QUALITY IN SPORT
eISSN 2450-3118 · Open Access · Peer-reviewed
apcz.umk.pl/QS Nicolaus Copernicus University in Toruń



CIĘSZCZYK, Angelika, CZAJKA, Alicja, BANAŚ, Anna, CZARNACKI, Dawid, ŚLICZNIAK, Iga, CARUK, Jan, CIESIELCZYK, Jan, LUKOVYCH, Kvitoslava, MŁYNARCZYK, Magdalena and SZKUP, Paweł. Probiotic Supplementation in Ultramarathon Runners: Effects on Gastrointestinal Symptoms and Intestinal Barrier Integrity — A Narrative Review. Quality in Sport. 2026.79.76663. https://doi.org/10.12775/QS.2026.79.76663

ARTICLE TIMELINE
Received: 13.10.2026.
Accepted: 05.11.2026.
Published: 11.11.2026.

INDEXING & EVALUATION
MEiN points: 20 Unique ID: 201398
Disciplines: Economics & Finance; Management & Quality Sciences

The journal has been awarded 20 points in the parametric evaluation by the Ministry of Higher Education and Science of Poland. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024 No. 32553. Unique Journal Identifier: 201398. Scientific disciplines assigned: Economics and Finance (Field of Social Sciences); Management and Quality Sciences (Field of Social Sciences).

Punkty Ministerialne z 2019 — aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

© The Authors 2026. This article is published with open access under the License Open Journal Systems of Nicolaus Copernicus University in Toruń, Poland. Open Access: This article is distributed under the terms of the Creative Commons Attribution Non-commercial Share Alike License (http://creativecommons.org/licenses/by-nc-sa/4.0/), which permits unrestricted, non-commercial use, distribution, and reproduction in any medium, provided the work is properly cited. The authors declare no conflict of interest regarding the publication of this paper.

Probiotic Supplementation in Ultramarathon Runners: Effects on Gastrointestinal Symptoms and Intestinal Barrier Integrity — A Narrative Review

Angelika Cięszczyk

ORCID: https://orcid.org/0009-0006-7011-3088

angelikacieszczyk87@gmail.com

Medical University of Lublin

Aleje Racławickie 1; 20-059 Lublin; Poland

Alicja Czajka

ORCID: https://orcid.org/0009-0005-8774-4743

alaczajka2003@gmail.com

Medical University of Lublin

Aleje Racławickie 1; 20-059 Lublin; Poland

Anna Banaś

ORCID: https://orcid.org/0009-0006-3227-7428

annabanas05@gmail.com

Medical University of Lublin

Aleje Racławickie 1; 20-059 Lublin; Poland

Dawid Czarnacki

ORCID: https://orcid.org/0009-0000-6403-0223

dawidchabrowaa@gmail.com

Medical University of Lublin

Aleje Racławickie 1; 20-059 Lublin; Poland

Iga Śliczniak

ORCID: https://orcid.org/0009-0006-5362-5161

Iga.sliczniak@gmail.com

Medical University of Lublin

Aleje Racławickie 1; 20-059 Lublin; Poland

Jan Caruk

ORCID: https://orcid.org/0009-0000-3823-688

jancaruk@interia.pl

Medical University of Lublin

Aleje Racławickie 1; 20-059 Lublin; Poland

Jan Ciesielczyk

ORCID: https://orcid.org/0009-0007-5919-7804

jancie.photo@gmail.com

Medical University of Lublin

Aleje Racławickie 1; 20-059 Lublin; Poland

Kvitoslava Lukovych

ORCID: https://orcid.org/0009-0005-4906-1167

kvitkalukovych@gmail.com

Medical University of Lublin

Aleje Racławickie 1; 20-059 Lublin; Poland

Magdalena Młynarczyk

ORCID: https://orcid.org/0009-0003-4151-661X

magdamlynarczyk10@gmail.com

Medical University of Lublin

Aleje Racławickie 1; 20-059 Lublin; Poland

Paweł Szkup

ORCID: https://orcid.org/0009-0007-9981-5080

pawelszkup22@gmail.com

Medical University of Lublin

Aleje Racławickie 1; 20-059 Lublin; Poland

Corresponding Author: Angelika Cięszczyk

Abstract

Background: Gastrointestinal (GI) symptoms are common during endurance exercise, particularly ultramarathons, where prolonged exertion may impair intestinal barrier function.

Aim: To review evidence on the effects of probiotics on GI symptoms and intestinal barrier integrity in ultramarathon and long-distance runners.

Methods: This narrative review synthesised scientific literature published between 2016 and 2026, identified through PubMed and Scopus, focusing on probiotic supplementation, gastrointestinal symptoms and intestinal barrier integrity in endurance athletes, particularly ultramarathon runners.

Results: Some probiotic interventions reduced selected GI symptoms, but findings varied across strains, doses, supplementation periods and exercise protocols. Evidence for improvements in intestinal barrier function and inflammatory markers remains inconsistent. Symptom relief did not necessarily coincide with changes in objective biomarkers. Direct intervention studies in ultramarathon runners are scarce.

Conclusions: Current evidence does not establish that probiotics reliably prevent GI symptoms or protect intestinal barrier integrity during ultramarathons. No optimal strain, dose or supplementation duration can be recommended. Further placebo-controlled trials in real-world ultramarathon settings are needed.

Keywords: Ultramarathon; probiotics; gut microbiota; gastrointestinal symptoms; intestinal barrier; exercise-induced gastrointestinal syndrome; endurance sports

1. Introduction

Ultramarathon running as a specific physiological stress

Ultramarathon running, defined as competitions covering distances exceeding those of a standard marathon, constitutes a specific form of endurance exercise. Prolonged physical activity can lead to significant disturbances in the body's homeostasis, affecting, amongst others, the cardiovascular, muscular and renal systems, as well as the gastrointestinal tract [7,11,13,14]. The significance of these changes may increase as the distance covered lengthens. A study by Hansson et al., covering runs ranging from 20 to 164 km, demonstrated that the response of selected markers of organ damage and inflammation was greater following ultra-distance runs than after shorter-distance events [11].

