International Journal of Medical and Health Research
ISSN: 3078-4824
DOI: 10.61424/ijmhr
Journal Homepage: www.bluemarkpublishers.com/index.php/IJMHR

IJMHR
BLUEMARK PUBLISHERS

| RESEARCH ARTICLE

Gut Health and Athletic Performance: Investigating the Influence of Nutrition on Microbiome Composition and Function

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| ABSTRACT
The human gut microbiome, a complex ecosystem of microorganisms, has become a key regulator of overall health, shaping numerous factors, including metabolic function and immune response. Recently, its role in athletic performance has become a focus of considerable empirical research. This review assesses the subtle relationship among gut health, nutrition, and athletic performance. We explore the bidirectional influence of exercise on the gut microbiota, highlighting distinct microbial compositions in elite athletes compared to sedentary individuals. The article comprehensively reviews how nutritional strategies, including dietary fiber, protein, and specific micronutrients, modulate the microbiome. The primary emphasis is on the roles of probiotics and prebiotics in improving performance, reducing the incidence of upper respiratory tract infections (URTIs), and controlling exercise-induced gastrointestinal distress. We synthesize evidence from recent studies to clarify the primary pathways by which the microbiome impacts athletic performance, including enhanced energy extraction, optimized nutrient bioavailability, reduced inflammation, and improved immune resilience. The review also discusses the practical significance of these outcomes, providing scientifically supported nutritional recommendations for athletes working to refine their gut health for competitive advantage. By consolidating current research, this article highlights the gut microbiome as a pivotal, modifiable factor in sports nutrition and athletic conditioning, identifies key gaps in the literature, and proposes directions to guide upcoming research efforts to fully exploit the possibilities of microbiome-targeted interventions in sports.

| KEYWORDS

Gut Microbiome, Athletic Performance, Sports Nutrition, Microbiota Composition, Exercise Physiology

| ARTICLE INFORMATION

ACCEPTED: 23 December 2025 **PUBLISHED:** 27 January 2026 **DOI:** 10.61424/ijmhr.v4.i1.675

1. Introduction

The human body is a complex and interconnected system, and in recent years, the scientific community has increasingly recognized the powerful effect of the gut microbiome on overall health and well-being. This finely woven ecosystem, comprising trillions of microorganisms residing in the gastrointestinal tract, plays a key role in a multitude of physiological processes, including digestion, nutrient bioavailability, immune system regulation, and even mood modulation (O'Brien et al., 2022). While the importance of the gut microbiome for general health is now well established, its specific role in athletic performance remains an emerging, fast-developing field of research.

Athletes, who push their bodies to the limits of exercise endurance, represent a unique population in which optimizing every physiological system can translate into a competitive edge. The gut microbiome, with its far-reaching influence, is increasingly viewed as a key, and importantly, modifiable factor in this equation. Historically, sports nutrition has focused on macronutrient and micronutrient intake, hydration, and supplementation methods to boost performance, endurance, and recovery. However, the discovery of the gut microbiome's function in facilitating the effects of diet on the host has added a new element of difficulty and opportunity to this field. The two-way interaction between exercise and the gut microbiome is a central theme in this new paradigm. Research has demonstrated that physical activity can modulate the composition and function of the gut microbiota, often leading to a more diverse and healthier microbial profile in athletes than in sedentary individuals (Jarrett et al.,2025). Conversely, the composition of an athlete's gut microbiome can substantially affect their ability to extract energy from food, synthesize essential nutrients, mitigate inflammation, and maintain a strong immune system, all of which are vital to peak athletic performance (Carlone et al.,2025). Despite the growing body of evidence supporting the link between the gut microbiome and athletic performance, a thorough comprehension of the basic mechanisms and the most effective nutritional strategies to harness this connection remains incomplete. This review seeks to address this deficiency by providing a systematic overview of the current scientific literature on the influence of nutrition on gut microbiome composition and its effects on athletic performance. We will investigate the main nutritional factors that shape gut microbiota, including dietary fiber and protein, as well as the roles of prebiotics and probiotics. Furthermore, we will investigate the specific mechanisms by which the microbiome influences athletic outcomes, including energy metabolism and immune function. By synthesizing the latest research, this article provides a clear, evidence-based framework for athletes, coaches, and sports nutrition professionals to understand and leverage the gut microbiome to optimize health and athletic potential. This review will not only summarize the current state of knowledge but also identify critical areas to inform future research aimed at further unveiling the mechanisms of the '*athletic gu*t'.

