

Food avoidance in athletes: FODMAP foods on the list

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Abstract: We surveyed 910 athletes to assess behaviours towards self-selected food/ingredient avoidance to minimize gastrointestinal distress. Fifty-five percent eliminated at least 1 high fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAP) food/category, with up to 82.6% reporting symptom improvement. In athletes indicating that high FODMAP foods trigger gastrointestinal symptoms, lactose (86.5%) was most frequently eliminated, followed by galactooligosaccharides (23.9%), fructose (23.0%), fructans (6.2%), and polyols (5.4%). Athletes avoid predominantly lactose and to a lesser extent other high FODMAP foods to reduce gastrointestinal distress.

Key words: lactose, fructans, fructose, elimination, diet, gastrointestinal.

Résumé : Dans cette enquête, on sonde les comportements de 910 athlètes dans leur choix personnel d'évitement de certains aliments/ingrédients pour minimiser les malaises gastro-intestinaux. Cinquante-cinq pour cent des répondants éliminent au moins un aliment/catégorie riche en fermentescibles oligosaccharides, des disaccharides, des monosaccharides, et les polyols (« FODMAP ») et jusqu'à 82,6 % rapportent une amélioration des symptômes. Chez les athlètes rapportant que les aliments riches en FODMAP déclenchent des malaises gastro-intestinaux, le lactose (86,5 %) est le plus souvent éliminé; puis, viennent les galacto-oligosaccharides (23,9 %), le fructose (23,0 %), les fructanes (6,2 %) et les polyols (5,4 %). Les athlètes évitent surtout le lactose et, à un moindre degré, les autres aliments riches en FODMAP afin de diminuer les malaises gastro-intestinaux. [Traduit par la Rédaction]

Mots-clés : lactose, fructanes, fructose, élimination, diète, gastro-intestinal.

Introduction

Gastrointestinal (GI) distress is reported to occur in 30%–70% of endurance athletes and has the potential to compromise training capacity and performance (de Oliveira et al. 2014). Numerous elements can trigger or intensify GI symptoms during exercise, including mechanical, physiological, and dietary factors (de Oliveira et al. 2014). Dietary elements, including high fibre, fat, and protein intakes, as well as concentrated carbohydrate loads, have been reported to elicit GI symptoms in triathletes (Rehrer et al. 1992). We have previously shown that 41% of athletes avoid gluten and that 81% of these athletes believe gluten-removal reduces GI symptoms (Lis et al. 2015a). Likewise, emerging anecdotal reports indicate that some athletes implement various low fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAPs) dietary strategies to alleviate GI symptoms (Despain 2014). For certain individuals, FODMAPs are poorly absorbed in the small intestine where they increase luminal fluid content and possibly affect gastric motility (Gibson and Shepherd 2010). Poorly absorbed, they subsequently transit to the colon and are rapidly fermented by colonic bacteria causing GI symptoms, such as diarrhea, luminal distension, and flatulence (Ong et al. 2010); issues potentially negatively affecting performance.

The aim of this brief communication is to report athlete behaviours in regards to (i) the elimination of foods/ingredients that are high in FODMAPs; (ii) foods/ingredients high in FODMAPs reported to trigger adverse GI symptoms (diarrhea, bloating, abdominal pain, flatulence); and (iii) perceived improvement in GI symptoms conse-

quent to elimination of foods/ingredients high in FODMAPs alone or with gluten elimination. Descriptive data collected from this questionnaire-based study enabled the quantification of self-reported food elimination, specifically high FODMAP foods, amongst athletes with GI symptoms.

Materials and methods

Participants

Athletes ($n = 910$, from recreational to Olympic medalists) were recruited to complete an online questionnaire as part of a larger published study examining the popularity, beliefs, and experiences of gluten-free diets in nonceliac athletes (Lis et al. 2015a). Recruitment was international, via email to professional and academic networks and social media outlets. Informed consent was obtained through completion of the questionnaire, withdrawal was possible at any point and questions could be skipped. Participation was anonymous, self-selected, and excluded athletes clinically diagnosed with celiac disease and under 18 years of age. Ethics approval was obtained from the University of Tasmania, Social Science Human Research Ethics Committee (H12933).