One of the systems particularly vulnerable to the consequences of prolonged exercise is the gastrointestinal tract. During intense physical activity, blood flow is redistributed towards the working skeletal muscles and the skin, which may lead to a reduction in visceral perfusion. Gastrointestinal hypoperfusion, combined with the neuroendocrine response and heat stress, constitutes one of the fundamental elements of the pathophysiology of exercise-induced gastrointestinal syndrome (EIGS) [6–8,13,14].

The significance of heat stress is particularly pronounced during prolonged competitions taking place in high ambient temperatures. An increase in core body temperature may exacerbate gastrointestinal dysfunction and damage to the gastrointestinal epithelium. Henningsen et al. demonstrated that an increase in core body temperature in response to exercise performed under heat stress may be associated with a worsening of the symptoms characteristic of EIGS [16].

The type of exercise undertaken may also influence the development of gastrointestinal complaints. Running involves repetitive mechanical stress on the gastrointestinal tract, the

nature of which differs from that experienced during cycling, amongst other activities [8]. Consequently, the pathogenesis of gastrointestinal disorders during an ultramarathon should be considered as the result of the interaction of circulatory, thermal, neuroendocrine, mechanical and nutritional factors [6–8,13].

1.1.Gastrointestinal complaints and the ‘runner’s gut’ phenomenon

Gastrointestinal complaints are a common problem amongst those who practise endurance sports. In the literature, this phenomenon is sometimes referred to as ‘runner’s gut’. Symptoms may affect both the upper and lower gastrointestinal tracts and include, amongst others, nausea, vomiting, reflux, a feeling of fullness, abdominal pain and cramps, bloating, the urge to pass stools and diarrhoea [4,6,7,9,13].

Smarkusz-Zarzecka et al. indicate that gastrointestinal complaints may occur in as many as 70 per cent of people practising endurance sports [9]. However, the frequency and severity of symptoms may vary depending on the nature of the exercise, its intensity and duration, environmental conditions, nutritional strategy, and the athlete’s individual susceptibility [6,7,13].

GI symptoms can negatively affect an athlete’s comfort and ability to continue exercising. The issue takes on particular significance during ultramarathons, during which exposure to potential triggers of gastrointestinal disturbances may persist for many hours [13,14,22].

The aetiology of these symptoms is not limited solely to physiological factors. Urwin et al. analysed the relationship between psychological stress and anxiety and GI symptoms before and during a 56 km ultramarathon. The results of this study highlight the importance of the

interaction between psychological factors and gastrointestinal function during ultra-endurance exercise [23]. This relationship forms part of the broader concept of the microbiota–gut–brain axis, the potential significance of which for athletes was also described by Clark and Mach [20].

Given the multifactorial aetiology of GI disorders, their assessment should take into account both the subjective severity of symptoms and – in mechanistic studies – objective parameters of gastrointestinal function. Costa et al. emphasise the need to standardise the methods used to assess exercise-related gastrointestinal disorders [6].

1.2.Gut microbiota and intestinal barrier integrity in athletes

The intestinal barrier is a complex system comprising the intestinal epithelium, intercellular junctions, the mucus layer, local components of the immune system and the gut microbiota. Its proper functioning allows for the selective absorption of nutrients whilst limiting the passage of potentially harmful substances from the intestinal lumen into the systemic circulation [1,2,5,7].

The microbiota plays a significant role in maintaining the homeostasis of the intestinal environment. Available studies indicate that regular physical activity may be associated with changes in its composition, diversity and metabolic activity [1,2,5]. At the same time, the nature of the observed changes may depend on the sporting discipline. Shalmon et al. demonstrated differences in gut microbiota profiles between long-distance runners and cyclists, suggesting that the specific type of endurance activity may influence the characteristics of the microbiome [17].

One of the key mechanisms linking the microbiota to the functioning of the host organism is the production of bacterial metabolites, including short-chain fatty acids (SCFAs) such as butyrate, propionate and acetate. These metabolites may play a role in regulating the metabolism of intestinal epithelial cells, the immune response and the integrity of the intestinal barrier [1,2,5].

Under conditions of prolonged and intense exercise, this balance may be disrupted. Visceral hypoperfusion, hyperthermia and other exercise-related factors may lead to damage to enterocytes and increased permeability of the intestinal barrier [6,7,13,14,16,22]. Consequently, there may be increased permeation of bacterial components from the gastrointestinal lumen and the development of an inflammatory response.

Various groups of biomarkers are used in studies of this phenomenon. Intestinal fatty acid-binding protein (I-FABP) is primarily used as a marker of enterocyte damage. Tests utilising specific sugars are used to assess intestinal permeability, whilst markers associated with lipopolysaccharide (LPS), LPS-binding protein (LBP) or sCD14 relate to exposure to bacterial components. Faecal calprotectin, on the other hand, serves as a marker of gastrointestinal inflammation [6,7,11].

In some studies involving athletes, zonulin has also been used as a marker associated with intestinal barrier function [4]. Given the diversity of methods and biomarkers employed, individual parameters of gastrointestinal function should be interpreted in the context of the physiological process they reflect [6].

Disorders of the intestinal barrier function in endurance athletes are the subject of growing interest, as reflected in reviews on ‘leaky gut’ and exercise-induced gastrointestinal damage [14,22]. Potential dietary strategies to mitigate these disorders include various types of

supplementation [15,19]. One of the most intensively studied approaches is the modulation of the microbiota using probiotics [3,4,10,12].

2. Aim of the study

The main aim of this narrative review is to synthesise the current knowledge regarding the effect of probiotic supplementation on the frequency and severity of gastrointestinal symptoms, as well as parameters related to intestinal barrier integrity, in ultramarathon runners and long-distance runners.

Particular attention was paid to the effect of probiotics on subjectively assessed GI symptoms and objective markers of intestinal epithelial damage, barrier permeability, inflammation and the systemic response. Potential mechanisms of action of probiotics related to the modulation of the microbiota, the production of bacterial metabolites and the regulation of the immune response were also considered.

