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The Impact of Probiotic Supplementation on Sports Achievement - Literature Review

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ABSTRACT

INTRODUCTION:

According to the official definition provided by the Expert Consultation of the Food and Agricultural Organization of the United Nations and the World Health Organization (FAO/WHO), probiotics are "Live microorganisms that, when administered in adequate amounts, confer a health benefit on the host". In recent years, interest in probiotics has increased not only in terms of supporting the relief of symptoms of diseases such as Crohn's disease, anorexia, depression, or type 1 diabetes. Another target group were athletes. Currently, science focuses on understanding the physiological and metabolic mechanisms occurring during intense physical activity. Research has begun on supporting the intestinal microbiome to achieve better results in sports.

PURPOSE OF THE WORK:

This work aims to present interesting research on the potential role of probiotics in athletes. It illustrates how probiotics act on the body through many different mechanisms, which result in what is most important: homeostasis. The main intention is to demonstrate the potential power of probiotics, which will allow us to compose personal probiotics to achieve better results in sports in the future thanks to the design of personalized probiotics.

MATERIAL AND METHOD:

PubMed and Google Scholar databases were used for the research. We used the following keywords: probiotic supplementation, probiotic on sport, the role of probiotics, and gut microbiota.

DESCRIPTION OF THE STATE OF KNOWLEDGE:

Recent research has shown the positive effect of probiotics on the processes occurring in the body. They reduce inflammatory parameters and oxidative stress, improve the tightness of the intestinal barrier, have immunomodulatory properties, and regulate the functioning of skeletal muscles, bones and other groups of organs. Thanks to the use of appropriately composed probiotics containing specific bacterial strains, the body's regeneration is shorter and the effectiveness of exercises is greater.

CONCLUSIONS: The presenting research results may be a turning point in researching probiotics' mechanism of action. Further probiotic research should optimize supplementation composition, dose, and duration to obtain maximum safety and health benefits.

Keywords: probiotic supplementation, gut microbiota, sports Nutrition, athletes, exercise

INTRODUCTION

GUT MICROBIOME:

The human intestine is a habitat for many microorganisms. The human-microbiota relationship is described as commensal and symbiotic. The human gut microbiota contains thousands of different bacterial taxa as well as various fungi, protozoa and viruses, more than three million genes, and harbors an enormous metabolic capacity. (1) One-third of the gut microbiota is common among all individuals and the other two-thirds are unique to each individual. (2) The composition of microorganisms is characteristic and unique. The largest group are bacteria. The most dominant bacterial groups in the human gut are Firmicutes, Bacteroidetes, Actinobacteria, and Proteobacteria and the most recorded bacterial genera are Bacteroides, Clostridium, Peptococcus, Bifidobacterium, Eubacterium, Ruminococcus, Faecalibacterium and Peptostreptococcus. (3) The benefits that we can mention include: the fermentation of nutrients, stimulation of the immune system in the fight against pathogenic diseases, minor hormonal

changes, production of vitamins (B vitamins and vitamin K), and the integrity of epithelial cells. Instead, some species of intestinal microflora may cause disease or carcinogenesis. (4) Research in recent years has proven that the intestinal microbiome may indirectly influence physiological processes throughout the body, thanks to which it maintains the body's homeostasis. (5) From a sports perspective, the impact of microorganisms on the functioning of skeletal muscles is provided. A new relationship has been discovered in organisms, called the gut-muscle axis, which is based on the assumption that specific microbes can influence muscle function. However, not only microorganisms are involved in the functioning of the inhabiting organism. Diet and physical activity levels are the main factors influencing changes in biodiversity or changes in the levels of specific bacterial species in the established gut microbiota. (6) The discovery of these interdependent relationships may provide the beginning of research into creating an optimal environment conducive to sports success.