2. Literature Review

2.1 The Gut Microbiome: Structure and Function

The human gut microbiome is a densely populated, metabolically active ecosystem consisting chiefly of bacteria, but also includes archaea, viruses, fungi, and protozoa. The bacterial component is the most studied, with two dominant phyla, Bacteroidetes and Firmicutes, accounting for over 90% of the microbial population in most healthy individuals (Sender et al.,2016). Other significant phyla include Actinobacteria, Proteobacteria, and Verrucomicrobia. The composition and diversity of the gut microbiome are highly individualized and determined by factors such as genetics, diet, age, and lifestyle (Rothschild et al., 2018). This microbial community performs a range of essential functions for the host. These include the fermentation of non-digestible carbohydrates into short-chain fatty acids (SCFAs), such as butyrate, propionate, and acetate, which serve as an energy source for the host and help regulate gut motility and inflammation (den Besten et al., 2013). The gut microbiome is also integral to the synthesis of essential vitamins, such as vitamin K and several B vitamins, and the metabolism of bile acids and other xenobiotics. Furthermore, it is vital for the development and maturation of the host's immune system, helping train immune cells to distinguish between pathogenic and commensal microbes (Zheng et al., 2020). Table 1 presents a view of this functioning:

Table 1. Bacterial Phyla and Their Functional Significance in the Gut Microbiome

Bacterial Phylum	Relative Abundance (%)	Key Functions	Athletic Relevance
Bacteroidetes	30-40%	Carbohydrate fermentation, SCFA production	Energy metabolism
Firmicutes	50-60%	Fiber degradation, butyrate production	Gut barrier integrity
Actinobacteria	3-5%	Vitamin synthesis, pathogen resistance	Immune function
Proteobacteria	1-3%	Metabolite production, inflammation signaling	Inflammatory response
Verrucomicrobia	0.5-1%	Mucin degradation, barrier maintenance	Gut health

2.2 The Interdependent Connection between Exercise and the Microbiome

The relationship between exercise and the gut microbiome is now understood to be bidirectional, with each determining the other in an elaborate interplay. Regular moderate-intensity exercise has been shown to benefit the gut microbiome, increasing microbial diversity and the abundance of beneficial bacteria (Monda et al.,2017). This is often referred to as the "J-curve" hypothesis, where moderate exercise confers health benefits, whereas excessive, high-intensity exercise can have detrimental effects, such as increased intestinal permeability and inflammation (Zierer et al., 2019). Studies comparing the gut microbiomes of elite athletes with those of sedentary individuals have consistently revealed substantial differences. Athletes tend to display greater diversity of gut microbes and higher abundance of specific bacterial species associated with enhanced metabolic function and reduced inflammation (Jarrett et al., 2025). Research has shown that elite athletes have a higher abundance of bacteria from the genus Veillonella, which can metabolize lactate, a byproduct of anaerobic exercise, into propionate, an SCFA that can serve as an energy source for the host (Scheiman et al.,2019). This suggests a symbiotic relationship in which the athlete's body produces a substrate (lactate) that the gut microbiota utilizes, which in turn produces a beneficial compound (propionate) for the athlete. Figure 1 presents this comparison graphically.

