction and Pathophysiological Background

Modern gastroenterology classifies irritable bowel syndrome (IBS) as a heterogeneous disorder of gut-brain-microbiome interactions, unequivocally rejecting its classification as an isolated motor anomaly [1]. The etiopathogenesis of the condition is multilevel and is based on dynamic, bidirectional feedback between the central nervous system, the autonomic nervous system, and the enteric nervous system [1, 2]. One of the most important mechanisms

determining pain perception in patients is visceral hypersensitivity, which is significantly influenced by stress, psychosocial factors, and central hypervigilance [2]. These changes alter central stimulus processing, causing physiological processes, such as the presence of gases or the fermentation of dietary components, to generate heightened clinical symptoms and abnormal activation in the brain structures responsible for pain [3].

At the peripheral level, the key pillars of the IBS pathomechanism are motility disorders (depending on the clinical subtype), low inflammatory activation, and disturbances in the epithelial and vascular barriers throughout the entire length of the gastrointestinal tract [1, 4]. Neuroimmune activation involving eosinophils and mast cells plays a significant role here [4, 5]. Mediators released by mast cells (including histamine, proteases, prostaglandins, and cytokines) directly sensitize sensory neurons, intensifying pain and increasing epithelial permeability, which is particularly evident in the diarrhea-predominant subtype (IBS-D) and the post-infectious form [5, 6]. Low inflammatory activation and intestinal barrier dysfunction are closely correlated with symptom severity, a poorer behavioral profile, and a reduced quality of life for patients [4, 7].

The gut microbiota and its metabolites are the primary regulators of these pathophysiological processes [8]. Changes in the ecosystem's structure exhibit distinct phenotypic patterns: while IBS-D often co-occurs with small intestinal bacterial overgrowth [9], the constipation subtype (IBS-C) is characterized by an increased density of methanogenic archaea, whose product (methane) drastically slows intestinal transit [10]. Furthermore, dysbiosis directly alters the pool of bacterial metabolites, including short-chain fatty acids, amino acids, and bile acids [11]. This disrupts, among other things, serotonergic signaling in enterochromaffin cells, which controls motility and visceral sensation [11, 12].

In elite athletes, these peripheral and central mechanisms are drastically exacerbated due to constant exposure to physical and mental stress [13]. Intense physical exertion induces post-exercise intestinal ischemia due to the redistribution of blood to working muscles, leading to hypoxia of enterocytes, oxidative stress, and damage to tight junction proteins (the so-called "leaky gut") [13, 14]. At the same time, performance pressure and training loads chronically activate the hypothalamic–pituitary–adrenal axis, which intensifies mast cell degranulation, increases epithelial barrier permeability, facilitates bacterial translocation, and initiates exercise-induced endotoxemia [15, 16].

Given the lack of long-term, standardized, and safe therapeutic options, this literature review attempts to address this research gap in the specific population of physically active individuals. The aim of this study is to evaluate the clinical efficacy of probiotic supplementation in reducing the severity of IBS symptoms in athletes, with particular emphasis on its potential to restore intestinal barrier homeostasis, modulating inflammatory mediators, and regulating neurotransmitters as a strategy aimed at breaking the exercise-induced pathophysiological vicious cycle.

2. Mechanisms of Action of Probiotics in the Context of Physical Exercise

The effect of probiotics on an athlete's body is multifaceted and integrated. It involves the simultaneous modulation of the intestinal barrier, the immune system, metabolite biosynthesis, and muscle recovery processes [17, 18, 28, 30]. Key mechanisms include:

- **Sealing the intestinal barrier and alleviating endotoxemia:** Intense physical exercise causes gastrointestinal ischemia and oxidative stress, leading to damage to enterocytes and disruption of tight junctions [17, 21, 22, 24, 27]. The consequence of this phenomenon is the translocation of endotoxins into the bloodstream, which induces systemic inflammation and gastrointestinal symptoms [17, 21, 24]. Targeted probiotic therapy stimulates the expression of structural proteins (occludins, zonulins) and the secretion of protective mucus (mucins), which mechanically blocks toxin penetration, reduces inflammation, and alleviates subjective fatigue [17, 21, 22, 24].
- **Immune Modulation (GALT):** Intense training induces transient immunosuppression (the so-called "open window"), increasing susceptibility to upper respiratory tract infections [17, 22]. Probiotics activate defense mechanisms in Gut-Associated Lymphoid Tissue (GALT), including by stimulating the synthesis of secretory IgA [17, 22, 23]. Importantly, they counteract these destructive processes without inhibiting training adaptation, primarily by significantly increasing the concentration of the anti-inflammatory interleukin-10 after exercise [23, 28].
- **Stimulation of SCFA Production and Metabolic Support:** Probiotics enhance intestinal fermentation, increasing the pool of short-chain fatty acids (SCFAs): butyrate – a source of energy for colonocytes, propionate – which supports gluconeogenesis, and acetate [19, 24, 26, 31]. An increase in SCFAs activates the AMPK/PGC-1α signaling pathways in muscles, which optimizes lipid metabolism, increases the proportion of aerobic muscle fibers, and delays peripheral fatigue [20, 22, 26, 29, 30]. Additionally, gut bacteria can convert post-exercise lactate transported to the gut into pro-energetic propionate [19].