PROBIOTICS:

Even though the adult intestinal microbiome is constant, some factors disturb its composition and proportions. The basic factors are physical exercise, diet and antibiotics. (7). These changes may cause unfavorable effects such as inflammation, metabolic disorders, immune disorders, oxidative stress, or disorders of intestinal barrier tightness. (8) This condition is called dysbiosis. Changes in the composition of the microbiota may negatively affect the body, causing diseases. In recent years, scientists have become interested in the impact of microbiome changes on sports performance. For this reason, scientists have interested in the role of probiotics in achieving the best results in sports. The beginnings of research gave hope for composing a composition of probiotics that could maintain homeostasis and intestinal composition, which would bring better results in sports. Additionally, probiotics improve the health status of the consumer by improving the composition of the microbiota, and competitive exclusion of pathogens by reducing the intestinal pH, increasing the short-chain fatty acids and mucus production, and bacteriocin production. (9) Bifidobacteria and Lactobacilli can produce lactates, which are used as an energy source for skeletal muscles. (10)

Wen-Ching Huang et. al. researched triathletes, which showed that supplementation of Lactobacillus strains (single-strain and multi-species) may have a positive effect on reducing oxidative stress and inflammation and improving intestinal metabolic function after intense exercise. Lactobacillus plantarum PS128 strain increases the activation of T and B lymphocytes, increases the level of anti-inflammatory cytokines (IFN-γ, IgA, IL-10) and suppresses the

expression of pro-inflammatory cytokines (TNF-α, IL-6, IL-8). It is possible to have a beneficial effect on better adaptation to physical exercise thanks to the knowledge of the mechanisms and physiology of the Lactobacillus strain. (11)

Another positive role of the use of probiotics is to improve the tightness of the intestinal barrier, which is necessary for the proper absorption of nutrients and water while preventing harmful substances from entering the bloodstream. Increased permeability can cause vulnerability to allergies and infections, along with various gastrointestinal complaints. Intense physical exercise increases key phosphorylation enzymes, which disrupts the tight junction proteins of intestinal epithelial cells. Intestinal permeability increases and endotoxins enter the bloodstream, which triggers the body's immune response. (12)

Probiotic bacteria such as Lactobacillus and Bifidobacterium can perform the functions of lactic and acetic acid. These acids cause pH and acidify the environment, preventing the colonization and development of pathogens. Faecalibacterium otherwise causes an increase in the yield of butyrate and other short-chain fatty acids in the capsules, which may also be important based on insulin response. (13)

In addition to improving the tightness of the intestinal barrier, reducing oxidative stress and immune response, or lowering the pH of the environment, probiotics play other roles. Many studies have shown the influence of the composition of the intestinal microbiome on central nervous system disorders. This communication is called the gut-brain axis. This knowledge may influence the decision to include probiotics to support the treatment of patients suffering from neurological and mental diseases.

However, we know that most probiotic strains for commercial use belong to the genera Lactobacillus, Bifidobacterium and Bacillus. (14) For this reason, further research is conducted with their participation on the mechanism and role of probiotics in achieving sports results. At this point, we know that administering a high dose of probiotic (1011 cells) for a short period (7 days) did not significantly improve the systemic cytokine profile and intestinal permeability compared to the placebo group. (15)

Recent years have resulted in a threat to the role and mechanisms of action of probiotics. Otherwise, the relationship between probiotics and risks in sports raises new questions for scientists. What should be the composition and risk of a probiotic? What is the best way to

consume it? How can and transport strains? How important is the duration of use of preparations? (16)

SPORTS ACHIEVEMENTS AND PROBIOTIC SUPPLEMENTATION:

Musculoskeletal system:

Physiological and metabolic processes occurring under the influence of physical activity have a generalized positive impact on the functioning of the human body. In skeletal muscles, the biogenesis of mitochondria increases and their role in cell function increases. Additionally, they begin to store glycogen and the concentration of proteins responsible for the transport of substrates increases. Regular exercise leads to protein synthesis and an increase in the concentration of enzymes involved in dynamic chemical, physical and biological transformations. (17)

Thinking about sports achievements, we first focus on building muscle strength. For this reason, from an athlete's point of view, it is important to take care of the musculoskeletal system, especially since it is significantly damaged in this group. An additional factor promoting sports achievements is reducing the number of injuries and fractures. Therefore, based on scientific evidence, we know that the proper structure and strength of bones can be supported by supplementation with Lactobacillus reuteri, Bifidobacterium longum, or Lactobacillus casei Shirota.

