Exercise and Gastrointestinal Complaints: an Overview

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Abstract. Physical activity affects individual's general health and can influence the gastrointestinal ecosystem. In athletes, various types of gastrointestinal problems can be observed linked to strenuous and continuous physical exercise. Overall, studies suggest that 30-50% of athletes suffer from such ailments. Recent studies have shown that it is possible to intervene through nutrition and food supplements to train the gut and support gastrointestinal health in athletes.

Key words: gastrointestinal complaints, exercise, prevention

Introduction

In the past, sports nutrition has focused exclusively on performance objectives and short-term interventions to achieve them. In recent years, the focus has expanded to include medium term interventions aimed at maintaining an optimal state of health, to allow the maximum expression of his skills in the execution of the athletic gesture. This scenario includes an evaluation of the effects that physical exercise can have on the gastrointestinal system and specialized interventions to provide the athletes with maximum support.

Gastrointestinal problems are common in athletes. This often impairs performance or subsequent recovery. Generally, studies suggest that 30–50 % of athletes experience such complaints.

The prevalence of symptoms varies considerably depending on the event, the environmental conditions, and the level of the athlete (1). GI problems often occur in endurance athletes and particularly during prolonged events such as cycling, triathlons and marathons (2).

Symptoms such as nausea, cramping, bloating, abdominal angina, and diarrhea most likely reflect redistribution of blood flow from the gut to the skin for cooling purposes. Among the reported deleterious manifestations of strenuous exercise are mucosal erosions and ischemic colitis, both observed after long-distance running (3)

The etiology of exercise-induced gastrointestinal distress is multifactorial, gastrointestinal ischemia is often acknowledged as the main pathophysiological mechanism for the emergence of the symptoms; the other factors are mechanical and nutritional in nature (1).

Exercise-induced redistribution of blood can result in splanchnic hypoperfusion as a possible mechanism for gut dysfunction and permeability in athletes. The mesenteric blood flow is reduced especially when the athlete is hypo hydrated (4).

The mechanical causes of gastrointestinal problems are related to either impact or posture. Symptoms are more common in runners than in cyclists. The physical up-and down movement of the gut during running could also explain an increase in the frequency of gut symptoms.

The mechanical trauma suffered by the gut from the repetitive impact of running in combination with gut ischemia is probably the cause of the bleeding.

Interactions between prolonged exercise, challenging environmental conditions (temperature, altitude, humidity, etc.), and nutrient and fluid intake may also increase risk of gut problems (1).

Van Wijck et al. argued that, if perfusion of the gut is one of the main causes of the problems, nitric oxide (NO) is a specific agent that may be used to enhance splanchnic perfusion and improve GI homeostasis during exercise. There are a number of options to upregulate intestinal nitric oxide availability that may be of value for athletes experiencing abdominal distress associated with splanchnic hypoperfusion, including nitric oxide synthase-dependent (glutamine-arginine-citrulline) and nitric oxide synthase-independent (nitrate-nitrite) supplementation.

Also, adequate hydration contributes to splanchnic perfusion maintenance by avoiding systemic hypovolemia and customized fluid replacement is recommended to maintain adequate hydration during exercise (5).

It is known that nutrition can have a strong influence on gastrointestinal distress. Fiber, fat, protein, and fructose have all been associated with gastrointestinal symptoms. Research suggests that foods that delay gastric emptying and might cause a shift of fluids into the intestinal lumen are more likely to cause gastrointestinal symptoms; indeed, fiber, fat, protein, and fructose have all been associated with a greater risk of developing gastrointestinal symptoms. Highly concentrated carbohydrate solutions with high osmolalities (>500mOsm/L) could cause a shift of fluids into the intestinal lumen and seemed to be associated with an increased incidence of symptoms. Dehydration, possibly as a result of inadequate fluid intake, may also exacerbate the symptoms in both cases (1).

Train the Gut

The supply of exogenous fluid and carbohydrate sources can enhance performance and prevent dehydration, especially during prolonged exercise (6).

The gastrointestinal (GI) tract plays a critical role in delivering carbohydrate; without a well-functioning GI system delivery of nutrients will be impaired and a range of GI symptoms may develop. The high incidence of GI problems in endurance athletes indicates that GI function is not always optimal. GI system seems to be highly adaptable, and it has been suggested that targeted training of the intestinal tract may improve the delivery of nutrients during exercise while at the same time alleviating the symptoms (6).