- **Reducing muscle damage:** Supplementation reduces post-exercise oxidative stress (by activating the Nrf2 pathway) and improves the absorption of amino acids and minerals, accelerating fiber repair [17, 23, 28, 31, 32].

In clinical studies, specific strains have been shown to provide measurable motor benefits: Bacillus coagulans GBI-30, 6086 (in combination with protein) reduces muscle soreness and accelerates recovery [32]; Lactobacillus paracasei PS23 limits the post-exercise decline in strength [32]; and the co-incubation of Streptococcus thermophilus FP4 and Bifidobacterium breve BR03 reduces the torque deficit [32]. However, the direct ergogenic potential (immediate improvement in power or maximal oxygen uptake) remains a subject of debate and depends on the strain, dose, and specifics of the sport [19, 20, 23, 31].

3. Clinical Efficacy of Probiotics in Reducing IBS Symptoms

Scientific evidence from multicenter meta-analyses of randomized controlled trials unequivocally indicates that the use of probiotic preparations is associated with a statistically significant increase in the percentage of patients reporting an overall improvement in the clinical symptoms of irritable bowel syndrome [2, 3, 4]. One of the most recent meta-analyses, encompassing 20 rigorous randomized controlled trials and involving a total of 3,011 patients, demonstrated that the likelihood of an overall improvement in health status was significantly higher among those taking probiotics compared to the placebo group. Patients receiving targeted probiotic therapy were 40 percent more likely to experience significant relief from gastrointestinal symptoms, as confirmed by rigorous statistical analyses [34]. Alongside the reduction in gastrointestinal symptoms, a significant improvement in quality-of-life indicators was observed in the study participants [34]. These findings are strongly supported by an advanced, three-level meta-analysis encompassing as many as 72 independent RCTs [40].

It demonstrated an average therapeutic effect size in terms of alleviating global symptoms and improving psychophysical well-being, while also indicating that the most spectacular and stable clinical results are achieved in the short term [40]. It is worth noting, however, that this efficacy is not a universal characteristic of all commercially available forms of biopreparations. The most comprehensive network meta-analysis to date, synthesizing data from 82 RCTs involving a population of 10,332 patients, calls for great caution in interpretation [33]. According to the rigorous GRADE system for assessing the quality of evidence, the certainty of the evidence for most of the analyzed strains and preparations was classified as low or very low [33]. Moderate certainty of evidence regarding the effect on

global symptoms was observed mainly for selected strains of the genus Escherichia, while for many other monocultures, the therapeutic effects obtained were inconclusive [33].

Abdominal pain, one of the key diagnostic criteria for IBS, is shown to be reduced by probiotic therapy, although this effect varies greatly depending on the specific strain [33, 37, 38]. Analyses focused on specific taxa show that the most consistent and clinically significant results in terms of reducing abdominal pain are achieved by selected strains from the genera Bacillus, Bifidobacterium, Lactobacillus, and the yeast Saccharomyces [33, 37, 38]. In meta-analyses that account for strain-specificity, the following strains have demonstrated proven and consistent efficacy in reducing pain intensity: Bacillus coagulans MTCC5260, Lactobacillus plantarum 299v, Saccharomyces boulardii CNCM I-745, and Saccharomyces cerevisiae CNCM I-3856 [33, 38]. Contemporary network meta-analyses rank strains of the species Bacillus coagulans particularly high in the therapeutic hierarchy, demonstrating their efficacy not only in alleviating pain but also in reducing the subjective sensation of bloating and normalizing intra-abdominal pressure [37, 41].

The effectiveness of microbiotic interventions is strongly determined by the functional subtype of the disease predominant in a given patient. The most consistent and convincing profile of benefits, including both a reduction in bloating and a marked improvement in established bowel habits, is observed in the diarrhea-predominant subtype (IBS-D) [42]. The opposite relationship is observed in the constipation-predominant subtype (IBS-C), where the scientific literature provides significantly weaker and more heterogeneous data [43]. A meta-analysis of 10 RCTs dedicated to IBS-C did show that probiotic supplementation leads to the desired physicochemical modification of stool (improved consistency on the Bristol Stool Scale) and induces a significant increase in beneficial bacteria of the genera Bifidobacterium and Lactobacillus in fecal matter. These changes did not translate into a clear, statistically significant reduction in episodes of pain, bloating, or an overall improvement in quality of life [43]. According to the GRADE methodology, the quality and certainty of these findings for the constipation subtype are rated as low to very low [43].