M. Lei et al. conducted a study on a group of 417 elderly patients with an acute fracture of the distal radius. Patients were divided into groups: taking probiotics containing Lactobacillus casei Shirota and a placebo group. The results indicated that probiotic treatment improved bone formation, increased bone density, and prevented bone loss. Thanks to this study, we know that probiotic supplementation can accelerate fracture healing. (18)

Peishun Li, et. al in their study showed that one-year supplementation with Lactobacillus reuteri ATCC PTA 6475 could potentially prevent the deterioration of gut microbiota and inflammation in older women with low bone mineral density, which may have a beneficial effect on bone metabolism. These conclusions allow us to assume that supplementation will also have a positive effect on the bone metabolism of athletes. Additionally, Lactobacillus reuteri supplementation in healthy individuals results in an increase in the level of serum 25OH vitamin D and thereby affects calcium absorption and is beneficial to bone health. (19)

In a study conducted on MMA fighters, it was shown that the combination of supplementation with probiotics and the vitamin D3 influences the lactate utilization rate, total power and efficiency obtained during anaerobic training in the participant. In a study conducted for 4 weeks on MMA fighters who supplemented probiotics in a vitamin D an improvement in epithelial cell permeability and an extended time to exhaustion during exercise was observed. The positive effect of certain bacterial strains may be enhanced by vitamin D3, combined probiotics with vitamin D3 supplementation improved the lactate utilization ratio, total work, and average power obtained during the anaerobic in the MMA athletes. (20)

In studies on the spread of bacteria from the Bacteroides group, an increase in the production of short-chain fatty acids, a change in intestinal pH, and the absorption of substances from the intestines were observed. The consequence was an increase in bone mineralization and bone structure. (21)

Chronic supplementation with Provotella species relief extends the duration of risk by the onset period. The study was conducted on mice fed a high-fat, sucrose-available diet. Bacteria from the Provotella copri strain have the power to act as Burstynate. Bacteria from the Prevotella copri strain have demonstrated the ability to produce succinate. This activates intestinal glucogenesis, improves glucose tolerance and insulin sensitivity and therefore skeletal muscle metabolism. Supplementation allowed to extend time of physical activity concerning the regeneration period. Generally speaking, probiotics containing appropriate strains of bacteria can benefit bone metabolism by influencing the immune system, the endocrine system or directly by regulating calcium absorption. This knowledge may be crucial for people after fractures or suffering from the osteoporosis healing process. (22)

Respiratory system:

The respiratory system and its proper functioning are controlled by the impact on athletic performance. An increase in respiratory capacity, or the frequency and maintenance of the respiratory system, is important for increasing performance in various sports activities. In addition to the high-frequency physical effects, this results in additional stress on the body, resulting in decreased function of the accessory system and delivery of the upper primary pathways at the source.

A randomized trial of probiotics was conducted on a group of rugby players (n=30). As a result, the incidence of the disease was reduced by 27% after shortening the duration of the study in

which the probiotic group participated, after learning about the placebo. In the absence of consistency in the occurrence of probiotic supplementation and the occurrence of placebo. (23)

Another study examined the correlation between diseases that result from probiotics and the incidence and symptoms. The study examined a large scale including (n=465). Supplementation with Bifidobacterium Animalis subsp. lactis Bl-04 significantly reduces the risk of developing upper respiratory tract diseases after receiving a placebo. However, supplementation with Lactobacillus acidophilus NCFM and Bifidobacterium Animalis subsp. lactis Bi-07 does not cause such effects. (24)

In turn, the oral addition of Lactobacilus fermentum VRI-003 had an impact on the exposure of the mucous membranes in the accident. The level of cytokines in use, the level of IgA in saliva, and the incidence, duration and severity of respiratory tract were measured. The result of oral supplementation with Lactobacilus fermentum VRI-003 probiotics was a solution with the number of days with the occurrence of respiratory problems. an additional complement in the form of a two-fold increase in IFN gamma in whole blood. The increase in INF gamma is extremely dangerous because its role is to activate the configurational response to pathogens. Thanks to it, the duration of the disease and illness is shortened. However, the supplement does not apply to any changes that occur in the patient's running condition. (25)

However, a study conducted on marathon runners (N=141) showed that three months of supplementation with Lactobacillus rhamnosus GG (LGG) had no effect on the incidence of respiratory infections and no differences were found in the number of respiratory infections. (26)

This was followed by research on kindergarten children, which may be linked to further research on athletes. 6-month supplementation with probiotics, Lactobacillus and Bifidobacterium strains in the article with vitamin C, the incidence and duration of typical vehicles that travel on upper roads. Supplementation with a combination of probiotics and C bugs is beneficial in the prevention and development of upper respiratory tract infection. (27) This knowledge may be beneficial in reducing breaks in training for people practicing intense or professional sports, which may translate into achievements.