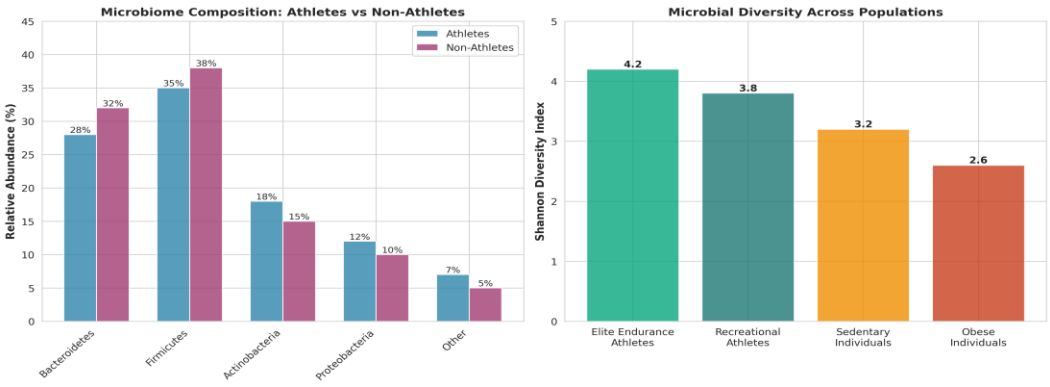

Figure 1. Microbiome Composition Comparison between Athletes and Non-Athletes

Comparative analysis showing (A) bacterial phyla distribution in athletes versus sedentary individuals, (B) Shannon diversity index across different populations (athletes show significantly higher diversity), and (C) relative abundance of key genera, including Veillonella, Akkermansia, and Prevotella, in elite athletes. Data demonstrates distinct microbial signatures in athletic populations

2.3 Nutritional Factors Influencing Microbiome Composition

Diet is arguably the most significant modifiable factor influencing the composition and function of the gut microbiome. The foods we consume provide substrates that our gut microbes ferment and metabolize, hence determining the microbial landscape. A diet rich in dietary fiber from fruits, vegetables, and whole grains is consistently associated with a more diverse and robust gut microbiome. These non-digestible carbohydrates, often referred to as prebiotics, are fermented by gut bacteria to produce beneficial SCFAs (Holscher,2017). Protein intake is also essential. Given that adequate protein is essential to promote muscle repair and growth in athletes, the source and quantity of protein can influence the gut microbiome. High-protein diets, particularly those rich in animal protein, can increase the production of protein fermentation byproducts, such as ammonia and hydrogen sulfide, which can have negative effects on gut health when produced in excess (Windey et al., 2012). The type of dietary fat consumed also affects the microbiome, with unsaturated fats generally associated with a healthier microbiome profile than saturated fats. Furthermore, the concept of probiotics, which are live microorganisms that confer a health benefit when consumed in adequate amounts, has received notable focus in the context of sports nutrition. Probiotic supplementation has been shown to modulate the gut microbiome, potentially resulting in a range of performance-enhancing effects (Jager et al.,2020).

2.4 Mechanisms Relating the Microbiome to Athletic Performance

The gut microbiome influences athletic performance through various connected mechanisms. One of the most direct is through its role in energy metabolism and nutrient bioavailability. The gut microbiota can salvage energy from indigestible carbohydrates, providing an additional energy source for the host. It also participates in the absorption of essential nutrients, such as amino acids and micronutrients, necessary for muscle function and recovery (Rowland et al.,2018). The microbiome's influence on the immune system is another key mechanism. Intense exercise can temporarily suppress the immune system, making athletes more susceptible to infections, particularly upper respiratory tract infections (URTIs). A well-functioning gut microbiome can help maintain a strong immune system, reducing the incidence and severity of such infections (Gleeson et al., 2013). The microbiome also plays a central role in regulating inflammation. Exercise-induced muscle damage triggers an inflammatory response, which is a necessary part of the repair and change process. However, chronic inflammation can undermine recovery and performance. The gut microbiome can modulate systemic inflammation through the production of anti-inflammatory compounds and by maintaining gut barrier integrity (Clark & Mach,2016). This leads to another key mechanism: the regulation of intestinal permeability. Intense exercise can increase intestinal permeability, a condition often called "leaky gut," which allows bacterial endotoxins to enter the bloodstream, triggering a systemic inflammatory response. A well-functioning gut microbial community helps sustain the integrity of the gut barrier, preventing this from occurring (Fasano, 2012). Finally, the production of short-chain fatty acids (SCFAs) by the gut microbiota has a wide range of beneficial effects, including providing an energy source, reducing inflammation, and improving gut motility. These data are graphically revealed in the following Figure 2.