An additional aim of this study is to present the probiotic strains, doses and duration of supplementation used in previous studies, and to identify the limitations of the current state of knowledge. Due to the limited number of studies conducted directly on ultramarathon runners, the analysis was extended to include data on long-distance runners and endurance athletes, whilst maintaining a distinction between evidence derived directly from ultramarathons and results obtained in other sporting populations.

Unlike broader reviews of probiotic supplementation in athletes, this narrative review focuses on the applicability of existing evidence to ultramarathon running and critically distinguishes subjective gastrointestinal symptoms from objective markers of intestinal barrier function.

3. Materials and methods

This study was conducted as a narrative review of scientific literature concerning the effects of probiotic supplementation on gastrointestinal symptoms and intestinal barrier integrity in endurance athletes, with particular emphasis on ultramarathon and long-distance runners.

The literature was identified using the PubMed and Scopus electronic databases. The review included relevant scientific publications published between 2016 and 2026, corresponding to the publication years represented in the final reference list.

The literature search focused on topics related to probiotic supplementation, gastrointestinal disturbances, intestinal permeability, intestinal barrier function, gut microbiota and endurance exercise. Relevant search terms included probiotics, ultramarathon, endurance running, gastrointestinal symptoms, exercise-induced gastrointestinal syndrome, intestinal permeability, intestinal barrier and gut microbiota.

The review considered original research articles, randomised controlled trials, observational studies, systematic reviews, meta-analyses and narrative reviews relevant to the research objectives. Particular attention was paid to studies investigating probiotic supplementation and its potential effects on gastrointestinal symptoms and physiological markers associated with intestinal barrier function.

Studies conducted directly in ultramarathon runners were given particular consideration. Due to the limited availability of research involving this population, studies conducted in marathon runners, long-distance runners and other endurance athletes were also included when relevant to the research question.

The analysis focused on probiotic strains, supplementation doses, intervention duration, participant characteristics and reported outcomes. Subjective gastrointestinal symptoms were evaluated separately from objective markers of intestinal epithelial damage, permeability and inflammation.

The findings were synthesised qualitatively, with particular consideration of methodological differences between studies and the limitations of the available evidence. As this was a narrative review, no meta-analysis or formal risk-of-bias assessment was performed.

4. Current state of knowledge

4.1. Pathophysiology of gastrointestinal symptoms during ultra-endurance exercise

Gastrointestinal complaints associated with physical exercise have a complex and multifactorial aetiology. One of the most commonly used concepts to describe their aetiology is exercise-induced gastrointestinal syndrome (EIGS). This encompasses disturbances in gastrointestinal function resulting from the interaction of circulatory and neuroendocrine mechanisms, the significance of which may increase with the intensity and duration of exercise [6,7,13].

One of the fundamental mechanisms of EIGS is a reduction in blood flow to the visceral region. During exercise, blood is redistributed towards active skeletal muscles and the skin, which supports exercise metabolism and thermoregulation, but may simultaneously reduce gastrointestinal perfusion. Visceral hypoperfusion can lead to hypoxia of enterocytes, impaired epithelial function and increased susceptibility of the intestinal barrier to damage [6,7,13,14].

Heat stress is a significant factor exacerbating these processes. Prolonged exercise, particularly when performed in high ambient temperatures, leads to an increase in core body temperature. Henningsen et al. demonstrated that an increase in core body temperature during exercise under heat stress may be associated with a worsening of the disturbances characteristic of EIGS [16]. In the case of ultramarathon events, this issue may be of particular significance due to the prolonged exposure to exercise and environmental stress.

The nature of the activity undertaken also influences the development of GI symptoms. Costa et al. indicate that the type of exercise can modify both physiological disturbances within the gastrointestinal tract and the accompanying symptoms [8]. Running is additionally associated with repetitive mechanical stress on the abdominal cavity, which may contribute to the development of symptoms, particularly in the lower gastrointestinal tract [8,13].

Damage to enterocytes and impaired functioning of the intestinal barrier may lead to increased intestinal permeability. Consequently, the passage of bacterial components from the gastrointestinal lumen may be facilitated, which may contribute to the development of a systemic inflammatory response [7,14,22]. These mechanisms are particularly significant during prolonged endurance exercise, where circulatory, thermal, mechanical and nutritional factors overlap [13,14].

In studies on exercise-induced gastrointestinal damage, various groups of biomarkers are used, each reflecting different physiological processes. I-FABP is primarily used as a marker of enterocyte damage, whilst tests based on the absorption of specific sugars allow the permeability of the intestinal barrier to be assessed. LPS, LBP and sCD14 relate to the body's exposure to bacterial components, whilst faecal calprotectin is used as a marker of gastrointestinal inflammation [6,7,11]. Zonulin is also used in some studies; however, the variety of markers and measurement methods employed makes it difficult to directly compare results [4,6].

It should also be emphasised that the presence of subjective GI symptoms does not necessarily directly reflect the extent of epithelial damage or increased intestinal permeability. Costa et al. Highlight the need to standardise the methods used to assess both symptoms and physiological abnormalities associated with EIGS [6]. Distinguishing between these endpoints is of particular importance when evaluating the potential effects of probiotics.

4.2.Potential mechanisms of action of probiotics in endurance athletes

The gut microbiota is involved in numerous processes essential for maintaining the body's homeostasis, including nutrient metabolism, immune system function, the production of bacterial metabolites, and the regulation of the gut environment [1,2,5]. For this reason, modulating the microbiota using probiotics has been proposed as one of the potential strategies to support gastrointestinal function in athletes [3,4,10].

However, the potential effects of probiotics should not be regarded as a uniform effect across the entire group of preparations. Individual microorganisms may differ in their biological properties; therefore, the effects observed for a single strain or a mixture of strains cannot automatically be attributed to all probiotics [3–5].

