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Human Kinetics
CASE STUDY

Case Study: Utilizing a Low FODMAP Diet to Combat Exercise-Induced Gastrointestinal Symptoms

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Athletes employ various dietary strategies in attempts to attenuate exercise-induced gastrointestinal (GI) symptoms to ensure optimal performance. This case-study outlines one of these GI-targeted approaches via the implementation of a short-term low FODMAP (Fermentable Oligosaccharides, Disaccharides, Monosaccharides and Polyols) diet, with the aim to attenuate persistent running specific GI symptoms in a recreationally competitive multisport athlete (male, 86 kg, 57.9 ml·kg·min^{-1} $V0_{2max}$, 10–15 hr/week training, with no diagnosed GI disorder). Using a single-blinded approach a habitual diet was compared with a 6-day low FODMAP intervention diet (81 ± 5g vs 7.2 ± 5.7g FODMAP s/day) for their effect on GI symptoms and perceptual wellbeing. Training was similar during the habitual and dietary intervention periods. Postexercise (*During*) GI symptom ratings were recorded immediately following training. *Daily* GI symptoms and the Daily Analysis of Life Demands for Athletes (DALDA) were 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). DALDA scores for *worse than normal* ranged from 3–10 vs 0–8 in the habitual and low FODMAP dietary periods, respectively, indicating improvement. This intervention was effective for this GI symptom prone athlete; however, randomized-controlled trials are required to assess the suitability of low FODMAP diets for reducing GI distress in other symptomatic athletes.

Keywords: runner, short-chain carbohydrates, lactose, fructose, runners gut

Gastrointestinal (GI) symptoms are common in up to 70% of endurance athletes (de Oliveira & Burini, 2009), and aside from mechanical, psychological and physiological triggers, several dietary factors are believed to influence symptoms (de Oliveira et al., 2014). Strategies to improve GI symptoms in athletes include: lower fiber (low residue) or fat intake; reduced fructose load; minimizing dehydration, and; consuming multiple transporter carbohydrates (de Oliveira et al., 2014). Training the gut to tolerate increased amounts of carbohydrate and fluids has also been shown to increase carbohydrate oxidation and may theoretically reduce the likelihood of GI distress (Cox et al., 2010). In some cases, regardless of the intervention, GI symptoms persist and novel individualized dietary approaches need to be employed. In the current case study, conventional interventions to reduce exercise-induced GI symptoms were unsuccessful. Therefore, a dietary approach utilizing a low FODMAP (Fermentable Oligosaccharides, Disaccharides, Monosaccharides and Polyols) diet was trialed over 6 days (3-day lead-in and 3 days of intense running-dominant training) in an attempt to mitigate GI issues.

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FODMAPs, a family of short-chain carbohydrates, are in foods including wheat (fructans), pears (excess fructose), cow's milk (lactose), legume beans (Galacto-oligosaccharides; GOS), and nectarines (polyols) (Shepherd et al., 2013). A low FODMAP diet is often implemented in clinical practice as a potentially efficacious treatment for irritable bowel syndrome (IBS; Shepherd et al., 2013). In IBS patients, the malabsorption of FODMAPs increases colonic fluid and gas, which subsequently may trigger or amplify GI symptoms including bloating, flatulence, abdominal pain, loose stool or diarrhea (Staudacher et al., 2014). The GI-related symptomology experienced in individuals with IBS is analogous to those reported by athletes under conditions of exercise stress where splanchnic hypoperfusion, gut ischemia, altered motility, reduced intestinal absorption and mechanical factors compromise gut integrity (Gisolfi, 2000; van Wijck et al., 2012). Despite some GI-adaptions in trained individuals, splanchnic blood flow is still reduced by up to 80% at 70% VO_2max (Qamar & Read, 1987). Given the compromised gut environment common during strenuous exercise (ter Steege & Kolkman, 2012), it is plausible that high intakes or residual presence of FODMAPs in the colon may trigger or amplify GI symptoms during or after exercise. This case study intervention is an attempt to assess the impact of a low FODMAP diet on a recreationally competitive athlete with persistent exercise-induced GI distress. The outcome was favorable and provides an impetus for larger systematic research of low FODMAP diets in athletes with GI distress.