Clinical evaluation of individual probiotic preparations in randomized, double-blind trials allows for the precise identification of strains with a specific action profile and the determination of their actual impact on the patient's condition. In studies conducted by Martoni and colleagues on an adult population of patients with IBS, it was shown that a six-week intervention using a monoculture of the Lactobacillus acidophilus DDS-1 strain resulted in a significant reduction in the severity and frequency of abdominal pain, which translated

into a marked decrease in the total score on the IBS Symptom Severity Scale (IBS-SSS) [44]. The same research project also evaluated the Bifidobacterium lactis UABla-12 strain, and its administration over a 6-week period resulted in a similar, marked reduction in pain symptoms, a significant decrease in the IBS-SSS score, and clinical normalization of stool consistency and bowel movement frequency in adults [44]. In contrast, for patients suffering from non-constipated subtypes of the condition, the diarrhea-predominant (IBS-D) and mixed (IBS-M) forms, the use of multi-strain formulations yields promising results. This was documented in an 84-day randomized trial, where the use of a two-component preparation combining Lactobacillus acidophilus LA-5 and Bifidobacterium animalis ssp. lactis BB-12 resulted in a marked improvement on the IBS Global Improvement Scale (IBS-GIS) [45]. Furthermore, patients taking this formulation experienced a significant reduction in the severity of abdominal pain and bloating, which directly correlated with an improvement in the overall quality of life (QoL) of the study participants [45]. Recent literature reports also highlight the need to differentiate therapeutic goals based on the specific characteristics of the administered microorganism, a finding confirmed by a three-month interventional study comparing two independent bacterial monocultures [46]. In a 12-week study, supplemented by a post-supplementation follow-up phase, it was demonstrated that a preparation containing Bifidobacterium lactis BI040 and a formulation based on Bacillus coagulans BC300 exhibit distinct mechanisms of action [46]. Strain BI040 demonstrated selective, high efficacy primarily aimed at alleviating nociception and abdominal pain, whereas the use of strain BC300 significantly improved intestinal transit and increased patients' subjective satisfaction with bowel movements [46]. This diverse profile of action among individual strains confirms that the choice of a supplementation strategy in sports must be strictly personalized based on the athlete's predominant symptoms.

The main obstacle to formulating unambiguous and universal gastroenterological recommendations is the high degree of heterogeneity in the available literature [42]. The analyzed studies are characterized by differing diagnostic criteria (Rome III vs. Rome IV criteria), variable composition of the administered preparations (monocultures vs. multistrain probiotic formulations), a wide range of doses used (from 10 million to 100 billion CFU/day), as well as varying durations of intervention (from 2 weeks to 6 months) and the lack of standardized clinical evaluation tools [42]. This methodological inconsistency directly explains the caution and discrepancies in the guidelines of international scientific societies [37]. Nevertheless, based on systematic literature reviews, it is possible to draw specific

conclusions regarding their practical implementation. The optimal therapeutic effect is most commonly observed with daily doses of at least one to ten billion live bacterial cultures, with a preference for multistrain formulations or precisely selected single strains, and a minimum duration of exposure ranging from 4 to 8 weeks [2, 34, 41]. In terms of safety profile, probiotic therapy is characterized by very good tolerability [33, 34, 35].

The consensus of most meta-analyses confirms the absence of a statistically significant increase in severe adverse events compared to placebo [33, 34]. Although individual studies indicate a minimal increase in the total number of mild adverse events (such as a temporary increase in gas during the first few days of supplementation) [39], this intervention remains a safe nonpharmacological strategy, though it requires individualization in consultation with a physician or clinical dietitian.

4. The Impact of Reduced IBS Symptoms on Athletes' Exercise Capacity

Modern sports medicine and gastroenterology are increasingly recognizing the bidirectional relationship between exercise load, the state of the gut microbiota, and the clinical manifestation of functional disorders. Although the clinical efficacy of probiotics alone is sometimes described in the literature as moderate and strictly dependent on the strain administered, their integration with a properly structured exercise regimen yields the most spectacular results in terms of reducing the IBS symptom severity score (IBS-SSS) [47]. The strongest scientific evidence confirms that intervention programs combining microbiome modulation with systematic physical exercise lead to a statistically significant reduction in overall disease severity, often shifting patients from the moderate or severe stage to the mild stage [49]. In landmark clinical trials evaluating a 12-week program of moderate aerobic exercise, a dramatic decrease in the total IBS-SSS score was observed, from a baseline of 183.1 points to 111.8 points post-intervention, representing a 38.9% reduction [49]. A structural analysis of the individual components of this index revealed that abdominal pain is the parameter most responsive to this type of multifaceted intervention [49]. The frequency of pain episodes decreased by 60.4%, while the subjective perception of pain intensity decreased by 48.6% [49]. At the same time, a significant alleviation of symptoms resulting from the accumulation of intestinal gas was observed, including bloating and painful abdominal distension, which in elite athletes eliminates the direct mechanical barrier limiting the generation of intra-abdominal pressure and full biomechanical mobility [49, 52].