One of the proposed mechanisms of action is the influence on the function of the intestinal epithelium and the mechanisms regulating barrier integrity. Modulation of the intestinal environment may potentially influence the functioning of intercellular junctions and mitigate the adverse consequences of gastrointestinal homeostasis disturbances [1,3,4]. However, the significance of this mechanism under conditions of exercise-induced hypoperfusion and hyperthermia remains a subject of research.

A second potential mechanism involves the influence on the metabolic activity of the microbiota and the production of short-chain fatty acids (SCFAs). SCFAs, including butyrate, acetate and propionate, are involved in communication between the microbiota and the host and

may influence epithelial cell metabolism and the immune response [1,2,5]. The relationship between the microbiota and exercise metabolism is of particular interest in sport; however, the observed correlations do not yet constitute proof that supplementation with any probiotic leads to improved performance.

The potential effects of probiotics also include the modulation of the immune response. Studies involving athletes have analysed, amongst other things, changes in cytokines, markers of inflammation and immune parameters [3,10,18]. Aquino-Lemos et al. assessed the effect of probiotic supplementation on inflammatory parameters and subjectively assessed sleep parameters following a marathon [18]. However, the changes observed were not consistent across all parameters assessed, which limits the possibility of drawing definitive conclusions regarding the anti-inflammatory effects of probiotics.

Interactions between the microbiota, the gastrointestinal tract and the central nervous system are also described within the context of the microbiota–gut–brain axis. Clark and Mach highlight potential links between exercise, stress, diet and the functioning of this axis in athletes [20]. In the context of ultramarathons, this issue is of interest due to the observed association between stress and anxiety and GI symptoms [23]. However, this does not currently allow us to conclude that probiotic supplementation reduces GI symptoms by influencing psychological factors.

4.3.The effect of probiotic supplementation on gastrointestinal symptoms

Studies on the effect of probiotics on GI symptoms in endurance athletes have yielded inconclusive results. Differences between individual studies relate to the study populations, the strains used, dosages, duration of supplementation, the nature of the exercise, and the methods used to assess symptoms [3,4,9,10,12].

Smarkusz-Zarzecka et al. conducted a randomised controlled trial investigating the effect of a multi-strain preparation on GI symptoms and selected biochemical parameters in long-distance runners [9]. Three months' supplementation was associated with beneficial changes in selected assessed symptoms, including a lower incidence of constipation. The results suggest that long-term multistrain supplementation may influence selected gastrointestinal symptoms; however, they should not be interpreted as evidence of the efficacy of all probiotic preparations in runners [9].

A more comprehensive assessment of the available evidence was carried out by Łagowska et al. In a systematic review of randomised controlled trials [4]. The authors included 10 publications involving a total of 822 athletes. The results suggested that certain interventions might have a beneficial effect on GI symptoms; however, the evidence was considered limited. The considerable heterogeneity of the preparations used and the supplementation protocols made it impossible to identify a single optimal probiotic for athletes [4].

Similar methodological issues were highlighted by Heimer et al. In a systematic review concerning the potential health benefits of probiotic use in sport [3]. The heterogeneity of the studies makes it difficult to draw general conclusions regarding the efficacy of probiotics, as the biological effect may depend on the strain used, the dose, the duration of supplementation and the characteristics of the study population [3].

Díaz-Jiménez et al. analysed the effect of probiotics on the performance of endurance athletes [10]. Although some studies suggested potential benefits in terms of selected exercise-related parameters, the available results did not allow for a clear determination of the effect of probiotic supplementation on performance. This is relevant to the present review, as improvements in gastrointestinal function should not automatically be equated with improved sporting performance [10].

In a systematic review on probiotic supplementation in endurance athletes, Andreoli et al. highlighted limited and heterogeneous evidence regarding the reduction of exercise-induced GI symptoms. Most of the studies analysed did not clearly demonstrate a beneficial effect of supplementation, and methodological differences made it difficult to draw definitive conclusions [12]. Taken together, the available data therefore suggest that selected interventions may influence certain gastrointestinal complaints; however, the effect is not consistently observed across all studies.

4.4. The effect of probiotics on intestinal barrier integrity and the inflammatory response

Assessing the effect of probiotics on intestinal barrier integrity is more complex than analysing subjective GI symptoms. Individual studies use different biomarkers, which relate to various aspects of the pathophysiology of EIGS [4,6]. For this reason, a change in a single parameter should not automatically be interpreted as a comprehensive improvement in intestinal barrier integrity.

A review by Heimer et al. Indicates that the results of studies on the effect of probiotics on health and physiological parameters in athletes remain heterogeneous [3]. Similarly, Łagowska et al. Emphasised that the limited number of studies does not allow for a clear link to be established between potential changes in barrier function and the cytokine response and a reduction in GI symptoms [4].

In the context of prolonged exercise, it is also important to distinguish between markers of epithelial damage, intestinal permeability and inflammation. In a study by Hansson et al., the response of a range of biomarkers was assessed during runs of varying lengths, including

ultramarathon events [11]. The results indicate that the length of the run is significant for the magnitude of the response of some markers, whilst the effect of probiotic supplementation was not consistent across all assessed parameters [11].

Aquino-Lemos et al. assessed the inflammatory response and LPS concentration following a marathon in a randomised, double-blind, placebo-controlled trial [18]. Despite observed changes in some parameters over time, no significant differences were found between the probiotic and placebo groups with regard to the cytokines analysed or LPS concentrations. These results therefore do not allow for unequivocal confirmation of the anti-inflammatory effect of the supplementation used or its protective effect on the intestinal barrier [18].

A broader context regarding the significance of supplementation for exercise-induced gastrointestinal damage was presented by Aitkenhead et al. In a systematic review and meta-analysis on the effect of dietary supplements on exercise-induced intestinal damage and GI symptoms [19]. Probiotics are one of several dietary strategies under investigation, and not the only potential method for modifying the gastrointestinal response to exercise [19].