Presentation and Assessment of Athlete

This 31-year-old recreationally competitive athlete (86 kg, 183.7 cm, 10% body fat, 57.9 ml·kg·min^{-1} VO_{2max}, training 10–15 hr/week) has a history of GI distress and is currently training for multisport events, culminating with Ironman Melbourne 2016. Ongoing nutrition support by an accredited sport dietitian (lead author) revealed persistent GI symptoms during and after high intensity or endurance training (heart rate >155 bpm or training > 60 min), primarily experienced during running. Previous screening was negative for celiac disease (tTg IgG and tTg IgA antibodies) and there was no history of self-reported functional bowel disorders, self-diagnosed GI condition or food intolerance. Prior self-implemented interventions aimed at reducing GI symptoms included: avoidance of spicy foods and caffeine before training, and sports drink and all foods during training. He had also previously trialed a gluten-free diet (GFD) without success. It is not possible to quantify the fructan or GOS intake during that GFD period. Consequently, FODMAPs were considered as a potential symptom modulator (Gibson et al., 2015) and investigated.

After the collection of the screening information (Figure 1), an assessment of FODMAP intake via Complete Nutrition Assessment Questionnaire (CNAQ; Barrett & Gibson, 2010) and background GI symptom questionnaire evaluation, quantifying frequency of symptoms (0: *never* to 9: *always*) was conducted (Lis et al., 2015; Pfeiffer et al., 2009). The presence and severity of upper and lower abdominal symptoms were determined using a 10-point scale ranging from 0: *no problem at all* to 9: *the worst it has ever been,* as previously applied (Lis et al., 2015). The response from the background GI symptom questionnaire indicated moderate to severe (> 4) upper and lower abdominal symptoms (Table 1). FODMAP intake was estimated to be 50.8 g FODMAP.day^{-1} (Table 2), which is considered to be a high FODMAP diet (Ong et al., 2010). Based on the result of the background GI questionnaire and CNAQ analysis the athlete was requested to record a detailed habitual diet and exercise log alongside questionnaires assessing GI symptoms and perceptual wellbeing.

Habitual Dietary Period

The 6-day habitual diet was analyzed for FODMAPs, average energy and macronutrient intake (FoodWorks Professional 7 Xyris, Brisbane, Australia; Table 2). During the habitual diet, GI symptom questionnaires were completed at the end of each day (*Daily*; GI symptoms occurring outside of exercise) and also immediately postexercise (*During*; GI symptom occurring during exercise). Information about life stressors and symptoms of stress were also collected daily using the Daily Analysis of Life Demands in Athletes (DALDA) over a range of training sessions, including cycling, swimming, and various running intensities/durations. DALDA requires participants to rate each variable as *worse than normal*, *norma*l, and *better than normal* and is a pragmatic tool to evaluate stress and stress response (Rushall, 1990).

Low FODMAP Intervention

To minimize potential bias of reported GI symptoms, the athlete was blinded to the intervention. This was achieved by informing the athlete that "specific carbohydrates" would be modified in the intervention period but that the intervention may worsen, improve or have no effect on symptoms. This dietary intervention period took place the week following the habitual dietary period on identical days of the week with similar training loads (Tuesday-Sunday).

Nutritional intervention consisted of a detailed meal plan that simulated the foods, nutrient profile and fluids taken during the habitual period, but exchanged high FODMAP foods for alternative foods low or void of FODMAPs. For example, habitual breakfast consisted of dried fruit and nut muesli with cow's milk yogurt and milk. The intervention low FODMAP breakfast included low FODMAP muesli, consisting of a small quantity of oats, seeds, puffed rice mixed with lactose-free yogurt and milk.