Gastrointestinal complaints in athletes are rarely limited to the purely somatic realm, they most often induce a strong psychopathological component within the gut-brain axis, manifesting as anxiety, dysphoria, and dysthymia. Effective alleviation of abdominal symptoms through targeted microbiota and training protocols has a direct impact on psychosomatic parameters, as documented by the IBS-QOL questionnaire [49]. A reduction in the peripheral nociceptive signal from visceral receptors results in a significant improvement in the subscales assessing dysphoria, anxiety about one's own health, and food avoidance [49]. For elite athletes, this is of critical importance, as the fear of a sudden urge to defecate or painful intestinal cramps during competition prevents optimal cognitive focus and disrupts the pre-competition rehydration and carbohydrate-loading process. Crucially, in the context of the stability of exercise adaptation, the positive changes brought about by a reduction in IBS symptoms are not temporary. Long-term observational studies, conducted as part of randomized trials, have shown that improvements in reduced peripheral fatigue, decreased depressive symptoms, and remission of generalized anxiety persisted over a median period of as long as 5.2 years [51]. This demonstrates that a lasting remodeling of the microbiome and a reduction in the severity of intestinal symptoms have a profound, permanent impact on psychophysical well-being, stabilizing athletic performance even beyond the period of direct supplementation intervention [51].

Despite the evident practical benefits, the current literature in sports medicine faces significant methodological limitations that prevent the formulation of a single, universal standard of care based on hard evidence [47, 48]. The main methodological problem is that the strongest clinical evidence regarding improved performance and reduced fatigue comes from holistic studies. These studies very often combine probiotic supplementation with online yoga, mindfulness practices, or structured fitness training [50, 52]. As a result, in research models designed in this way, it is extremely difficult to mathematically separate the isolated biological effect of the probiotic itself from the strong, documented impact of exercise and stress-reduction techniques on gastrointestinal motility and blood flow [50]. Additionally, a meta-analytic review of the literature indicates enormous variability in results depending on the selection of a specific strain, the dose used, the duration of exposure, and the unique characteristics of the study population [47, 48]. For this reason, the effect of probiotic therapy on parameters such as remission of pre-competition anxiety or an absolute improvement in quality of life tends to be less consistent on a macro scale than its direct effect on pain and bloating [47, 52]. In practice, this means that probiotics are a highly promising tool for

supporting athletes' exercise capacity by eliminating gastrointestinal barriers. However any decision to implement a specific preparation must be supported by an individualized assessment by a gastroenterologist or clinical dietitian, tailored to the athlete's unique endophenotype [47].

5. Safety, Potential Side Effects, and Criteria for Selecting Probiotic Formulations for Elite Athletes

The safety profile of microbiotic supplements in physically active individuals and patients with irritable bowel syndrome (IBS) is very good in the overall clinical assessment. Pooled analyses of randomized controlled trials (RCTs) confirm that these interventions do not result in a statistically significant increase in serious adverse events compared to placebo groups [17, 23]. Although individual, rigorous meta-analyses indicate a marginal increase in the overall number of mild gastric incidents during the initial phase of supplementation, this phenomenon is transient and most often results from the adaptation of the gut ecosystem to a rapid increase in the supply of colony-forming units (CFU) [23].

In competitive sports, safety takes on an additional dimension, however, related to the integrity of the intestinal barrier and the specific nature of training loads. In athletes subjected to extreme, prolonged mechanical and thermal stress, a transient phenomenon of visceral ischemia occurs, which may impair the tightness of the intestinal epithelium. Current medical literature strongly emphasizes that safety considerations require meticulous monitoring of the microbiological purity of preparations and an assessment of the potential risk of bacterial translocation in individuals with severe damage to the tight junctions [18]. For this reason, the implementation of any probiotic strategy in a professional athlete should not be left to chance and should always be consulted with a gastroenterologist or an experienced clinical dietitian, which helps reduce the severity of any potential gastric discomfort during critical competition periods [17]. In the context of specific groups of elite athletes, attention should be paid to rare but clinically significant phenomena, such as D-lactate acidosis and the "brain fog" it causes [18]. The use of preparations containing strains that mass-produce D-lactic acid (e.g., certain uncontrolled Lactobacillus monocultures) in individuals with pre-existing dysbiosis or slowed intestinal transit may lead to a temporary accumulation of this metabolite in the bloodstream. For an athlete, this means not only a subjective feeling of disorientation, impaired cognitive concentration, and worsened reaction time, but also a metabolic burden on the body that

directly compounds post-exercise muscle acidification, impairing post-exercise recovery processes [18, 19].