4.5.Data relating directly to ultramarathons

One of the most significant limitations of the current state of knowledge is the small number of interventional studies on probiotics conducted directly under ultramarathon conditions. A significant proportion of the available data comes from marathon runners, long-distance runners or more broadly defined groups of endurance athletes [3,4,9,10,12].

A study by Hansson et al. from 2026 provides significant data on the effect of distance and probiotic supplementation on markers of kidney and muscle damage, as well as markers of

gastrointestinal inflammation, during running [11]. The study involved 34 runners, and the analysis covered 42 completed runs over distances ranging from 20 to 164 km. Participants received Lactiplantibacillus plantarum 299v at a dose of 40×10^9 CFU per day or a placebo for four weeks [11].

The response of some biomarkers was greater during runs over distances of 107–164 km than in shorter races, highlighting the particular physiological strain associated with ultra-long-distance exercise [11]. In the case of faecal calprotectin, the probiotic intervention was found to influence the running-related response; however, interpretation of the result is complex, as a change in the level of this marker was also observed during the supplementation period prior to the start of the race [11]. No consistent protective effect of the probiotic was found across all the markers analysed.

This study is particularly relevant for assessing supplementation in ultramarathons, as it involved an actual race covering 164 km. At the same time, its results show that the effect of probiotics cannot be interpreted as an unequivocal protective effect on the integrity of the intestinal barrier [11].

Data on ultramarathon runners also highlight the importance of factors not directly related to supplementation. Urwin et al. demonstrated associations between stress, anxiety and GI symptoms before and during a 56 km run [23]. This implies that future intervention studies should also control for psychological factors that may influence the subjective assessment of symptoms.

The limited number of studies directly concerning ultramarathon runners means that some conclusions regarding probiotics must currently be based on cautious extrapolation of data from

marathons and other endurance disciplines. This represents a significant research gap and justifies further research during actual ultramarathon events.

4.6.Strains, doses and duration of supplementation used in the studies

Research into probiotic supplementation in athletes is characterised by considerable diversity in the interventions used. Both single-strain and multi-strain preparations were used, and the duration of supplementation and dosages varied between studies [3,4,9–12].

Smarkusz-Zarzecka et al. Administered a multi-strain preparation to long-distance runners over a three-month period [9]. Hansson et al., on the other hand, used a single strain, Lactiplantibacillus plantarum 299v, at a dose of 40×10^9 CFU/day for four weeks [11]. These differences demonstrate that the term ‘probiotic supplementation’ encompasses interventions that vary considerably in biological terms.

The significance of a specific strain is particularly important, as the effect observed for a particular microorganism cannot be directly extrapolated to other strains, even those belonging to the same genus [3–5]. Similarly, there are insufficient grounds to assume that a multi-strain preparation is, by definition, more effective than a single-strain preparation.

Systematic reviews indicate considerable heterogeneity in dosages and duration of supplementation [3,4,10]. For this reason, the available data do not currently allow for the determination of a single minimum effective dose or an optimal duration of probiotic supplementation for ultramarathon runners.

The protocol-based study by McDermott et al. [24] is an example of the ongoing development of clinical research into the effect of probiotics on exercise performance in non-elite athletes. Such randomised, placebo-controlled and double-blinded studies may contribute to a better understanding of the potential effects of supplementation; however, the study protocol itself does not yet constitute proof of the intervention's efficacy [24].

Based on the available literature, it is therefore more appropriate to outline the scope of the protocols studied to date rather than to formulate specific recommendations regarding the strain, dose or duration of supplementation.

Table 1. Selected placebo-controlled probiotic studies in runners

Study and setting	Intervention	Duration	Main finding and interpretation
Pugh et al. [25]; 24 recreational marathon runners	L. acidophilus CUL60/CUL21; B. bifidum CUL20; B. animalis subsp. lactis CUL34; 25 × 10^9 CFU/day	28 days	Lower GI symptom severity during the final third of the marathon; no between-group differences in circulating physiological marker responses.
Hansson et al. [11]; 34 runners, 42 running observations; 20–164 km	Lactiplantibacillus plantarum 299v; 40 × 10^9 CFU/day	4 weeks	Altered faecal calprotectin response, with baseline changes complicating interpretation; no general demonstration of intestinal barrier protection.

Aquino-Lemos et al. [18]; 27 male marathon runners	L. acidophilus and B. lactis; 1 × 10^{10} CFU/day each	30 days	No significant between-group differences in analysed cytokines or LPS; within-group changes do not establish superiority to placebo.

CFU = colony-forming units; GI = gastrointestinal; LPS = lipopolysaccharide. Study populations, interventions and outcomes differ and should not be considered directly comparable.

4.7.GI symptoms and intestinal barrier integrity – distinct endpoints

One of the key interpretative problems in research on EIGS is the conflation of a reduction in subjective GI symptoms with an improvement in intestinal barrier integrity. However, these are distinct phenomena that require the use of different assessment methods [4,6].

Nausea, abdominal pain, bloating, reflux, the urge to defecate and diarrhoea are symptoms reported by the athlete. Their occurrence may depend on numerous factors, including the intensity of exercise, the type of food consumed, hydration, psychological stress and individual gastrointestinal tolerance [6,13,23].

In turn, damage to enterocytes, increased barrier permeability, exposure to bacterial components and inflammation are physiological processes assessed using appropriate biomarkers or functional tests [6,7]. An improvement in subjective symptoms therefore does not necessarily imply a simultaneous improvement in each of these parameters.

This distinction is of particular importance when interpreting probiotic studies. A review by Łagowska et al. Indicates that the available data do not allow for the demonstration of a simple relationship between the potential effect of probiotics on barrier function, the cytokine response and GI symptoms [4]. Similarly, the results of studies on biological markers suggest that potential effects may relate to selected endpoints rather than the entire EIGS mechanism [11,18].

From a methodological point of view, future studies should therefore combine a standardised assessment of subjective GI symptoms with measurements of appropriately selected biological markers [6]. Such an approach will make it possible to determine whether the potential reduction in symptoms following probiotic supplementation is indeed associated with a change in the functioning of the intestinal barrier.