Questionnaire development

As previously described by Lis et al. (2015a), the 17-item questionnaire (supplementary Fig. S3¹), run through the Survey Monkey platform from January 24th to March 2nd, 2013, addressed the following: (i) demographics; (ii) GI symptoms attributed to food categories, focusing on gluten and high FODMAP foods (lactose, fructose, fructans, galacto-oligosaccharides (GOS), and polyols); and (iii) reported GI

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symptom reduction with offending food elimination. The primary aim of this questionnaire was to explore the popularity, perceptions, and experiences of gluten-free diets in athletes, as described in Lis et al. (2015a). A secondary aim was to gather data about athletes' experiences and avoidance rates of other foods or dietary constituents that the athletes believed exacerbated their GI distress/symptoms. The lists of foods/categories provided were primarily high in FODMAPs. We also queried high fibre and fat intake; however, for the purpose of this brief communication we focused on high FODMAP food categories. To avoid bias, the term FODMAP was not used in the survey itself. GI symptoms were described to include abdominal pain, bloating, cramping, flatulence, and/or diarrhea. For data handling and analysis, responses pertaining to lactose sources, dairy (milk, cheese, yogurt) and lactose (milk, ice cream, custard, soft cheese) were amalgamated into a single lactose category as athletes may use different terminology to refer to the same food category. Excess fructose (apples, mango, honey) and fructose (apple-sauce, pears, agave) responses were also amalgamated to represent fructose categorically.

Data management and statistical analysis

From the total survey population, the frequency of athletes indicating elimination of each high FODMAP category queried (lactose, fructose, fructans, GOS, polyols) was quantified. Supplementary Fig. S1¹ shows the arrangement in which the elimination of high FODMAP food information was organized and quantified. The athletes eliminating high FODMAP foods were successively grouped into: (i) athletes that attributed at least 1 high FODMAP food(s) to GI symptoms but did not necessarily eliminate the offending food; (ii) athletes that then eliminated high FODMAP food(s) because of adverse GI symptoms; and (iii) athletes that reported GI symptom improvement with removal of high FODMAP food(s). Frequency analysis (STATA version SE12; Statacorp LP, College Station, Tex., USA) was used to analyze the demographics, quantify high FODMAP food(s) elimination, identify the high FODMAP foods reported as GI symptom triggers, and subsequent GI symptom improvement with removal. These analyses were conducted in the same manner on those athletes that avoided gluten alongside high FODMAP food(s) (Supplementary Fig. S1¹).

Results

Study participants and demographics

Demographic information including age, sport category, and competitive level are shown in supplementary Table S1¹. Nine hundred and twenty-four athletes completed the survey. Fourteen athletes were removed because of not meeting the inclusion criteria (celiac disease ($n = 5$) or under 18 years of age ($n = 9$)). Analysis was conducted on 910 athletes (female = 528, male = 377, no sex selected = 5), between the ages of 18 to over 50 years, from a broad range of sports and competitive levels, including 47 World and Olympic medalists. Fifty-five percent ($n = 501$) reported avoidance of at least 1 food that can be categorized as high FODMAP. Of this group, 64.7% ($n = 324$) were female and 35.1% ($n = 176$) were male (no sex selected, $n = 1$). Of the entire athlete questionnaire population, lactose was the high FODMAP food category (44.2%, $n = 402$ of 910) most frequently attributed to lactose-related GI issues. Subsequent elimination of lactose-containing foods was reported by 35.1% ($n = 319$ of 910) of the questionnaire population.