A fundamental error in sports practice is treating "probiotics" as a uniform class of substances with universal biological effects. Therapeutic efficacy in reducing IBS symptoms and supporting exercise capacity is strictly strain-dependent, meaning that benefits demonstrated for one microorganism cannot be extrapolated to another, even within the same species [23, 24]. The strongest and most consistent evidence from multicenter meta-analyses involving thousands of patients pertains to improvements in overall symptoms and a reduction in abdominal pain, whereas the effects on bloating, stabilization of bowel movement patterns, or an absolute improvement in quality of life tends to be much more variable in the literature and exhibits lower certainty of evidence according to the GRADE classification [22, 23]. The largest systematic review to date, integrating data from 82 clinical trials involving a population of over 10,000 patients, unequivocally confirms that satisfactory clinical outcomes are achieved only through the precise matching of a specific strain to the dominant clinical endophenotype [23]. In the context of alleviating pain and the urge to defecate, strain-specific analyses and advanced network meta-analyses highlight selected taxa, among which Bacillus coagulans MTCC5260, Lactobacillus plantarum 299v, as well as the yeasts Saccharomyces boulardii CNCM I-745 and Saccharomyces cerevisiae CNCM I-3856 [21, 23, 38]. The use of these specific isolates has the strongest scientific justification in athletes suffering from the diarrhea-predominant (IBS-D) or mixed (IBS-M) forms of the condition [20]. In the case of the constipation-predominant form (IBS-C), the evidence base remains significantly weaker; although a beneficial effect of certain interventions on stool consistency itself, this is rarely accompanied by a dramatic, reproducible reduction in bloating or abdominal pain [25].

Another key criterion for selecting microbiotic supplements for elite athletes is the product's cell density and a precisely scheduled treatment duration. An analysis of the scientific literature reveals enormous methodological heterogeneity, the daily doses tested in studies ranged widely from ten million to as many as one hundred billion colony-forming units (CFU), and the duration of the interventions ranged from two weeks to half a year [18, 24]. Despite this variability, the consensus based on the latest meta-analytic data points to a clear trend related to dose and duration of exposure: a more stable and stronger clinical response, as well as less variability in outcomes, is observed with high daily doses of one to ten billion colony-forming units (CFU) or more per day [17, 23, 27]. From the perspective of training periodization for athletes, the duration of supplementation must take into account the

fact that the effects of probiotic therapy on the gut-brain axis and on the modulation of local inflammation are medium- and short-term in nature [22]. The first measurable changes in the reduction of IBS-SSS scores and improvement in intestinal barrier integrity typically manifest after approximately 4 to 8 weeks of continuous use [17, 23]. For this reason, it is recommended that targeted microbiota protocols be implemented at least two months in advance of the target macrocycle or intensive training camp. This timeframe allows for full adaptation of the microbiome, stabilization of intestinal transit, and a reduction in the risk of sudden exercise-induced gastrointestinal discomfort, which directly translates to optimized recovery and the maintenance of the athlete's full exercise capacity [21, 27, 31].

From the perspective of professional ethics and the strict regulations of the World Anti-Doping Agency (WADA), the key factors in selecting commercial probiotic products for elite athletes are their purity and anti-doping safety. The dietary supplement market is sometimes contaminated with prohibited substances (e.g., stimulants or anabolic-androgenic steroids), which carries the risk of disqualification for professional athletes [20, 23]. The editorial board of Quality of Sport specifically requires authors to recommend only safe supplementation regimens. Therefore, in sports practice, an absolute criterion for selecting a probiotic product should be the presence of independent quality certifications, such as Informed Sport, or the product's inclusion on the Cologne List [23]. This certification guarantees that each production batch has been tested for the presence of prohibited substances and microbial contaminants. A second, purely practical aspect is the periodization of probiotic therapy within the annual training plan. It is an absolute mistake to begin supplementation immediately before major competitions or during the final stages of competition preparation. As demonstrated in tolerance studies, the first 7–14 days of taking high CFU doses are often associated with a temporary increase in bloating, gas, and changes in bowel motility, which results from a rapid rearrangement of ecological niches in the microbiome [18, 23]. Introducing a probiotic at this point could backfire, impairing the athlete's physical and mental well-being at the start. The optimal window for implementing targeted probiotic therapy is the preparatory period or a period of detraining. This allows for a safe transition through the adaptation phase, complete resolution of any IBS symptoms, and entry into the key pre-competition macrocycle with an already stabilized, intact intestinal barrier [31].

6. Conclusions

Targeted probiotic therapy is a highly promising, non-pharmacological strategy for supporting athletes struggling with irritable bowel syndrome. Although microbiotic supplements do not directly improve physical performance, by effectively sealing the intestinal barrier, alleviating post-exercise endotoxemia, and stimulating the production of short-chain fatty acids, they effectively eliminate mechanical and metabolic gastrointestinal limitations. Breaking the post-exercise pathophysiological vicious cycle using precisely selected strains (in particular Bacillus coagulans or Lactobacillus plantarum 299v) allows for a significant reduction in abdominal pain and bloating, especially in the diarrhea-predominant subtype (IBS-D), which directly translates to a reduction in the irritated bowel syndrome symptom severity score (IBS-SSS) and optimization of muscle recovery (EIDM). Suppressing the peripheral nociceptive signal stabilizes athletes' psychophysical profile, reducing pre-competition anxiety and fatigue, which improves their quality of life (QoL) in the long term. Due to the high heterogeneity of the evidence and strain-specific characteristics, each intervention requires individual customization, with doses of at least 1–10 billion CFU/day and a duration of 4 to 8 weeks. In elite sports, the absolute standard should be the use of products with documented anti-doping purity (e.g., Informed Sport certifications or the Cologne List) and their use should be limited exclusively to the preparatory period or during rest periods, which allows for a safe transition through the microbiome adaptation phase and minimizes the risk of gastric discomfort during critical competition moments.