A randomized, double-blind, placebo-controlled study of marathon runners administered multi-strain Lactobacillus and Bifidobacterium probiotics or a placebo 30 days before the race. Consuming Lactobacillus and Bifidobacterium supplements may reduce the incidence of

sequelae and upper respiratory symptoms. This can be done by regulating monocytes and macrophages. Their production in the group of supplements was induced by these strains, which led to the fight against pro-inflammatory cytokines by non-existent: IL-2, IL-4 and IL-6. However, not all mechanisms of action have been known.(28)

RESEARCH CONDUCTED ON ATHLETES INVOLVED IN OTHER SPORTS

The most commonly studied species in athletes and active individuals are Lactobacillus casei, L. fermentum, L. acidophilus and L. rhamnosus. (29) Triathlon is a high-intensity sport with a high rate of injury and inflammation. For this reason, research was conducted on athletes regarding physiological adaptation. A beneficial effect of Lactobacillus plantarum PS128 supplementation has been demonstrated. Supplementation reduced the level of oxidative stress and inflammatory reactions by reducing the levels of pro-inflammatory cytokines (TNF-α, IL-6 and IL-8) and increasing anti-inflammatory cytokines (IL-10) after intense exercise. Additionally, supplementation with Lactopacillus plantarum PS128 increases exercise performance compared to the placebo group. For these reasons, L. plantarum PS128 may be a potential ergogenic aid in better training management, physiological adaptation to exercise and health promotion and maintenance of homeostasis not only among triathletes, but also in people participating in marathons or sports exhibiting high levels of oxidative stress. (30)

Of particular interest is a small cross-over study of 10 runners taking a multi-species formulation of Lactobacillus, Bifidobacterium and Streptococcus strains. A moderate enhancement of run time to fatigue in hot conditions with probiotic supplementation was observed, accompanied by reductions in gut permeability and gastrointestinal discomfort in comparison with the control group. (31)

Jang et al. compared the composition of the microbiome of bodybuilders, long-distance runners and young men who do not regularly practice sports. Athletes of different groups followed different eating habits. The method of physical activity was related to the different diets of each group, which influenced the different quantitative and qualitative composition of bacteria in the intestines at the genus and species level. Additionally, it has been shown that a high-protein diet combined with a low carbohydrate supply reduces the number of commensal bacteria and additionally reduces the diversity of bacteria found in the intestinal microbiota. Additionally, a lower number of commensal bacteria causes a reduction in the production of short-chain fatty acids, which was observed in a group of bodybuilders. Additionally, athletes performing

aerobic and resistance exercises showed a similar composition of intestinal microflora if they consumed food with a low fiber value and containing an unbalanced composition of micronutrients. (32)

Petersen et al. conducted a study on 33 cyclists who were divided into 3 groups: known by either high Prevotella, high Bacteroides or a mix of many genera including Bacteroides, Prevotella, Eubacterium, Ruminococcus, and Akkermansia. A significant correlation was found between exercise load and the abundance of Prevotella. The abundance of Provotella species began to increase at 11 hours of training per week, but was highest in the group of cyclists training more than 20 hours per week. Provotella is associated with the metabolism of proteins, drugs, carbohydrates, vitamins and cofactors, and was then linked to the pathways responsible for muscle regeneration. Thanks to these processes, it is possible to compensate for energy deficits generated by intense physical exercise. The presented study can be used as a starting point for creating probiotics with a composition beneficial for people with high intensity of physical activity. (33)

CONCLUSION:

Intense physical exercise causes significant changes in the body at the cellular level. There is an increase in reactive oxygen species, free radicals, activation of the immune system, increase in inflammatory processes and changes in the structure of DNA. These changes cause impairment of cell function and, consequently, apoptosis. The desire to achieve good results in sports and reduce the processes that burden the body as a result of physical activity prompted researchers to start working on personalized probiotics.The mechanisms that increase the efficiency of the human body during physical activity have not been fully understood, so work on creating a probiotic suitable for a given group of athletes is still ongoing. At this stage, scientists focused on suppressing immune processes, oxidative stress and the functioning of the intestinal barrier.

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