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Restriction of Dietary Short Chain Carbohydrates may Attenuate Symptoms of Irritable Bowel Syndrome in Athletes

Short Review

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Abstract

Athletes represent a population that are especially at risk for gut dysfunction, and are known to employ a multitude of therapies to reduce symptoms. Meanwhile, carbohydrates are the main energy source during exercise, but the amount and type consumed can contribute to gastrointestinal (GI) distress. There is evidence that short chain carbohydrates (referred to as FODMAPs) are poorly absorbed in the small intestine, and trigger functional gut symptoms. Therefore, it is speculated that athletes who consume foods rich in FODMAPs may experience heightened GI distress and subsequent reduction in performance. While the evidence has consistently shown symptomatic benefits for the use of a low FODMAP diet in clinical patients with irritable bowel syndrome (IBS), limited research is available as to the benefits for reducing GI distress in symptomatic athletes. The purpose of this review is to explore the evidence and impact of a low FODMAP diet on exercise induced gastrointestinal issues.

Key Words: FODMAPS, Gastrointestinal, Irritable Bowel Syndrome

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Introduction

The most common gastroenterological disorder is IBS which affects nearly 15% of the population [1]. Data indicates that up to 50% of the endurance athletic population have reported some form of GI distress [2]. Anecdotal evidence suggests that GI problems are the most common cause of underperformance in endurance events. Altered bowel habits, abdominal pain, flatulence, distention, nausea, vomiting, and bloating are common concerns that can inhibit performance.

Due to the fact that carbohydrates enhance exercise performance, and the body's carbohydrate stores are somewhat limited, athletes have to pay special attention to their needs in order to optimize performance [3]. However, different types of carbohydrate impact the gut differently [4]. Some work has suggested the use of multiple transportable carbohydrates (glucose + fructose) as an optimal strategy to improve oxidation and performance, and decrease intestinal distress. But, there are multiple limitations and more research needs to be conducted.

In the clinical setting, gastroenterologists recommend diet therapy as a means to decreasing GI issues. It has been reported that over 75% of IBS patients are

recommended by their physicians to follow a diet limited in short chain carbohydrates, including fermentable oligosaccharides, disaccharides, monosaccharaides, and polyols (FODMAPs) [5]. All studies on low FODMAP diets have consistently shown symptomatic benefits in the majority of patients with IBS [6].

Given that athletes face a myriad of GI distress and IBS symptoms that can reduce performance, and the low FODMAP diet is used with great success in the clinical setting, there is great overlap potential. The purpose of this review is to explore the impact of a low FODMAP diet on exercise associated gastrointestinal issues. This review will not explore other influencers of gastrointestinal distress (e.g., dehydration, high fiber intake, etc).

Pathophysiological Causes of Gastrointestinal Symptoms

While the etiology of gastrointestinal distress is multifactorial, ischemia is considered the pathophysiological mechanism responsible for intestinal symptoms. When norepinephrine is released from nerve endings during exercise, splanchnic vasoconstriction occurs. Splanchnic blood flow may be reduced up to 80% to provide blood flow to working muscle and skin. Gut ischemia, as well as in increase in mucosal permeability, may result as blood is shunted from viscera to the active tissues. Nausea, vomiting, abdominal pain, and diarrhea are likely associated [7].

Moreover, an exercise-induced reduction of blood flow not only affects the small intestine, but also the colon. Continuous physical activity agitates the intestinal tract, and there is a strong possibility that more gas is generated and faster. In order to better understand the origin of these symptoms, Murray et al investigated whether the ingestion of fructose and fructans can exacerbate IBS symptoms. Sixteen healthy volunteers participated in a four-way, randomized, single-blind, crossover study in which they consumed 500 ml of water containing 40 g of either glucose, fructose, inulin, or a 1:1 mixture of 40 g glucose and 40 g fructose. Magnetic resonance imaging (MRI) scans were performed hourly for 5 hours, to assess the volume of gastric contents, small bowel water content (SBWC), and colonic gas. It was found that fructose increases intestinal gas from 2-5 hours and distends the small bowel with water, but adding glucose to fructose reduces the effect of fructose on SBWC [8]. Hence, when exercising after ingesting solely fructose foods, an increase in intestinal pressure from gas occurs.