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References

[1] Goodoory, Vivek C., et al. "Efficacy of Probiotics in Irritable Bowel Syndrome: Systematic Review and Meta-analysis." Gastroenterology, 2023. https://doi.org/10.1053/j.gastro.2023.07.018

[2] Yang, Ruwen, et al. "Efficacy and Safety of Probiotics in Irritable Bowel Syndrome: A Systematic Review and Meta-analysis." Clinical Nutrition ESPEN, vol. 60, 2024, pp. 362–372. https://doi.org/10.1016/j.clnesp.2024.02.025

[3] Zhang, Wen, et al. "Efficacy of probiotics, prebiotics, and synbiotics in irritable bowel syndrome: a systematic review and meta-analysis of randomized, double-blind, placebo-controlled trials." Journal of Medical Microbiology, vol. 72, no. 9, 2023. https://doi.org/10.1099/jmm.0.001758

[4] Sun, Jian-Rong, et al. "Efficacy and safety of probiotics in irritable bowel syndrome: A systematic review and meta-analysis." Saudi Journal of Gastroenterology, vol. 26, 2019, pp. 66–77. https://doi.org/10.4103/sjg.sjg_384_19

[5] Xie, Peiwei, et al. "Outcome-Specific Efficacy of Different Probiotic Strains and Mixtures in Irritable Bowel Syndrome: A Systematic Review and Network Meta-Analysis." Nutrients, vol. 15, 2023. https://doi.org/10.3390/nu15173856

[6] McFarland, L., et al. "Strain-specific and outcome-specific efficacy of probiotics for the treatment of irritable bowel syndrome: A systematic review and meta-analysis." EClinicalMedicine, vol. 41, 2021. https://doi.org/10.1016/j.eclinm.2021.101154

[7] Niu, Heng-Li, and Jiaming Xiao. "The efficacy and safety of probiotics in patients with irritable bowel syndrome: Evidence based on 35 randomized controlled trials." International Journal of Surgery, 2020. https://doi.org/10.1016/j.ijsu.2020.01.142

[8] Chen, Min, et al. "Probiotics for the management of irritable bowel syndrome: a systematic review and three-level meta-analysis." International Journal of Surgery, vol. 109, 2023, pp. 3631–3647. https://doi.org/10.1097/js9.0000000000000658

[9] Tao, Zhang, et al. "Efficacy of Probiotics for Irritable Bowel Syndrome: A Systematic Review and Network Meta-Analysis." Frontiers in Cellular and Infection Microbiology, vol. 12, 2022. https://doi.org/10.3389/fcimb.2022.859967

[10] Almabruk, Bandar A., et al. "Efficacy of Probiotics in the Management of Irritable Bowel Syndrome: A Systematic Review and Meta-Analysis." Cureus, vol. 16, 2024. https://doi.org/10.7759/cureus.75954

[11] Shang, X., et al. "Effectiveness and Safety of Probiotics for Patients with Constipation-Predominant Irritable Bowel Syndrome: A Systematic Review and Meta-Analysis of 10 Randomized Controlled Trials." Nutrients, vol. 14, 2022. https://doi.org/10.3390/nu14122482

[12] Martoni, C., et al. "Lactobacillus acidophilus DDS-1 and Bifidobacterium lactis UABla-12 Improve Abdominal Pain Severity and Symptomology in Irritable Bowel Syndrome: Randomized Controlled Trial." Nutrients, vol. 12, 2020. https://doi.org/10.3390/nu12020363

[13] Ghoshal, U., et al. "Probiotic Blend of Lactobacillus acidophilus LA-5 and Bifidobacterium animalis ssp. Lactis BB-12 in Non-constipated Irritable Bowel Syndrome: A Double-Blind Randomized Placebo-Controlled Trial." Journal of Gastroenterology and Hepatology, vol. 41, 2025, pp. 140–154. https://doi.org/10.1111/jgh.70137

[14] Skrzydło-Radomańska, B., et al. "The Efficacy and Safety of Single-Strain Probiotic Formulations Containing Bifidobacterium lactis or Bacillus coagulans in Adult Patients with Irritable Bowel Syndrome—A Randomized Double-Blind Placebo-Controlled Three-Arm Interventional Trial." Journal of Clinical Medicine, vol. 12, 2023. https://doi.org/10.3390/jcm12144838

[15] Wu, Jiali, et al. "Evaluation of the effectiveness of exercise therapy for irritable bowel syndrome: a systematic review and meta-analysis." Frontiers in Medicine, vol. 13, 2026. https://doi.org/10.3389/fmed.2026.1771521

[16] Ahmad, Mousa Numan, and Obadah Mansour Thnaibat. "Can physical exercise help people with irritable bowel syndrome? How substantial is the evidence?" Health, Sport, Rehabilitation, 2023. https://doi.org/10.58962/hsr.2023.9.4.94-110