4.8.The role of probiotics in the broader context of nutritional strategies

Probiotics represent one of many nutritional strategies analysed in the context of exercise-induced gastrointestinal disorders. Bazarewicz et al. presented a review of functional supplements used to reduce exercise-induced GI symptoms, highlighting the diversity of potential interventions [15]. Aitkenhead et al., on the other hand, conducted a systematic review of the effect of dietary supplements on exercise-induced gastrointestinal damage and GI symptoms [19]. Probiotics should therefore be considered as one of the dietary strategies under investigation, rather than as the sole potential method for reducing exercise-related gastrointestinal disorders.

The modulation of the gut microbiota in the context of exercise and recovery remains an important area of research. Czarnota et al. conducted a systematic review on this topic [21].

However, the available data indicate that the relationships between the composition of the microbiota, its modulation, probiotic supplementation and the body's response to exercise are complex. The current state of knowledge does not allow for the formulation of a universal probiotic supplementation protocol applicable to all endurance athletes [1,3,5,10,21].

Murawiec and Konert describe gastrointestinal disorders and increased intestinal permeability associated with prolonged endurance exercise [22], whilst Purpura et al. Outline the mechanisms, risk factors and significance of exercise-induced gastrointestinal damage [14]. These publications emphasise the multifactorial nature of disorders associated with EIGS. For this reason, potential probiotic supplementation should be considered as one element of a broader approach to the functioning of an athlete's gastrointestinal tract, rather than as a standalone method for preventing all disorders occurring during prolonged exercise.

The current state of knowledge points to a biological basis for further research into the use of probiotics in endurance sports; however, it does not allow for unequivocal confirmation of their efficacy in preventing GI symptoms or disturbances of the intestinal barrier in ultramarathon runners [3,4,11,12]. There is a particular need for randomised controlled trials conducted during actual ultramarathon events, utilising well-characterised probiotic strains and involving the simultaneous assessment of subjective GI symptoms and appropriately selected objective markers of gastrointestinal function.

5. Discussion

5.1.Interpretation of results and implications for ultramarathon runners

An analysis of the available literature suggests that probiotic supplementation may influence certain aspects of gastrointestinal function in endurance athletes; however, the current level of

evidence does not allow for unequivocal confirmation of its effectiveness in preventing gastrointestinal complaints and intestinal barrier dysfunction [3,4,9–12]. The results of individual studies vary, which may be due, amongst other things, to the use of different probiotic strains and doses, varying durations of supplementation, the characteristics of the study populations, and different exercise protocols [3,4].

Some studies point to potential benefits regarding selected GI symptoms. Smarkusz-Zarzecka et al. observed beneficial changes in certain symptoms among long-distance runners using a multi-strain preparation [9]. At the same time, a systematic review by Łagowska et al. revealed only limited evidence of a beneficial effect of probiotics on GI symptoms in athletes and did not allow a specific preparation to be identified as optimal [4]. This suggests that positive results from individual studies should not be automatically generalised to all probiotic preparations and all groups of athletes.

It is particularly important to distinguish between subjective GI symptoms and objective parameters related to the functioning of the intestinal barrier. A reduction in symptom severity does not necessarily imply a concurrent reduction in enterocyte damage, intestinal permeability or inflammation. The available data do not currently indicate a simple correlation between the effect of probiotics on GI symptoms and changes in all markers related to gastrointestinal function [4,6,11].

This issue is of particular significance for ultramarathon runners. Prolonged exercise can lead to the overlapping effects of visceral hypoperfusion, heat stress, mechanical stress and other factors associated with EIGS [6–8,13,14,16]. A study by Hansson et al., covering runs of up to 164 km, also indicates that the duration of exercise may influence the magnitude of the response of certain biomarkers [11]. However, the effect of Lactiplantibacillus plantarum 299v was not consistent across all analysed parameters; therefore, these results should not be interpreted as

unequivocal confirmation of the protective effect of probiotics on the intestinal barrier during an ultramarathon [11].

There remain few direct studies on probiotic supplementation in ultramarathon runners. For this reason, some of the current knowledge is based on results obtained from marathon runners, long-distance runners and other endurance athletes. These results should be extrapolated to the population of ultramarathon runners with caution.

5.2.Limitations of the available evidence

A fundamental limitation of the current state of knowledge is the considerable heterogeneity of the studies. The interventions used vary in terms of the type and number of probiotic strains, the dose and the duration of supplementation [3,4,9–12]. As the effects of probiotics depend on the specific strain, a result obtained for one preparation cannot be directly attributed to other probiotics.

There are also significant differences between the study populations and exercise protocols. The available studies include participants from various endurance disciplines, and the very nature of the activity may influence the gastrointestinal response [8]. Furthermore, differences in microbiota profiles have been demonstrated between long-distance runners and cyclists [17], which further highlights the need for caution when comparing results obtained across different groups of athletes.

Another limitation is the lack of standardised endpoints. Studies utilise both subjective scales of GI symptoms and various biological markers associated with epithelial damage, inflammation, intestinal permeability or exposure to bacterial components [4,6,11]. These parameters describe different processes and should not be treated as equivalent.

The occurrence of GI symptoms may also be influenced by factors independent of probiotic supplementation, including ambient temperature and core body temperature [16], the nature of the physical exertion [8], dietary strategy and psychological factors. Urwin et al. highlighted a relationship between stress, anxiety and GI symptoms during an ultramarathon [23]. Controlling for such factors is therefore important in future intervention studies.

The most significant limitation from the perspective of this review remains the small number of studies directly concerning ultramarathon runners. Consequently, the available evidence is insufficient to determine the optimal strain, dose or duration of probiotic supplementation specifically for this population.

Limitations of this narrative review also include the absence of a documented reproducible database search, a formal study-selection flow and a formal risk-of-bias assessment. The selection and qualitative interpretation of studies may therefore be subject to selection bias. These limitations prevent claims of systematic completeness.