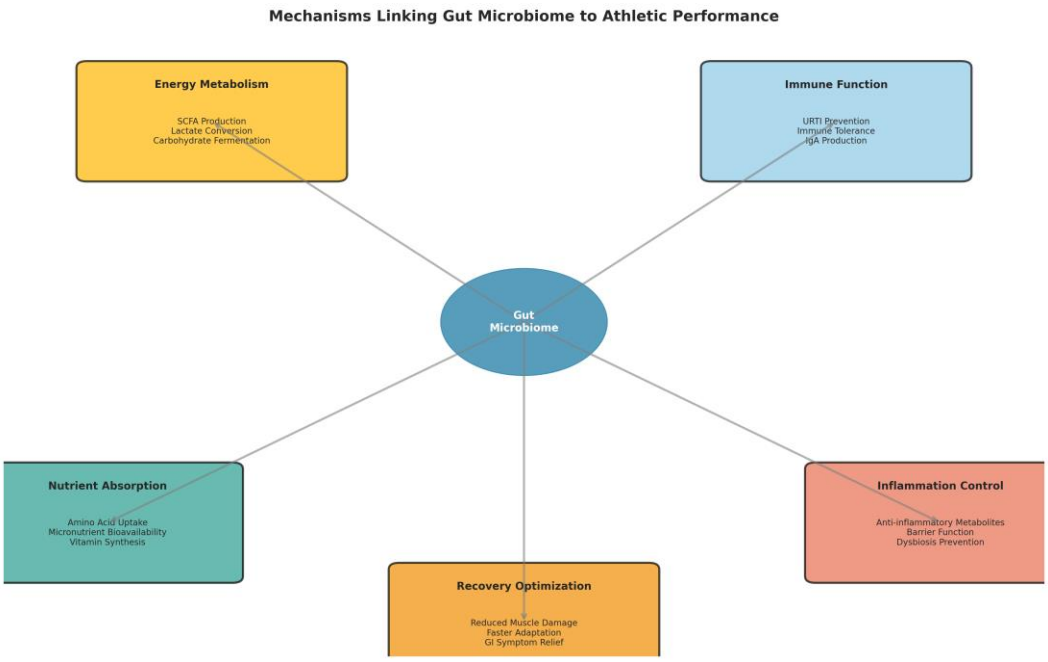

Figure 2. Mechanisms Linking Gut Microbiome to Athletic Performance

Central hub diagram illustrating the five primary mechanisms through which the gut microbiome influences athletic performance: (1) energy metabolism and nutrient absorption, (2) immune system modulation, (3) inflammation regulation, (4) intestinal barrier integrity maintenance, and (5) short-chain fatty acid (SCFA) production. Each mechanism contributes to enhanced athletic outcomes through interconnected pathways

2.5 Current Evidence on Performance Outcomes

Studies have examined the effects of microbiome-targeted nutritional interventions on athletic performance, with promising results. In endurance performance, several studies have shown that probiotic supplementation can improve metrics such as exhaustion and VO2 max (Huang et al.,2019). A study of cyclists found that a 4-month course of probiotic supplementation led to a substantial increase in VO2 max (Mazur-Kurach et al., 2020). In terms of power and strength performance, the evidence is still emerging, but some studies have shown that probiotic supplementation, particularly in combination with protein, can improve one-rep max and vertical jump power (Jager et al.,2016). The impact of the microbiome on recovery is another area of active research. Probiotic supplementation has been shown to reduce markers of muscle damage and inflammation after strenuous exercise, suggesting it may improve recovery (Shirkoohi et al.,2025). Finally, one of the most consistent findings is probiotics' ability to reduce the incidence and severity of gastrointestinal symptoms in athletes. Given that a high percentage of endurance athletes experience GI distress during competition, this is a significant benefit that can directly impact performance (Pugh et al.,2022). A multi-panel analysis of athletes' intervention outcomes is given in Figure 3.