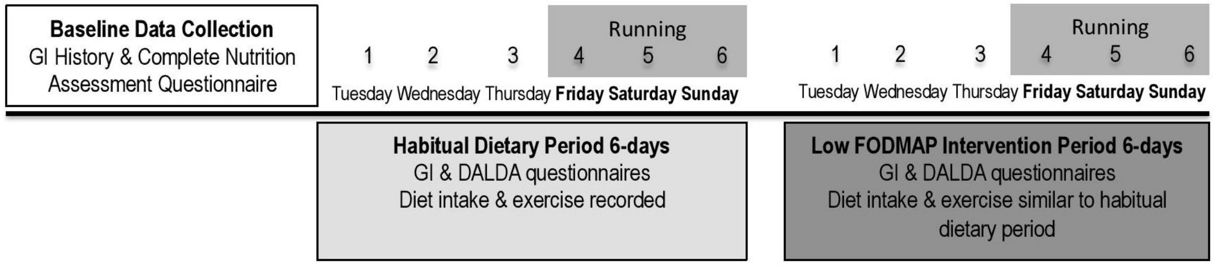

Figure 1 — Case study intervention timeline

Training was also simulated throughout both dietary phases to ensure the stress placed on the gut was consistent. Training was monitored and closely replicated using Garmin Connect and included: swim 60 min (Tuesday); cycle 60 min (Wednesday); rest (Thursday); run intervals 70 min (Friday); cycle 180 min and steady state run 65 min (Saturday) and; run intervals 65 min (Sunday). Three days of a low FODMAP diet leading into the first of three running-focused training days was chosen with the goal to transit any residual FODMAPs through the gut before the first strenuous running day (Friday). Dietary and exercise log, GI symptoms and DALDA questionnaires were recorded and analyzed in the same manner as the habitual dietary period.

Outcomes

Nutrient and FODMAP Intake

Daily food intake was effectively replicated from the habitual dietary record with the only meaningful variance being in FODMAP foods (Table 2). FODMAP intake during the habitual diet was 81.0 ± 5.0 g FOD-

Table 1 Baseline, *Daily* and *During* GI Symptoms Scores for Running Training Days*

Section	Symptom	Background (Baseline)	Habitual		Low FODMAP	
			Min	Max	Min	Max
Daily						
	Upper					
	reflux/heartburn	2	1	2	0	0
	belching	2	1	2	0	0
	bloating	4	1	3	0	0
	upper ab cramp	4	0	1	0	0
	vomiting	0	0	0	0	0
	nausea	0	0	0	0	0
	Lower		1	3	0	0
	lower ab cramp	4	1	3	0	0
	side stitch	2	0	2	0	0
	flatulence	7	3	4	0	0
	urge to defecate	5	0	3	0	0
	diarrhea	5	0	0	0	0
	intestinal bleeding	0	0	0	0	0
During Exercise						
	Upper				0	0
	reflux/heartburn		0	2	0	0
	belching		0	2	0	0
	bloating		0	0	0	0
	upper abdominal cramp		0	0	0	0
	vomiting		0	0		
	nausea		0	0	0	0
	Lower				0	0
	lower abdominal cramp		0	3	0	0
	side stitch		0	3	0	0
	flatulence		0	4	0	0
	urge to defecate		0	3	0	0
	diarrhea		0	3	0	0
	intestinal bleeding		0	0	0	0

*Day 4,5 and 6 of the habitual and Low FODMAP dietary periods

GI symptom scores >4 are considered moderate to severe.