5.3.Practical implications and directions for future research

Based on current data, probiotics can be considered a potential strategy to support gastrointestinal function in endurance athletes; however, there is currently no basis for

formulating a universal protocol for their use in ultramarathon runners [3,4]. In particular, it would be unjustified to specify a single minimum effective dose or a single optimal duration of supplementation, regardless of the strain used.

Future studies should involve larger groups of ultramarathon runners and, where possible, be conducted during actual competitions. Randomised, double-blind, placebo-controlled trials with a precisely defined strain, dose and duration of supplementation would be particularly valuable. The importance of properly designed interventional studies is highlighted by both existing reviews and study protocols concerning probiotic supplementation and exercise performance [3,4,24].

It is also important to use, in parallel, a standardised assessment of GI symptoms and appropriately selected biological markers [6]. This would help answer one of the most important questions arising from the current state of knowledge: whether the reduction in subjective symptoms following probiotic use is indeed accompanied by an improvement in parameters related to the integrity of the intestinal barrier.

Future studies should also take into account potential confounding factors, such as race distance, environmental conditions, diet and hydration, and psychological factors [11,16,23]. A deeper understanding of the relationship between the microbiota, exercise and the gastrointestinal response may enable a more precise assessment of the validity of using specific probiotic strains in endurance athletes [1,5,21].

In summary, the available findings justify further research into the use of probiotics in ultra-endurance sports, but do not currently allow for a definitive conclusion that supplementation effectively prevents exercise-induced GI symptoms or protects the intestinal barrier in ultramarathon runners.

6. Conclusions

Probiotic supplementation is a strategy currently being investigated for its potential to support gastrointestinal function in endurance athletes. Available studies suggest that selected strains or multi-strain preparations may influence certain gastrointestinal symptoms; however, the results are not sufficiently consistent to confirm the universal efficacy of probiotics in this regard [3,4,9,12].

The evidence regarding the effect of probiotic supplementation on the integrity of the intestinal barrier is even less conclusive. An improvement in subjectively assessed GI symptoms does not necessarily correspond to an improvement in objective parameters related to epithelial damage, intestinal permeability or inflammation [4,6,11]. For this reason, clinical effects and changes in biomarkers should be assessed as separate, albeit related, endpoints.

The number of studies conducted directly on ultramarathon runners is particularly limited. The current state of knowledge therefore does not allow for the identification of an optimal probiotic strain, dose or duration of supplementation for this group of athletes. Results obtained in marathon runners, long-distance runners and other endurance athletes may provide an important point of reference; however, caution is required when extrapolating these findings to the population of ultramarathon runners.

Further randomised controlled trials conducted under conditions mirroring actual ultramarathon competitions are necessary. These should involve precisely characterised probiotic strains and a concurrent, standardised assessment of GI symptoms and objective markers of gastrointestinal function. This will enable a more accurate determination of whether probiotic supplementation

may have practical significance in reducing gastrointestinal disturbances associated with ultra-endurance exercise.

Author's contribution:

Conceptualization: Angelika Cięszczyk

Methodology: Anna Banaś, Jan Caruk, Magdalena Młynarczyk

Software: Not applicable

Check: Paweł Szkup

Formalanalysis: Iga Śliczniak, Dawid Czarnacki

Investigation: Kvitoslava Lukovych, Jan Ciesielczyk

Sources: Alicja Czajka

Data curation: Jan Caruk, Alicja Czajka

Draft preparation: Angelika Cięszczyk , Anna Banaś, Iga Śliczniak, Alicja Czajka

Writing review and editing: Paweł Szkup, Kvitoslava Lukovyc

Visualization: Jan Ciesielczyk, Dawid Czarnacki

Supervision: Angelika Cięszczyk

Project administration: Angelika Cięszczyk, Magdalena Młynarczyk

Receiving Funding:

Not applicable.

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

Funding Statement:

This research received no external funding.Institutional Review

Board Statement:

Not applicable.

Informed Consent Statement:

Not applicable. Data Availability Statement:Not applicable.

Acknowledgments:

Not applicable.

Conflict of Interest Statement:

The authors declare no conflict of interest.

Declaration of the use of generative AI and AI-assisted technologies in the writing process.

During the preparation of this work, the authors used ChatGPT to improve the clarity and readability of the text and to assist with basic data analysis. The authors reviewed and edited the generated content where necessary and take full responsibility for the final content of the publication.

References

1. O'Brien MT, O'Sullivan O, Claesson MJ, Cotter PD. The Athlete Gut Microbiome and its Relevance to Health and Performance: A Review. Sports Med. 2022;52(Suppl 1):119–128. https://doi.org/10.1007/s40279-022-01785-x