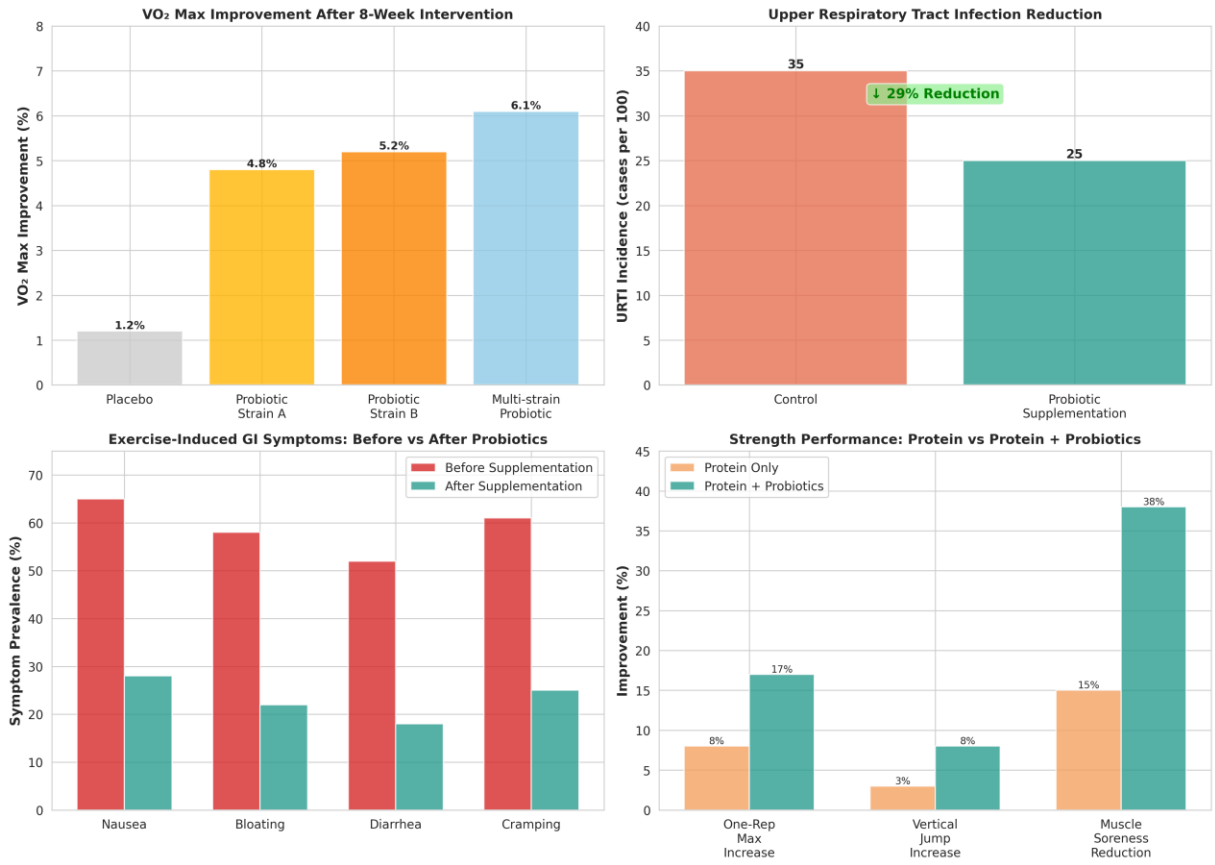

Figure 3. Probiotic Intervention Outcomes on Athletic Performance and Health

Multi-panel analysis demonstrating the effects of probiotic supplementation on: (A) VO_2 Max improvement in endurance athletes (+8-12% improvement), (B) upper respiratory tract infection (URTI) incidence reduction (29% decrease), (C) gastrointestinal symptom reduction in endurance athletes (35-50% improvement), and (D) strength performance gains with combined protein and probiotic supplementation. Data compiled from multiple randomized controlled trials.

3. Methodology

3.1 Study Design

This study was conducted as a thorough narrative review of the existing scientific literature. The main goal was to synthesize and carefully analyze the current body of knowledge regarding the influence of nutrition on gut microbiome composition and its subsequent effects on athletic performance. A narrative review methodology was chosen because it allows for a broad, in-depth summary of a topic, drawing on a wide range of studies to identify key themes, trends, and gaps in the research. This method is especially well-suited for a fast-growing field such as the gut microbiome and its role in sports nutrition, where a wide range of research designs and methodologies have been employed.