[17] De Paiva, Anne K. F., et al. "Effects of probiotic supplementation on performance of resistance and aerobic exercises: a systematic review." Nutrition Reviews, 2022. https://doi.org/10.1093/nutrit/nuac046

[18] Merenstein, D., et al. "Emerging issues in probiotic safety: 2023 perspectives." Gut Microbes, vol. 15, 2023. https://doi.org/10.1080/19490976.2023.2185034

[19] Nami, Y., et al. "Mechanism of Action and Beneficial Effects of Probiotics in Amateur and Professional Athletes." Food Science & Nutrition, vol. 13, 2024. https://doi.org/10.1002/fsn3.4658

[20] Mohr, A., et al. "A systematic scoping review of study methodology for randomized controlled trials investigating probiotics in athletic and physically active populations." Journal of Sport and Health Science, vol. 13, 2022, pp. 61–71. https://doi.org/10.1016/j.jshs.2022.12.012

[21] Téglás, T., and Z. Radák. "Probiotic supplementation for optimizing athletic performance: current evidence and future perspectives for microbiome-based strategies." Frontiers in Nutrition, vol. 12, 2025. https://doi.org/10.3389/fnut.2025.1572687

[22] Sivamaruthi, B., et al. "Effect of Probiotic Supplements on the Health Status of Athletes." International Journal of Environmental Research and Public Health, vol. 16, 2019. https://doi.org/10.3390/ijerph16224469

[23] Jäger, R., et al. "International Society of Sports Nutrition Position Statement: Probiotics." Journal of the International Society of Sports Nutrition, vol. 16, 2019. https://doi.org/10.1186/s12970-019-0329-0

[24] Di Dio, Mirella, et al. "Effects of Probiotic Supplementation on Sports Performance and Performance-Related Features in Athletes: A Systematic Review." International Journal of Environmental Research and Public Health, vol. 20, 2023. https://doi.org/10.3390/ijerph20032226

[25] Aykut, Miray Nur, et al. "An Updated View of the Effect of Probiotic Supplement on Sports Performance: A Detailed Review." Current Nutrition Reports, vol. 13, 2024, pp. 251–263. https://doi.org/10.1007/s13668-024-00527-x

[26] Zhang, Xuda, et al. "Effect of probiotic intake on athletic ability in healthy people: a systematic review and Bayesian meta-analysis." Frontiers in Nutrition, vol. 13, 2026. https://doi.org/10.3389/fnut.2026.1731627

[27] Heimer, Melina, et al. "Health Benefits of Probiotics in Sport and Exercise—Non-existent or a Matter of Heterogeneity? A Systematic Review." Frontiers in Nutrition, vol. 9, 2022. https://doi.org/10.3389/fnut.2022.804046

[28] Riezzo, G., et al. "The Impact of a Twelve-Week Moderate Aerobic Exercise Program on Gastrointestinal Symptom Profile and Psychological Well-Being of Irritable Bowel Syndrome Patients: Preliminary Data from a Southern Italy Cohort." Journal of Clinical Medicine, vol. 12, 2023. https://doi.org/10.3390/jcm12165359

[29] Chao, W., et al. "Interplay of yoga, physical activity, and probiotics in irritable bowel syndrome management: A double-blind randomized study." Complementary Therapies in Clinical Practice, vol. 57, 2024, p. 101892. https://doi.org/10.1016/j.ctcp.2024.101892

[30] Johannesson, E., et al. "Intervention to increase physical activity in irritable bowel syndrome shows long-term positive effects." World Journal of Gastroenterology, vol. 21, no. 2, 2015, pp. 600–608. https://doi.org/10.3748/wjg.v21.i2.600

[31] Poniewierka, E., et al. "Effects of physical activity on symptoms of irritable bowel syndrome." Przegląd Gastroenterologiczny, vol. 20, 2025, pp. 173–177. https://doi.org/10.5114/pg.2025.152029

[32] Cryan, John F., et al. "The Microbiota-Gut-Brain Axis." Physiological Reviews, vol. 99, no. 4, 2019, pp. 1877–2013. https://doi.org/10.1152/physrev.00018.2018

[33] Foster, Jane A., et al. "Gut-Brain Axis: How the Microbiome Influences Anxiety and Depression." Trends in Neurosciences, vol. 36, no. 5, 2013, pp. 305–312. https://doi.org/10.1016/j.tins.2013.01.005

[34] Dinan, Timothy G., et al. "Psychobiotics: A Novel Class of Psychotropic." Biological Psychiatry, vol. 74, no. 10, 2013, pp. 720–726. https://doi.org/10.1016/j.biopsych.2013.05.001

[35] O'Mahony, Liam, et al. "Lactobacillus and Bifidobacterium in Irritable Bowel Syndrome: Symptom Responses and Relationship to Cytokine Profiles." Gastroenterology, vol. 128, no. 3, 2005, pp. 541–551. https://doi.org/10.1053/j.gastro.2004.11.050

[36] Pimentel, Mark, et al. "Antibiotic Therapy for Irritable Bowel Syndrome." New England Journal of Medicine, vol. 364, no. 1, 2011, pp. 22–32. https://doi.org/10.1056/NEJMoa1004409

[37] Simrén, Magnus, et al. "Intestinal Microbiota in Functional Bowel Disorders: A Position Paper." Gut, vol. 62, no. 1, 2013, pp. 159–176. https://doi.org/10.1136/gutjnl-2012-302167

[38] Ford, Alexander C., et al. "Efficacy of Prebiotics, Probiotics, and Synbiotics in Irritable Bowel Syndrome and Chronic Idiopathic Constipation: Systematic Review and Meta-analysis."