2. Miranda-Comas G, Petering RC, Zaman N, Chang R. Implications of the Gut Microbiome in Sports. Sports Health. 2022;14(6):894–898. https://doi.org/10.1177/19417381211060006
3. Heimer M, Teschler M, Schmitz B, Mooren FC. Health Benefits of Probiotics in Sport and Exercise – Non-existent or a Matter of Heterogeneity? A Systematic Review. Front Nutr. 2022;9:804046. https://doi.org/10.3389/fnut.2022.804046
4. Łagowska K, Bajerska J, Kamiński S, Del Bo' C. Effects of Probiotics Supplementation on Gastrointestinal Symptoms in Athletes: A Systematic Review of Randomised Controlled Trials. Nutrients. 2022;14(13):2645. https://doi.org/10.3390/nu14132645
5. Pérez-Castillo ÍM, Sabag-Daigle A, López-Chicharro J, Mihic N, Rueda R, Bouzamondo H. The athlete's gut microbiota: state of the art and practical guidance. Benef Microbes. 2024;15(2):97–126. https://doi.org/10.1163/18762891-bja00007
6. Costa RJS, Young P, Gill SK, Snipe RMJ, Gaskell S, Russo I, Burke LM. Assessment of exercise-associated gastrointestinal perturbations in research and practical settings: methodological concerns and recommendations for best practice. Int J Sport Nutr Exerc Metab. 2022;32(5):387–418. https://doi.org/10.1123/ijsnem.2022-0048
7. Costa RJS, Snipe RMJ, Kitic CM, Gibson PR. Systematic review: exercise-induced gastrointestinal syndrome—implications for health and intestinal disease. Aliment Pharmacol Ther. 2017;46(3):246–265. https://doi.org/10.1111/apt.14157
8. Costa RJS, Mika AS, McCubbin AJ. The impact of exercise modality on exercise-induced gastrointestinal syndrome and associated gastrointestinal symptoms. J Sci Med Sport. 2022;25(10):788–793. https://doi.org/10.1016/j.jsams.2022.07.003
9. Smarkusz-Zarzecka J, Ostrowska L, Leszczyńska J, Cwalina U. Effect of a multi-strain probiotic supplement on gastrointestinal symptoms and serum biochemical parameters in long-distance runners: a randomised controlled trial. Int J Environ Res Public Health. 2022;19(15):9363. https://doi.org/10.3390/ijerph19159363
10. Díaz-Jiménez J, Sánchez-Sánchez E, Ordoñez FJ, Rosety I, Díaz AJ, Rosety-Rodriguez M, et al. Impact of Probiotics on the Performance of Endurance Athletes: A Systematic Review. Int J Environ Res Public Health. 2021;18(21):11576. https://doi.org/10.3390/ijerph182111576
11. Hansson E, Skinner B, Falcone T, Halder A, Lucas RAI. Effects of race distance and probiotic intervention on kidney, muscle, and gut injury and inflammation biomarker

responses during running. J Int Soc Sports Nutr. 2026;23(1):2651356. https://doi.org/10.1080/15502783.2026.2651356

12. Andreoli RVT, Ulbrich AZ, Bertin RL. Probiotic supplementation in reducing exercise-induced gastrointestinal symptoms in endurance athletes: an integrative review. O Mundo da Saúde. 2025;49:e16902024I. https://doi.org/10.15343/0104-7809.202549e16902024I
13. Ribichini E, Scalese G, Cesarini A, Mocci C, Pallotta N, Severi C, Corazziari ES. Exercise-Induced Gastrointestinal Symptoms in Endurance Sports: A Review of Pathophysiology, Symptoms, and Nutritional Management. Dietetics. 2023;2(3):289–307. https://doi.org/10.3390/dietetics2030021
14. Purpura A, Rolski W, Przybylska Z, Michalska P, Przystaś B, Grzechowiak M, et al. Exercise-induced gastrointestinal injury in endurance athletes: mechanisms, risk factors and clinical implications – a review. Quality in Sport. 2026;54:70038. https://doi.org/10.12775/QS.2026.54.70038
15. Bazarewicz J, Adaśko G, Świda M, Kubuj C, Mazur U, Ogonowska P, et al. Functional Supplements for Managing Exercise-Induced Gastrointestinal Distress: A Focused Review for Athletes. Quality in Sport. 2025;45:66517. https://doi.org/10.12775/QS.2025.45.66517
16. Henningsen K, Mika A, Alcock R, Gaskell SK, Parr A, Rauch C, Russo I, Snipe RMJ, Costa RJS. The increase in core body temperature in response to exertional-heat stress can predict exercise-induced gastrointestinal syndrome. Temperature (Austin). 2024;11(1):72–91. https://doi.org/10.1080/23328940.2023.2213625
17. Shalmon G, Ibrahim R, Israel-Elgali I, et al. Differential gut microbiome profiles in long-distance endurance cyclists and runners. Life. 2024;14(12):1703. https://doi.org/10.3390/life14121703
18. Aquino-Lemos V, Leite GSF, Silva ET, Batatinha HAP, Resende AS, Lancha-Junior AH, et al. Probiotic supplementation can alter inflammation parameters and self-reported sleep after a marathon: a randomised, double-blind, placebo-controlled study. Nutrients. 2025;17(23):3762. https://doi.org/10.3390/nu17233762
19. Aitkenhead R, Waldron M, Conway GE, Horner K, Heffernan SM. The Influence of Dietary Supplements on Exercise-Induced Gut Damage and Gastrointestinal Symptoms: A Systematic Review and Meta-Analysis. Nutrients. 2025;17(3):443. https://doi.org/10.3390/nu17030443

20. Clark A, Mach N. Exercise-induced stress behaviour, gut-microbiota-brain axis and diet: a systematic review for athletes. J Int Soc Sports Nutr. 2016;13:43. https://doi.org/10.1186/s12970-016-0155-6
21. Czarnota M, Ossowska W, Ösztreicher W. Gut Microbiota Modulation to Enhance Exercise Performance and Recovery – Systematic Review. Quality in Sport. 2025;43:62420. https://doi.org/10.12775/QS.2025.43.62420
22. Murawiec I, Konert M. The gastrointestinal disorders and leaky gut syndrome in endurance athletes. Journal of Education, Health and Sport. 2023;15(1):151–162. https://doi.org/10.12775/JEHS.2023.15.01.015
23. Urwin CS, Main LC, Mikocka-Walus A, et al. The Relationship Between Psychological Stress and Anxiety and Gastrointestinal Symptoms Before and During a 56 km Ultramarathon Running Race. Sports Med Open. 2021;7:93. https://doi.org/10.1186/s40798-021-00389-5
24. McDermott CE, Vincent HK, Mathews AE, Gonzalez Cautela B, Sandoval M, Tremblay A, et al. Impact of probiotic supplementation on exercise endurance among non-elite athletes: study protocol for a randomised, placebo-controlled, double-blind clinical trial. Trials. 2022;23:603. https://doi.org/10.1186/s13063-022-06552-x
25. Pugh JN, Sparks AS, Doran DA, Flemming SC, Langan-Evans C, Kirk B, Fearn R, Morton JP, Close GL. Four weeks of probiotic supplementation reduces GI symptoms during a marathon race. Eur J Appl Physiol. 2019;119:1491–1501. https://doi.org/10.1007/s00421-019-04136-3