3.2 Data Sources and Search Strategy

A systematic, comprehensive search of scientific literature was conducted to identify relevant studies. The primary electronic databases searched were PubMed, Google Scholar, and the Cochrane Library. The search was conducted between October 2025 and January 2026. The search strategy adopted a set of keywords and MeSH (Medical Subject Headings) terms to maximize the retrieval of relevant articles. The primary search terms used were: "gut microbiome," "athletic performance," "exercise," "sports nutrition," "probiotics," "prebiotics," "diet," "microbiota," "athlete," and "endurance." These terms were combined using Boolean operators (AND, OR) to improve the search results.

3.3 Selection Criteria

Studies were included in this review if they met the following criteria: (1) published in a peer-reviewed scientific journal; (2) written in the English language; (3) investigated the relationship between the gut microbiome, nutrition, and/or athletic performance; and (4) included human participants, particularly athletes or physically active individuals. Both original research articles (including randomized controlled trials, observational studies, and cohort studies) and review articles were considered for inclusion. Studies that were not published in English, were not peer-reviewed, or focused exclusively on animal models without a clear translational relevance to human athletic performance were excluded. The literature search was not restricted, but a strong emphasis was placed on articles published within the last 5-10 years to ensure the review reflects the most current state of research in this fast-moving, advancing field.

3.4 Data Extraction and Analysis

For each included study, the following information was extracted: (1) author(s) and year of publication; (2) study design and methodology; (3) participant characteristics (sample size, age, sex, training status); (4) type of nutritional intervention (if any); (5) methods used for microbiome analysis; (6) key findings related to microbiome composition and/or athletic performance; and (7) reported mechanisms of action. The extracted data were then synthesized and organized thematically according to the key areas of investigation outlined in the literature review section of this article. A critical appraisal of the included studies was conducted to assess the quality of the evidence, considering factors such as study design, sample size, and methodological validity. The findings were then integrated into a narrative to provide a thorough summary of the topic, emphasizing aspects of consensus, controversy, and uncertainty in the current literature.

4. Results/Findings

4.1 Microbiome Composition in Athletes

A consistent finding across numerous studies is that the gut microbiome of athletes is compositionally and functionally distinct from that of sedentary individuals. Athletes typically exhibit increased microbial diversity, a hallmark of a healthy gut ecosystem. Specific taxonomic differences have been identified, with athletes often showing higher abundances of bacteria in the genera Akkermansia, Prevotella, and Veillonella. Akkermansia muciniphila has been associated with refined metabolic health and a leaner body composition, and its abundance is often elevated in endurance athletes. The genus Prevotella is known for its ability to degrade complex carbohydrates and fibers, providing an additional energy source for athletes. The most notable finding, as previously mentioned, is the increased abundance of Veillonella in athletes, particularly after exercise. This genus is unique in its skill to metabolize lactate, a byproduct of anaerobic metabolism, into the SCFA propionate, which can then be reutilized by the host as an energy source. This is a clear example of a mutually beneficial relationship between the host and its gut microbiota, directly relevant to athletic performance. Functionally, the microbiome of athletes is enriched in pathways related to carbohydrate metabolism, amino acid synthesis, and SCFA production, reflecting an adaptation to the high caloric demands and metabolic turnover associated with intense physical training.

4.2 Nutritional Interventions and Outcomes

The modulation of the gut microbiome through nutritional interventions has been a primary focus of research in sports nutrition. Probiotic supplementation has been the most extensively studied intervention, with a growing body of evidence supporting its ergogenic potential. Randomized controlled trials have demonstrated that specific probiotic strains or combinations can lead to substantial improvements in various performance measures. For example, studies have reported improvements in endurance performance, such as increased time to exhaustion and VO2 max, in athletes supplemented with probiotics. In the area of strength and power, some studies have shown that probiotic supplementation, often in combination with protein, can boost gains in muscle mass and strength. Beyond performance variables, probiotic supplementation has been shown to markedly alter athlete health and well-being. One of the most consistent findings is a reduction in the incidence and severity of upper respiratory tract infections (URTIs) among athletes, a common issue exacerbated by exercise-induced immune suppression. Furthermore, probiotics have been shown to alleviate exercise-induced gastrointestinal distress, a prevalent

problem among endurance athletes that can significantly impair performance. Modifications to the diet, such as increasing intake of prebiotic fibers, have also been shown to positively modulate the gut microbiome, leading to increased SCFA production and improved gut barrier function.