Table 2 Composition of Dietary Intake During the Habitual and Low FODMAP Dietary Periods

Dietary Component	*CNAQ Background Macronutrient and FODMAP Intake	Habitual	Low FODMAP
Total energy (kcal)	2456	2586 ± 416	2527 ± 407
Total carbohydrate (g)	242	295 ± 68	303 ± 69
Total protein (g)	119	136 ± 9	132 ± 24
Fat (g)	93	88 ± 22	85 ± 28
Fiber (g)	25.9	34 ± 9	33 ± 6
Total FODMAPs (g)	**50.8**	**81.0 ± 5.0**	**7.2 ± 5.7**
Fructose (g)	23.5	20.9 ± 7.9	8.8 ± 4.0
Excess fructose (g)	3.4	0.5 ± 0.6	0.3 ± 0.1
Lactose (g)	42	70.3 ± 3.1	0.5 ± 0.7
Total oligosaccharides (g)	3	7.1 ± 3.9	6.2 ± 6.0
Fructo-oligosaccarides (g)	1.6	6.5 ± 4.0	5.9 ± 5.7
Galacto-oligosaccarides (g)	1.2	0.6 ± 0.2	0.3 ± 0.5
Raffinose (g)	0.3	0.4 ± 0.2	0.3 ± 0.5
Stachylose (g)	0.9	0.2 ± 0.1	0.1 ± 0.1
Total Polyols (g)	2.6	3.1 ± 2.2	0.2 ± 0.4
Sorbitol (g)	1	0.3 ± 0.2	0.2 ± 0.3
Mannitol (g)	1.6	2.7 ± 2.1	0.0 ± 0.1

Note. Dietary macronutrients and fiber were calculated using FoodWorks dietary software, which is based on the Australian Food Composition tables. Total FODMAPs = excess fructose + lactose + sorbitol + mannitol + fructans + galacto-oligosaccharides (GOS). All values are represented as mean (*SD*) for the two 6-day dietary periods (habitual and low FODMAP intervention). Bold text indicates additive constituents for total FODMAPs.

*Complete Nutrition Assessment Questionnaire (CNAQ)

MAPs/day while the intervention diet provided 7.2 ± 5.7g FODMAPs/day.

GI Symptoms (Background, Daily, and During Exercise) and DALDA

Table 1 shows individual minimum and maximum symptoms scores reported for *Daily* and *During* GI symptoms for days 4, 5 and 6; the days when strenuous running training sessions were completed and GI symptoms were more severe. Compared with the habitual diet, the *Daily* GI symptoms severity scores were lower on the low FODMAP diet (0–4 during vs 0; no symptoms at all); indicating a measureable improvement (Table 1). Similar improvement was observed for the *During* GI symptom severity scores (0–4 during the habitual diet vs 0; no symptoms at all during the low FODMAP diet). DALDA scores of "worse than normal" ranged from 3–10 (average 6.1) during the habitual diet compared with 0–8 (average 3.7) during the low FODMAP diet.

The cumulative GI symptoms scores for *Daily* and *During* (Figure 2) further show that total symptoms scores were higher each day of the habitual diet than on the low FODAMP diet. This illustrates higher *Daily* and *During* GI symptoms throughout the habitual diet, in particular on intensified running days. However, on day 6, *During GI* symptoms scores were zero for the habitual diet. This may have been the result of the self-selected breakfast (eggs, milk, banana) on the day-6 (preexercise meal) being lower in fructan and lactose content compared with his usual breakfast (muesli, milk and yogurt). It is plausible that the lowered FODMAP quantity in breakfast on day-6 contributed to the absence of *During* GI symptoms in the habitual period. Although during the habitual dietary period GI symptoms scores were predominantly minor, the athlete, blinded to the intervention, verbally confirmed an improvement in symptoms supported by his statement; "symptoms were remarkably better compared to habitual period and were basically non-existent during exercise or during the day throughout the intervention period."