Carbohydrate and Exercise-Induced Gastrointestinal Distress

While ischemic factors cause a multitude of GI problems during exercise, manipulating dietary factors (i.e. fructose ingestion) may be a more effective strategy for reducing symptoms. It is well known that carbohydrates are the primary fuel source utilized by skeletal muscle tissue during prolonged exercise. Thus, exercise performance is largely dependent on carbohydrate availability. Ingesting carbohydrates during prolonged (>2 h) moderate-to-high intensity exercise can considerably improve endurance performance [9]. Therefore, it is not surprising that athletes aim to increase their intake. Many turn to large amounts of hyperosmolar beverages, but these can lead to water retention and incomplete absorption [10].

It becomes enigmatic in the sense that while carbohydrates serve as fuel for muscles, and increase performance, evidence suggests that a high intake can further aggravate GI symptoms. To mitigate this, specific types of carbohydrates and their transporters have been studied. A recent article discussed a strategy to decrease residual carbohydrate in the GI tract by ingesting multiple transportable carbohydrates, glucose + fructose. Consuming multiple carbohydrates improves exogenous carbohydrate oxidation, while lowering the amount of residual carbohydrate in the intestine, which can support an increase in performance [10]. This research parallels the previously discussed work of multiple carbohydrate ingestion, in which fructose

ingestion distended the small bowel with water, but adding glucose reduced the effect of fructose.

Recently, Costa et al investigated the effects of a gut training protocol on gastrointestinal symptoms in endurance runners. The gut-challenge trial consisted of a 2 hour running exercise at 60% VO2max while consuming gel-discs containing 30g carbohydrates (2:1glucose/fructose) every 20 minutes, and a 1 hour distance test. Subsequently, the runners were assigned carbohydrate gel-disc (CHO-S), carbohydrate food (CHO-F), or placebo (PLA) for 2 weeks of repetitive gut-training. It was discovered that this training technique reduced carbohydrate malabsorption, and enhanced blood glucose availability, compared with a placebo[11].

Fructose as a FODMAP

Given the evidence that fructose absorption is poor without the co-ingestion of glucose, a dietary strategy exists that reduces foods that trigger abdominal symptoms. FODMAPs (Fermentable Oligo- Di- and Mono-saccharides And Polyols) are short chain carbohydrates that are poorly absorbed. They include short chain oligo-saccharide polymers of fructose and galactooligosaccharides, disaccharides, monosaccharides, and sugar alcohols, such as sorbitol, mannitol, xylitol and maltitol. Current evidence suggests that dietary FODMAPs induce prolonged hydrogen and methane production, and flatus in healthy individuals. They are rapidly fermented in the small and proximal large intestine, and thus have been shown to induce luminal distention related to the osmotic load and gas producing effects [12].

A low FODMAP diet limits many popular foods that have been recommended for athletes, including fructose-containing foods, like apples, mango, and watermelon. It restricts lactose-containing foods, like milk, yogurt, and ice cream. Polyols from artificial sweeteners, like sorbitol, or mannitol, are to be avoided as well. Yet, much of the work on low FODMAP diets has been limited to the clinical population, as it is the first line for treatment of IBS. Approximately 70% of those suffering with IBS note improvement in GI symptoms after transitioning diets. From a clinical perspective, the low FODMAP diet provides an effective approach to the management of patients with GI symptoms [13].

Low FODMAPs for Runners

While "running" is both a competition and a type of training, the term can refer to speeds from jogging to sprinting. During this type of strenuous exercise, blood is redistributed from the GI tract towards the working muscle. This can cause gastrointestinal symptoms and is speculated to influence gut dysfunction, but dietary factors also play a role.