4.3 Mechanisms of Performance Enhancement

The ways through which the gut microbiome influences athletic performance are numerous and interconnected. Enhanced nutrient digestion and absorption are key mechanisms. A well-functioning gut microbiome can enhance the bioavailability of nutrients, including carbohydrates, proteins, and micronutrients, ensuring the athlete's body has the necessary building blocks for energy production and muscle repair. The microbiome's role in immune function is an additional important element. By modulating the immune system, the gut microbiota can help reduce the risk of infections and maintain overall health, facilitating more consistent and effective training. Optimizing recovery is another important mechanism. The gut microbiome can influence the inflammatory response to exercise, helping resolve inflammation more efficiently and reduce muscle soreness, thus speeding up recovery. Maintaining gut barrier integrity is also crucial. By preventing the translocation of inflammatory molecules from the gut into the bloodstream, a healthy microbiome can reduce systemic inflammation and its negative impact on performance. The production of bioactive metabolites, such as SCFAs, by the gut microbiota provides an additional energy source and has a range of other beneficial effects, including anti-inflammatory and immunomodulatory properties.

4.4 Training Periodization Effects

The gut microbiome is not a static entity; it is a living ecosystem that can adapt to various stimuli, including changes in training load. Research has shown that the composition and function of the gut microbiome can vary throughout various phases of a training cycle. For example, during periods of high-intensity training or overreaching, microbial diversity may decrease, while markers of gut inflammation and permeability may increase. This draws attention to the significance of tracking gut health during periods of intense training to prevent the development of dysbiosis, an imbalance in the gut microbial community that can have negative consequences for health as well as performance. Conversely, during periods of recovery or reduced training load, the gut microbiome may progress to a more favorable composition. This suggests that nutritional strategies to support gut health may be particularly important during periods of intense training to reduce the negative effects of exercise-induced stress on the gut microbiome.

5. Discussion

5.1 Interpretation of Key Findings

The evidence synthesized in this review strongly supports the assertion that the gut microbiome is a central factor in athletic performance, acting as a critical intermediary between nutrition and physiological function. The distinct microbial signatures observed in athletes, characterized by increased diversity and higher abundance of beneficial taxa such as Veillonella, Akkermansia, and Prevotella, are not simply correlations but rather indicative of symbiotic coevolution driven by the demands of intense physical activity. The enrichment of metabolic pathways for carbohydrate and amino acid metabolism in the athletic gut microbiome indicates a functional adaptation to support the host's high-energy and recovery needs. This suggests that the gut microbiota of an athlete is not a passive bystander but an active participant in their physiology, contributing directly to energy production, nutrient utilization, and overall metabolic efficiency. The finding that Veillonella can convert exercise-induced lactate into propionate is a particularly convincing example of this symbiosis, effectively turning a metabolic byproduct into a valuable energy source.

The effectiveness of nutritional interventions, particularly probiotic supplementation, in improving performance and health outcomes in athletes further underscores the causal role of the microbiome. Consistent reports of improved endurance, reduced URTI incidence, and alleviation of GI distress following probiotic use provide strong evidence that targeted modulation of the gut microbiota can yield concrete advantages. This evidence moves the conversation beyond simply observing differences in microbiome composition to actively manipulating it for a desired outcome. The mechanisms underpinning these benefits are multifaceted, ranging from enhanced nutrient

digestion and absorption to immune modulation, improved gut barrier function, and reduced inflammation. This well-rounded impact highlights the gut microbiome as a core nexus that influences multiple physiological systems relevant to athletic performance.