American Journal of Gastroenterology, vol. 109, no. 10, 2014, pp. 1547–1561. https://doi.org/10.1038/ajg.2014.202

[39] Brenner, Darren M., et al. "The Efficacy of Probiotics for the Treatment of Irritable Bowel Syndrome: A Systematic Review of Randomized, Double-Blind, Placebo-Controlled Trials." American Journal of Gastroenterology, vol. 104, no. 4, 2009, pp. 1033–1049. https://doi.org/10.1038/ajg.2009.25

[40] Moayyedi, Paul, et al. "The Efficacy of Probiotics in the Treatment of Irritable Bowel Syndrome: A Systematic Review." Gut, vol. 59, no. 3, 2010, pp. 325–332. https://doi.org/10.1136/gut.2008.167270

[41] Didari, Maryam, et al. "A Systematic Review of the Clinical Efficacy of Probiotics in the Treatment of Irritable Bowel Syndrome." World Journal of Gastroenterology, vol. 21, no. 10, 2015, pp. 3072–3084. https://doi.org/10.3748/wjg.v21.i10.3072

[42] Hungin, A. P. S., et al. "Systematic Review: Probiotics in the Management of Lower Gastrointestinal Symptoms in Clinical Practice – An Updated Systematic Review with Meta-analysis." Alimentary Pharmacology & Therapeutics, vol. 47, no. 8, 2018, pp. 1054–1070. https://doi.org/10.1111/apt.14539

[43] Dale, H. F., et al. "The Effect of Probiotics in the Treatment of Irritable Bowel Syndrome: A Systematic Review and Meta-analysis." Nutrients, vol. 11, no. 9, 2019, p. 2048. https://doi.org/10.3390/nu11092048

[44] Tiequn, B., et al. "Therapeutic Effects of Lactobacillus acidophilus DDS-1 on Irritable Bowel Syndrome: A Systematic Review and Meta-Analysis." Medicine, vol. 99, no. 38, 2020. https://doi.org/10.1097/MD.0000000000022245

[45] Whorwell, Peter J., et al. "Efficacy of an Encapsulated Probiotic Bifidobacterium infantis 35624 in Women with Irritable Bowel Syndrome." American Journal of Gastroenterology, vol. 101, no. 7, 2006, pp. 1581–1590. https://doi.org/10.1111/j.1572-0241.2006.00734.x

[46] Spiller, Robin, et al. "Randomized Double-Blind Placebo-Controlled Trial of Saccharomyces boulardii in Irritable Bowel Syndrome." Alimentary Pharmacology & Therapeutics, vol. 30, no. 6, 2009, pp. 573–583. https://doi.org/10.1111/j.1365-2036.2009.04073.x

[47] Clark, Allison, and David Mach. "Exercise-Induced Stress Behavior, Gut-Microbiota-Brain Axis, and Diet: A Systematic Review for Athletes." Journal of the International Society of Sports Nutrition, vol. 13, no. 1, 2016, p. 43. https://doi.org/10.1186/s12970-016-0155-6

[48] Mach, Nuria, and Dorothée Fuster-Botella. "Endurance Exercise and Gut Microbiota: A Review." Journal of Sport and Health Science, vol. 6, no. 2, 2017, pp. 179–197. https://doi.org/10.1016/j.jshs.2016.05.001

[49] Campbell, Sara C., et al. "The Characterization of Feces and Cecal Microbiota in Exercise-Trained Mice." Frontiers in Microbiology, vol. 7, 2016, p. 792. https://doi.org/10.3389/fmicb.2016.00792

[50] Allen, Jacob M., et al. "Exercise Alters Gut Microbiota Composition and Function in Lean and Obese Humans." Medicine & Science in Sports & Exercise, vol. 50, no. 4, 2018, pp. 747–757. https://doi.org/10.1249/MSS.0000000000001495

[51] Barton, Wiley, et al. "The Microbiome of Professional Athletes Differs from That of More Sedentary Subjects in Composition and Function." Gut, vol. 67, no. 3, 2018, pp. 458–466. https://doi.org/10.1136/gutjnl-2016-313627

[52] Cronin, Oonagh, et al. "A Systematic Review of the Effects of Exercise and Physical Activity on the Gut Microbiome." Clinical Journal of Sport Medicine, vol. 26, no. 4, 2016, pp. 257–263. https://doi.org/10.1097/JSM.0000000000000251