Probiotic Supplementation in Elite Athletes:

Does it help Improve Performance and Overall Health?

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Introduction

Many Gastrointestinal (GI) and upper respiratory symptoms (URS) are two of the most common health issues that affect athletes and can reduce both their training days and availability to compete. Athletes who partake in strenuous exercise, as in the category of elite athletes, are more susceptible to URS due to a transient weakened immune system. The mechanism of exercised immune suppression is thought to be multifactorial involving a reduction in lymphocytes in the blood and IgA in the mucosa, a rise in neutrophil blood concentration along with increased inflammatory cytokines [Perserson and Rhode]. Exercise and re-modulation of athletes' immune response has been demonstrated among various exercise intensities and also among healthy versus illness prone athletes [Cox et al]. Upper respiratory infections (URI) are the most common illness affecting athletes [Walsh et al]. URS symptoms among elite rugby athletes accounted for 30% of visits to sports clinics [Schwelnus et al]. URS are influenced by a myriad of factors including both identifiable and non identifiable etiology [Cox et al]. Probiotics have been investigated as a way to improve immune health, namely upper respiratory health [Nishida et al].

In addition to the respiratory system, gut health has a significant influence on immune function [Shi et al]. The gut microbiota regulates extra-intestinal immunity via the common mucosal immune system which involves the upper respiratory tract [Colbey et al]. GI distress is also common among athletes. Between 30-50% of athletes experience GI symptoms that can impair performance and prolong recovery [de Oliveria et al]. The incidence of GI symptoms in long distance runners is even higher, approaching 90% [Jeukendrup et al]. The symptoms of GI distress experienced by athletes can vary and include abdominal cramping, diarrhea, flatulence and nausea but can also be severe including hematochezia and anemia [Rudzki et al]. The mechanism behind exercise-induced GI distress is multifactorial and thought to be related to ischemia, inflammation, decreased motility and increased gut permeability [ter Steege et al, Rao et al, Oktedalen et al]. Furthermore, the sheer mechanical irritation on the GI tract during high impact activities such as running can lead to GI distress in athletes [Rudzki et al].

Management of GI distress in athletes can be challenging to the clinician and frustrating for the athlete. Altering diet has been investigated as a potential way to reduce GI problems in athletes with mixed results. Restricting gluten intake in endurance cyclists was found to have no effect on GI symptoms during exercise, performance and inflammatory markers in athletes that did not have celiac disease [Lis et al]. Low fermentable oligosaccharide, disaccharide, monosaccharide and polyol (FODMAP) diets have shown some promise in reducing GI distress, but have only been investigated in recreational runners [Wiffin et al]. The nutritional needs of elite athletes differ greatly from those of recreational athletes and make a restrictive diet difficult to maintain. Nutritional timing before, during and after competition as well as gut "training" to allow for the GI system to adapt to the stress of

endurance sports has also been explored as a means to decrease GI distress in athletes with early promising results [Jeukendrup et al].

The gut contains a complex system of microbes that exist in a unique balance that is intimately related to immune function and nutrition [Nishida et al]. Evidence is emerging that exercise can alter the gut microbiome [Mach et al]. Probiotics are a common supplement used to improve digestive health and immune function. Probiotics have been documented to influence the gut microbiota to improve overall GI health and reduce symptoms of bowel diseases [Kim et al]. It is therefore an area of interest to examine the impact of probiotics on GI distress, upper respiratory illness and performance in athletes. The aim of this paper is to review the most up-to-date literature to help guide clinicians advising athletes on probiotic supplementation.

Methods

PubMed was used to search the literature for studies examining the effect of probiotics in athletes. We used the keywords "probiotics", "athlete", "microbiota", "upper respiratory infection" and "gastrointestinal". In an effort to include the most up-to-date information, studies prior to 2005 were excluded from this review. Review papers, letters to the editor and opinion papers were also excluded from this paper. We chose to focus on articles pertaining to probiotic supplementation related to GI distress, immune function and respiratory symptoms, and athletic performance.

Results and Discussion:

Probiotics and GI symptoms

The effect of probiotics on GI symptoms experienced by athletes have been examined in several studies A randomized, controlled trial examining probiotic effects on gut permeability and GI discomfort showed a trend of decreased gut permeability in athletes supplementing with probiotics. The pre and post urine lactulose:rhamnose ratios were reduced in the probiotic group when compared to the control group, but these findings were not found to be statistically significant. Athletes in this study also reported fewer GI symptoms when supplementing with probiotics [Shing et al]. A similar randomized, controlled trial looking at marathon runners performance after probiotic supplementation also demonstrated a decrease in GI symptoms and helped maintain running pace though the finish times between the placebo and treatment group were similar [Pugh et al]. There is some evidence that combination of multiple strains has additive benefits for GI modulation [Roberts et al].

Another study showed decreased duration of exercise-induced GI symptoms seen in athletes supplementing with probiotics as compared to the control group [Kekkonen et al]. Other studies have explored this further and measured blood markers of immune function. A randomized, controlled trial examining the relationship between immune function and probiotics found no difference in incidence of upper respiratory infection or differences in blood leukocyte, neutrophil, monocyte, lymphocyte counts of saliva IgA levels in highly active individuals over a 4-month period [Gleeson et al].