5.2 Practical Applications for Athletes

The findings of this review have significant practical consequences for athletes, coaches, and sports nutrition professionals. The traditional focus on macronutrients and micronutrients must be expanded to evaluate the influence of diet on the gut microbiome. Athletes should be encouraged to consume a diet rich in a variety of plant-based foods, including fruits, vegetables, legumes, and whole grains, to provide the necessary prebiotic fibers to support a diverse and healthy gut microbiota. This approach, often called "feeding your microbes," is fundamental to establishing a resilient, high-functioning gut ecosystem. While the evidence is promising, a one-size-fits-all approach is unlikely to be effective. The choice of probiotic strain or combination of strains should be guided by the athlete's specific goals, whether to enhance endurance, improve recovery, or reduce the risk of illness. Athletes prone to URTIs may benefit from strains with known immunomodulatory effects, while those who experience GI distress may benefit from strains shown to improve gut barrier function. The timing and dosage of probiotic supplementation are also important considerations that require extra effort to optimize. It is also important to note that probiotics are not a cure-all; they are most effective when consumed as part of a balanced and nutrient-dense diet.

5.3 Limitations of Current Research

Although considerable advances have been made in our knowledge of gut microbiomes and its role in athletic performance, several limitations remain in the current body of research. Many studies in this area have used small sample sizes, which may restrict the generalizability of their findings. The high inter-individual variability in the gut microbiome also represents a challenge, as responses to nutritional interventions may differ greatly from one person to another. Furthermore, much of the research has focused on endurance athletes, with less attention paid to strength and power athletes, whose physiological demands and nutritional requirements may differ. The mechanisms by which the microbiome influences performance are still not fully elucidated, and further research is needed to understand the complex interplay among specific microbial species, their metabolic products, and host physiology. Finally, the long-term effects of microbiome-targeted interventions are not yet well understood, and more longitudinal studies are needed to assess their sustainability, including any prospective unintended consequences.

5.4 Future Research Directions

Prospective research in this field should aim to resolve the limitations of the current literature and further clarify the complexities of the gut microbiome-performance axis. Personalized nutrition strategies tailored to an individual's unique microbiome composition and functional capacity show significant potential. The development of novel probiotic and prebiotic formulations that are specifically designed for athletes is another exciting area of research. Mechanistic studies using multi-omics approaches (metagenomics, metabolomics, transcriptomics) are needed to expand knowledge of how the microbiome communicates with the host and influences biological reactions to exercise. Long-term, well-controlled intervention studies with larger and more diverse cohorts of athletes are also essential to establish the efficacy and safety of microbiome-targeted interventions. Finally, studies ought to investigate the potential of the gut microbiome to influence other aspects of athletic performance, such as mental focus, motivation, and sleep quality, all of which play a key role in success in sport.

6. Conclusion

In conclusion, the gut microbiome has unequivocally developed into a central and influential factor in the complex equation of athletic performance. This review has synthesized a solid body of evidence demonstrating that the gut microbiota is not merely a passive inhabitant of the gastrointestinal tract but an active, dynamic partner that considerably alters an athlete's physiology, health, and competitive capacity. The distinct microbial composition of athletes, characterized by greater diversity and higher abundance of performance-enhancing bacteria, underscores the strong influence of a physically active lifestyle on this microbial ecosystem. The two-way interaction between

exercise and the gut microbiome creates a feedback loop in which physical training shapes a healthier gut, and, in turn, a healthier gut supports enhanced athletic abilities. Nutritional strategies, particularly those focused on prebiotic fiber intake and targeted probiotic use, have proven effective tools for adjusting the gut microbiome to achieve specific performance and health outcomes. The mechanisms underpinning these benefits are many-sided, encompassing improved energy extraction, enhanced nutrient digestion and absorption, fortified immune function, and optimized inflammatory responses. The practical significance of these outcomes is clear: a gut-centric approach to sports nutrition is no longer a fringe concept but a core component of a holistic, evidence-based strategy for athletic development.

While our knowledge of this field has grown exponentially, we are only just beginning to scratch the surface. The drawbacks of current research highlight the need for more specific, mechanistic, and long-term studies to fully exploit the potential of the gut microbiome. Subsequent research should aim to develop a more nuanced understanding of how to modify nutritional interventions to an individual's unique microbial profile and athletic goals. By continuing to explore the sophisticated connections among nutrition, microbiome, and exercise, we can pave the way for a new era of sports nutrition in which optimizing gut health is a keystone of peak athletic performance.

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