The purpose of stomach training is to improve gastric emptying, which is an important step towards delivering exogenous carbohydrate and fluids to the working muscle.

The stomach can adapt to ingesting large volumes of fluid, solids or combinations; this adaptation is very important to contain more food and to not feeling bloated during the competition (7).

The purpose of intestinal training is to improve carbohydrates absorption because it is likely that a reduced capacity of the intestine in combination with a higher carbohydrate intake may result in GI distress (1).

There also appears to be a dose-response relationship between carbohydrate intake and performance. When the exercise lasts >2 h greater amounts of carbohydrate would be recommended and with multiple transportable carbohydrates fewer symptoms have been observed but training the gut and getting used to high intakes is recommended (8-10).

Therefore, one other benefit of increasing the transport capacity for carbohydrate is that fluid intake is likely to also be improved, for a given carbohydrate intake. Improved fluid absorption can help prevent dehydration and subsequent reductions in performance, but more complete absorption may also reduce the chances of GI discomfort. Since the gut is so adaptable, it seems wise to include training with high-carbohydrate intake into the weekly routine and regularly ingest carbohydrate during exercise. With these strategies, the gut may be trained to absorb and oxidize more carbohydrate, which in turn should result in less GI distress and better performance (7).

Pre and Probiotics: Gastrointestinal Health and Benefits of Supplementations in Athletes

The mucosal barrier of the GI tract represents the "first-line of defense" against pathogens agents and is an important interface with the host immune system. Very intense exercise negatively impacts immunity competence, compromising the population and function of immune cells, such as natural killer (NK) cells and T lymphocytes. Some proinflammatory cytokines

such as IL-1, TNF-α and IFN-γ generally are not affected after prolonged exercise whereas the inflammation-responsive cytokine IL-6 and anti-inflammatory cytokines such as IL-10, IL-1ra, sTNFR increase markedly. The increase in IL-6 is determined by contracting muscle and is strongly associated with glycogen regulation. Gene expression in white blood cells is upregulated for most anti-inflammatory markers and downregulated for pro-inflammatory markers and Toll-like receptor (TLR) signaling (11).

The Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) defines probiotics as "live micro-organisms that, when administered in adequate amounts, confer a health benefit on the host" (12).

Additionally, the International Olympic Committee (IOC) has stated that, "Probiotics are live micro-organisms that when administered orally for several weeks can increase the numbers of beneficial bacteria in the gut. These have been associated with a range of potential benefits to gut health, as well as modulation of immune function" (13).

Unique in comparison to other dietary supplements, probiotic preparations contain live, viable, defined microorganisms in sufficient numbers to provide beneficial health effects.

Reported health benefits of probiotics include modulation of the immune response, maintenance of the intestinal barrier, antagonism of pathogen adhesion to host tissue, and production of different metabolites such as vitamins, short-chain fatty acids (SCFAs), and molecules that act as neurotransmitters involved in gut-brain axis communication (14).

The body of probiotic research in recreational and competitive athletes is expanding, including investigations in GI health, exercise performance, recovery, physical fatigue, immunity, and body composition. Numerous factors such as age, genetics, drug use, stress, smoking, and especially diet can all affect the gut microbiome, influencing a complex ecosystem that is highly dynamic and individual. Physical activity has been an area of growing interest in gut microbiome research and appears to promote a health-associated microbiota and to increase microbiome diversity.

Prebiotics are dietary fibers that are not digested by our digestive enzymes but from the gut microbiota, providing energy to symbionts microorganisms. Microbial digestion of prebiotics fibers provides SCFA (short chain fatty acids) like propionate, acetate and butyrate that can strongly influence not only the gut microbiota composition but many human metabolic pathways acting as signaling molecules (15)

For that reason, sport nutritionist should consider the soluble fiber content of the diet in order to address the fermentable polysaccharides need and optimize gut transit and gastrointestinal health (16).

Athletes had relative increases in pathways (e.g., amino acid and antibiotic biosynthesis and carbohydrate metabolism) and faecal metabolites (e.g., microbial produced short-chain fatty acids (SCFAs) acetate, propionate and butyrate) associated with enhanced muscle turnover (fitness) and overall health when compared with control groups (17).