Recently, Dana et al examined the effects of a short-term low FODMAP diet on GI symptoms and well being in runners with a history of GI distress, in a controlled, singed-blinded crossover study. Eleven runners were allocated to a randomized 6-day low FODMAP or high FODMAP diet, separated by a one-day wash out period, and then followed by the alternative diet. The athletes recorded their daily exercise and food intake. They also completed a post exercise GI questionnaire, daily GI questionnaire, and Daily Analysis of Life Demands (DALDA) questionnaire everyday through the dietary intervention periods. Nine out of 11 subjects reported a reduction in daily GI symptoms in the short term, low FODMAP diet. While moderate to severe GI symptoms can inhibit performance, this work demonstrated that dietary modification via a low FODMAP diet could be beneficial to running athletes [14].

A similar follow up case study by Dana et al examined a short-term low FODMAP diet in a competitive, multisport athlete with no diagnosed GI disorder. A standard diet was compared with a 6-day low FODMAP intervention diet (81 ± 5g vs 7.2 ±

5.7g FODMAP s/day). Post exercise GI symptoms were recorded daily after training. Daily GI symptoms and the Daily Analysis of Life Demands for Athletes (DALDA) were also recorded at the end of each day. Daily and during GI symptom scores (scale 0-9) ranged from 0-4 during the habitual dietary period while during the low FODMAP dietary period all scores were 0 (no symptoms at all). Thus, the low FODMAP diet was an effective intervention for this athlete [15].

Another case study examined the effects of a low FODMAP diet on upper- and lower-gastrointestinal symptoms for a woman with IBS, participating in a multi-stage ultra-marathon. The athlete initiated the low FODMAP diet six days before the event, and maintained it during. Nutrition intake was analyzed through dietary analysis software, while a visual analogue scale quantified the incidence and severity of GI symptoms. GI symptoms were reported as modest, except for nausea, which was severe. Moreover, carbohydrate intake did not meet recommendations, likely due to the reported nausea negatively impacting the woman's appetite. While the athlete did adhere to the low-FODMAP diet and complete the marathon with minimal GI symptoms, it is unclear as to whether the suboptimal energy and carbohydrate intake was responsible for the modest GI symptoms, or the low FODMAP diet [16].

FODMAP Avoidance in World Class Athletes

GI distress is not limited to recreational athletes. Dana et al investigated the dietary habits of 910 athletes, ranging from recreational to Olympic and world-class level. The aim of the study was to gather data about athlete's avoidance rates of foods that they believed to exacerbate GI distress. Athletes were recruited to complete an online, 17 item questionnaire as part of a larger study. 55% of the participants reported avoiding at least 1 high FODMAP food. Lactose was the most common food constituent reported as a trigger for GI symptoms, and its elimination resulted in perceived improvements in GI symptoms. However, the study did not distinguish between those that completely refrained from all lactose sources over a defined period of time, to those that only refrained prior to training [17].

Discussion

Given that the short chain carbohydrates found in FODMAP containing foods are poorly absorbed, diarrhea, luminal distention, and flatulence are common amongst individuals with increased sensitivity. Athletes fall into this category of individuals, as exercise influences their guts, and they may be more susceptible to gastrointestinal distress. In addition, it is imperative for the athlete to consume an adequate amount of carbohydrates at consistent intervals to sustain performance, especially during prolonged exercise lasting longer than one hour. Therefore, the low FODMAP diet is emerging as a nutritional tool for mitigating GI distress and enhancing performance, with one study demonstrating 50% of athletes have reported eliminating at least one high FODMAP food source.

To date, there are only three publications in PubMed that examine the low FODMAP diet in the athletic population, and they are all by the same author. While the limited evidence base strongly supports the low FODMAP diet and its widespread application, more work is needed to further understand nutritional approaches to reduce the risk of GI discomfort during exercise.

Media-Friendly Summary

Gastrointestinal problems are common for athletes who engage in intense exercise. This may be detrimental to athletic performance. Nutritional factors also play a considerable role. Since short-chain carbohydrates are poorly absorbed in the small intestine, athletic individuals who suffer from gastrointestinal distress can perhaps benefit from adhering to a diet that eliminates them, otherwise known as the low FODMAP diet.

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