Probiotics and respiratory illnesses

Immune function is an interesting area that has been examined in relation to probiotic supplementation. In a randomized controlled study of elite rugby players, daily probiotic supplementation for four weeks was shown to reduce the duration and incidence of GI and upper respiratory illnesses (URI), but no impact was seen on the severity of the infections [Haywood et al]. Similar studies have shown the decrease in URI symptoms among trained athletes [Strasser et al, Kumano et al]. The mechanism of action is thought to be due to the modification of various metabolic processes and immunologic stress response. A double blinded RCT among rugby players showed a decrease in salivary cortisol and mucosal immunity with probiotic supplementation [Pumpa et al]. Another study examining probiotics and upper respiratory infections found that endurance runners taking lactobacillus fermentum suffered from URIs half as many days when compared to the control group taking placebo treatment. This same study also demonstrated a two-fold increase in interferon gamma levels, an important immune-

mediator cell, which could account for this enhanced immune function [Cox et al]. One study found an interesting difference between men and women endurance cyclists in relation to probiotic supplementation and immune health. Male cyclists were found to have a reduction of respiratory illness symptoms by 30% but the women in the study showed an increase of respiratory illness symptoms of 220%. When lactobacillus levels were measured in the participants, men were found to have a 7.7 fold increase in lactobacillus whereas women only had a 2.2 fold increase, which may account for the discrepancy of respiratory illness symptoms between the two groups [West el al].

Contrary to these studies, some studies have found little or no difference in elite athletes taking probiotics on immune function or performance [Roberts et al]. A randomized controlled trial examining incidence of upper respiratory infections in marathon runners over a 3-month period found no significant difference between the probiotic group and the placebo group.

Probiotics and Athletic Performance

The effect of probiotics on various aspects of athletic performance have been investigated in several studies. In one randomized, controlled trial, runners performing in temperatures of 35 degrees Celsius (95 degrees Fahrenheit) were found to have an increased time to fatigue in athletes taking probiotic supplements [Shing et al]. Another study examined the effect of lactobacillus plantarum on oxidative stress and performance in triathletes. They found a decrease in markers of oxidative stress in triathletes when compared to the control group by 6-13%. This study also found a 24-69% increase in the branched chain amino acids valine, leucine and isoleucine which has previously been shown to improve symptoms of fatigue and maintain power output in endurance athletes [Huang].

Another randomized, double blinded placebo-controlled crossover study in trained male cyclists examined the relationship between probiotic supplementation and carbohydrate metabolism. They found that the overall performance was not affected by probiotic consumption and showed only a minimal increase in absorption and oxidation of glucose [Pugh et al].

Alternatively the impact of probiotics were found to have an interesting affect on hemoglobin and growth hormone levels in a study by Sawada et al. They found increased growth hormone levels in runners supplementing with Lactobacillus gasseri after 12 weeks when compared to placebo. They also found athletes in the probiotic group maintained hemoglobin levels well into training when compared to the control group [Sawada et al]. Though athletic performance was not directly measured, these laboratory findings have implications that could support probiotic use to enhance performance.

Post-exercise inflammatory markers were found to be decreased in athletes taking part of a resistance training program and supplementing with the probiotics Streptococcus thermophilus and Bifidobacterium breve for 3 weeks [Jager et al]. This study also found an improved mean peak torque production at 24-72 hours into the recovery period. These findings highlight the possibility of probiotic supplementation helping to aid in recovery for athletes.

According the International Society of Sports Nutrition (ISSN) Position Statement on Probiotics, athletes who are unable to consume sufficient amounts of probiotics through whole foods, supplementation with clinically researched strains of probiotics have a role in promoting immune function, gut absorption and improving recovery from exercise. The ISSN also recommends allowing athletes a 2-week period of adjusting to probiotic supplements, as the alteration in gut microbiota may cause an acute exacerbation of GI symptoms, including flatulence and abdominal cramping.

Conclusions:

In summary, probiotic supplementation can influence the composition of gut microbiota, therefore influencing several aspects of athlete health and immune function. Following probiotic supplementation several studies have demonstrated some physical improvement due to changes in the immune, respiratory and GI systems of athletes involved in strenuous activity. Some studies demonstrated that probiotics enhance the performance of athletes, improve their general health and reduce illness, while other studies have found no difference in athletes consuming probiotics. For many of the studies the sample sizes were small and failed to show clear or consistent differences in performance when compared to the placebo. It may be difficult to ascertain the validity and relevance with varying protocol for probiotic use as a staple among elite athletes. It may be beneficial to extend the duration of studies where the data was inconclusive to see if more long term studies would change the outcome compared to the short term studies. It should also be noted, that different strains and doses of probiotics were used in these studies, making standardization difficult to achieve. While limited evidence exists directly demonstrating general athletic performance improvements, it is possible that probiotic supplementation may positively impact physiological adaptations during training that may prove useful to enhancing overall athletic performance.

The benefits of probiotic supplementation illustrated by the various studies were dependent on multiple properties of the probiotic including species, strain, dosage and duration of treatment. Further studies are needed to examine the impact of supplementation on the variety of possible training adaptations with potential to enhance athletic performance. Furthermore, more research is warranted to determine consistent beneficial effects on performance as compared to symptomatic relief. Given that the general health and wellness of an athlete underpins performance, the sports medicine practitioner would benefit from additional evidence on the health promoting properties of probiotics and optimal strain combination(s) among athlete populations as a means of sustaining athletic performance. Additional studies are also important to discuss the benefits from other uncommon strains.
to WBC and cold water immersion as compared to placebo (13).

Peake et al. also showed very little influence on inflammatory markers after intense resistance exercise with the use of cold water immersion for active recovery. They tested 9 physically active men using single leg exercises and then 10 minutes of cold water emersion at 5 degrees C. Participants completed muscle biopsies before and at 2, 24, and 48 hours after exercise. They found that inflammatory cells cytokines, neurotrophins and heat shock proteins did not differ significantly between the recovery treatments (14).

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