GI symptoms attributed to high FODMAP foods and high FODMAP foods plus gluten

Ninety-three percent (92.8%, $n = 465$ of 501) attributed at least 1 high FODMAP food or category to be linked to negative GI symptoms. The remaining ($n = 36$) indicated that the same foods that are high FODMAP foods triggered other symptoms, such as skin conditions or fatigue, which is likely related to other food constituents concurrently present. Of the 92.8% attributing high FODMAP foods to GI symptoms, lactose (86.5%, $n = 402$ of 465) was reported as the largest

trigger followed by GOS (23.9%, $n = 111$ of 465), fructose (23.0%, $n = 107$ of 465), fructans (6.2%, $n = 29$ of 465), and polyols (5.4%, $n = 25$ of 465). Gluten alongside high FODMAP food avoidance is shown in supplementary Fig. S1¹. Lactose and gluten together were most frequently attributed to GI symptoms by 52.7% ($n = 245$ of 465) of respondents, eliminating at least 1 FODMAP because of GI symptoms (supplementary Fig. S1¹).

Removal of FODMAP with the aim to improve GI symptoms

Seventy-eight percent ($n = 362$ of 465) of athletes eliminated at least 1 high FODMAP food or category from their diet with the intention to improve GI symptoms (supplementary Fig. S1¹). Aimed at reducing GI symptoms lactose was the most highly eliminated (88.1%, $n = 319$ of 362), followed by fructose (23.8%, $n = 86$ of 362), GOS (22.4%, $n = 81$ of 362), polyols (6.1%, $n = 22$ of 362), and fructans (5.2%, $n = 19$ of 362). Of the athletes eliminating at least 1 high FODMAP food/category to improve GI symptoms, 82.6% ($n = 299$ of 362) reported symptom improvement (supplementary Fig. S1¹). Supplementary Fig. S2¹ shows the frequency of reported GI symptom improvement subsequent to high FODMAP food elimination.

Discussion

This questionnaire is the first to quantify the number of athletes avoiding foods that are categorized as high FODMAP and to assess the subsequently reported GI symptom improvement. Although our results may not be more generalizable beyond female endurance athletes because of the over-representation of this cohort, over half of the questionnaire population reported the elimination of at least 1 high FODMAP food or category, with 93% self-reporting that these triggered adverse GI symptoms. Subsequent to high FODMAP food removal aimed at reducing GI symptoms, athletes reported symptom improvement rates ranging from 68.2% (polyols) to 83.7% (lactose; supplementary Fig. S2¹). The effects of various high FODMAP foods or groups of foods on exercise-induced GI symptoms or in athletes on a daily basis have not yet been investigated. Our study now confirms that athletes remove sources of lactose, and to a lesser degree other high FODMAP foods, with the intention to improve GI symptoms.

Lactose was the most highly reported FODMAP identified as a trigger for GI symptoms with a correspondingly high frequency of perceived symptom improvements with its elimination (supplementary Fig. S2¹). GI symptoms from lactose-containing foods can be caused by lactose malabsorption, but can also mask the symptoms caused by other FODMAPs or cow's milk protein allergy (Lomer et al. 2008). Lactose plus gluten elimination were reported by 52.7% of athletes avoiding at least 1 high FODMAP food or category because of GI symptoms. This finding parallels a recent Australian survey, which indicated wheat avoidance to be greatly correlated with dairy avoidance (52.9%) and predicted by sex (female) (Golley et al. 2015). Gluten avoidance and gluten-free diets have been discussed previously by our research group Lis et al. (2015a, 2015b). Our dataset does not allow delineation of the triggering mechanism(s) of undiagnosed functional GI disorders or the possibility of undiagnosed celiac disease. It is important to acknowledge that the widespread rates of lactose malabsorption are influenced by factors such as ethnicity, genetics, lactase activity, co-ingested foods, quantity ingested, lactose fermentation pathways, and complicating conditions (Mattar et al. 2012; Levitt et al. 2013; Misselwitz et al. 2013). Our observational data identifies that 44.2% ($n = 402$ of 910) of this athlete questionnaire population report lactose-related GI issues and subsequent lactose avoidance (35.1%, $n = 319$ of 910), which is comparable to the general population (35%) (Levitt et al. 2013). Lactose elimination, as queried in our study, could range from avoidance of all lactose sources or limiting exclusively concentrated sources, or avoidance only prior to training. If athletes are eliminating lactose to reduce GI symptoms, individualized dietary strategies should be applied to ensure adequate calcium intake as this is of concern when eliminating lactose-containing foods (Mattar et al. 2012).