Glutamine, the most abundant aminoacid in the blood stream, is considered semi-essential. Glutamine modulates enterocyte proliferation, transcription of tight-junction proteins, inflammatory pathways, such as NF-κB and STAT signaling, and can provide protection against apoptosis and cellular stress (18).

Glutamine is one of the most important energy sources for enterocytes and several conditions like sepsis, large tissue damages and physical activity can dramatically reduce glutamine availability for in the gastrointestinal mucosa (19).

There are some anedoctal reports regarding the responsibility of the leaky gut syndrome in the G.I.D. in sport. It is a very convincing reasoning, but there is no data or demonstrations in the literature. This is only one aspect of the entire topic that has not been addressed enough yet.

Convincing reports suggest that exercise training induces compositional and functional changes in the human gut microbiota that are dependent on obesity status, independent of diet and contingent on the sustainment of exercise. Indeed, exercise-induced changes in the microbiota were largely reversed once exercise training ceased (20).

In researching the human gut microbiota, it is difficult to examine exercise and diet separately as this relationship is compounded by changes in dietary intakes that often are associated with physical activity (e.g., increased protein intake in resistance trained

athletes or carbohydrate intake in endurance athletes and increased total energy and nutrient intake in general).

Strenuous and prolonged exercise places stress on the GI tract that increases the likelihood of multiple symptoms associated with a disturbed gut microbiota and decreased performance (21).

Therefore, probiotics as functional modulators of the microbiome can potentially promote health, exercise adaptation, and indirectly performance in athletes.

A small number of studies assessing GI benefit in athletes and physically active individuals have yielded mixed results with considerable variation in methodology, making comparison difficult (11).

Positive results reported included decreases in concentrations of zonulin and endotoxin, intestinal hyperpermeability and duration of GI-symptom episodes (22).

Levels of anti-inflammatory cytokines and immunoglobulins, immune cell proliferation, and production of pro-inflammatory cytokines by T cells may be modulated following probiotic supplementation (23).

It is important to specify that the positive effects of probiotics for athletes are indirect. Several studies investigating the effects of multi-strain probiotics on aerobic performance, none have suggested any effects. A study in endurance-trained men, 14 weeks of a multi species probiotic had no effect on VO2 max and maximum performance (22). In another study, 30-day period of supplementation with a 14-strain probiotic at rest, during prolonged cycling exercise for 2 h at 60% VO2max, there was no significant change in rating of perceived exertion and heart rate (24).

In terms of implementation, probiotic supplementation should commence at least 14 days before a major training period or competition to allow adequate time for transient colonization or adaptation period of bacterial species in the gut. Probiotic supplementation should be tested during the offseason or preseason phases, so the athlete is familiar with taking the probiotic supplements or foods before travel or major competition and can see how he/she responds (11).

As with any dietary supplementation, probiotics should be considered in the overall context of a balanced dietary intake, i.e., nutrient needs should be met by a "food first" approach via consumption of whole foods rather than supplements.

Despite the existence of shared, core mechanisms for probiotic function, health benefits of probiotics are strain- and dose-dependent and above all these potential benefits require validation in more rigorous human studies and in an athletic population.

Even if literature is not sufficient, we consider a remarkably interesting possibility the use of blends of different components designed for protecting GI efficiency during prolonged and intense exercise. Mixed probiotics, micronutrients (vitamins and minerals), glutamine, plant extracts and nutraceuticals, could give an effective contribution to GI protection. A combined approach of this type, which exploits the synergies of various components, would make it possible to act effectively on the various levels of the gastrointestinal system. There is an early confirm in a ultraendurance race about this hypothesis (25). We need confirms of this chance of intervention.

Conclusion

Gastrointestinal diseases in sport are common, so it could be very useful to find some possible ways to prevent these disturbances. In addition to correct nutrition and hydration strategies, some supplement intake usefulness, is arising. Specifically: regular consumption of specific probiotics may help immune function and may reduce the number of sick days for athletes, may reduce the severity of GI disturbance when they occur. To be explored is the addition of prebiotic, micronutrients and vitamins to preserve prevent the gut-barrier disfunction, for health, performance and recovery in athletes.

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