Other high FODMAP foods, including foods or food classifications containing fructose, GOS, fructans, and polyols, were reported as GI-symptom triggers less frequently. These rates may have been higher with a more comprehensive list of food examples provided within the questionnaire (supplementary Fig. S3¹). Eliminating fructose-containing foods because of GI symptoms was reported in 9.5% ($n = 86$ of 910) of the current study population, which is much lower than the 60% of healthy individuals reported by hydrogen breath test to malabsorb a dose of ≥ 40 g of fructose (Raithel et al. 2013). The lower rates found in our data may be due to the fact that in habitual eating fructose is often co-ingested with other sugars, which enhances absorption (Skoog and Bharucha 2004). Fructose malabsorption rates calculated using breath testing techniques may report higher frequencies compared with symptom-based estimates as positive breath tests can occur in the absence of GI symptoms (Skoog and Bharucha 2004). However, fructose has garnered particular attention as consumption of high doses or in excess of co-ingested glucose has shown fructose to be incompletely absorbed and causes bloating, abdominal pain/discomfort, and flatulence (Raithel et al. 2013). In populations with fructose intolerance, adherence to a reduced fructose diet has decreased GI symptoms (Johlin et al. 2004). Furthermore, athlete populations may consume high fructose intakes as fructose is a common ingredient in sports foods and fruits (e.g., ripe bananas, watermelon, apples), may be consumed in elevated quantities to meet athlete energy demands, and are popular staples at race feed stations. Nonetheless, our results indicate that athletes report less fructose-containing food elimination to reduce GI symptoms when considering population-based malabsorption rates. For individuals restricting fructose-containing foods, strategies shown to attenuate fructose-induced GI symptoms, including eating balanced macronutrients or glucose alongside fructose, could be implemented to increase fructose tolerance and minimize dietary restriction (Raithel et al. 2013).

Fructan-containing foods may also be of particular concern for athletes as these carbohydrates are commonly found in wheat products. Only 5% of fructans are digested in all individuals, which may augment GI symptoms during exercise. Our previous research has quantified that 41% of nonceliac athletes follow a gluten-free diet, and that 81% of these athletes attribute reduced GI symptoms to gluten removal (Lis et al. 2015a), despite our intervention study finding no difference in GI symptoms with a gluten-free diet (Lis et al. 2015b). However, available literature suggests that it is the reduced fructan and GOS quantity in a gluten-free diet that modulates GI symptoms and not gluten itself (Gibson and Muir 2013; Gibson et al. 2015). It is pertinent to investigate if the generally higher fructan content or other constituents of wheat versus gluten-free grain products (Biesiekierski et al. 2011; Gibson and Muir 2013) augment GI symptoms, as many sport foods are wheat-based and some athlete's diets are heavily reliant on wheat-based foods to meet carbohydrate demands.

Conclusions

This is the first study to investigate dietary habits surrounding the elimination of foods high in FODMAPs to reduce reported GI symptoms in recreational to Olympic and World-class level athletes. With the aim to decrease GI symptoms, over 50% of athletes report avoiding at least 1 high FODMAP food source or FODMAP category: predominantly lactose (and dairy) and fructose. Athletes' guts are under repetitive stress and may be more susceptible to GI symptom triggers, such as short-chain carbohydrates or the high fibre or lactose content inherent in some high FODMAP foods. Unnecessary dietary elimination, without appropriate food substitutions, should also be carefully evaluated as inadequate nutrient and

prebiotic intake may risk optimal fueling and compromise healthy gut bacterial populations (Halmos et al. 2015). This novel data provides essential underpinning evidence to support the future investigation of individualized approaches to investigate the effects of certain high FODMAP foods, predominantly lactose, in athletes with persistent exercise-induced GI symptoms.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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