Reflections

Many endurance athletes who struggle with persistent exercise-induced GI distress fail to resolve these potentially debilitating symptoms through commonly recommended dietary approaches. Although a subjective measure, GI symptoms have the potential to negatively impact performance (Jeukendrup et al., 2000) and thus it may be important to assess even lower severity symptoms (<3), particularly at the elite level where very small changes can have important performance impacts (Hopkins, 2005). Athletes and some practitioners believe that interventions such as low-residue or GFDs will improve GI issues (de Oliveira et al., 2014; Lis et al., 2014). GFDs

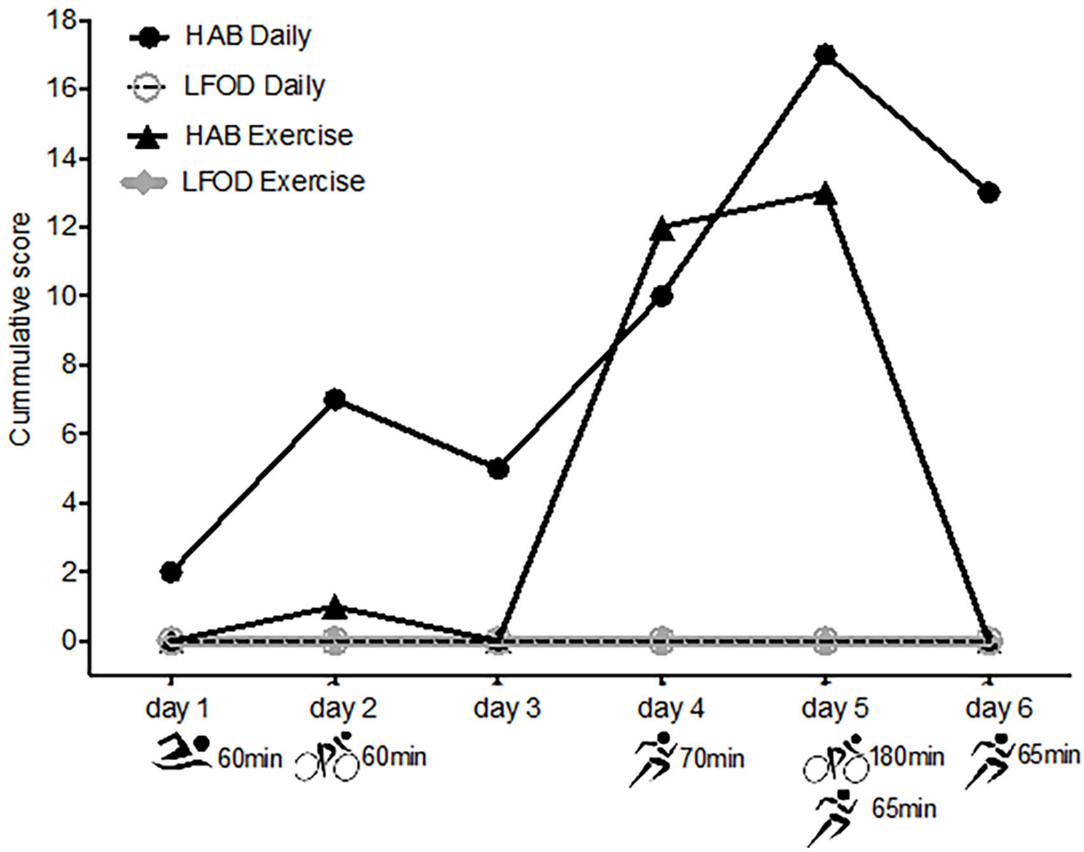

Figure 2 — Cumulative Daily and During GI symptoms scores; HAB = habitual, LFOD = low FODMAP

are naturally low in fructan and GOS, and may actually be the modulating factors in reported symptom improvement and not gluten itself (Gibson & Muir, 2013). However, the athlete in this case study indicated no improvement with a previous GFD. Instead the results suggest a low FODMAP intervention as a potentially novel approach to improve GI symptoms occurring with strenuous exercise, where the gut is compromised (van Wijck et al., 2012).

Through this case study, we are unable to identify whether an individual FODMAP or a combination of foods rich in FODMAPs were responsible for the GI distress reported by the athlete during the habitual diet. The habitual diet was extremely high in lactose and lactose may be a primary trigger, however, the athlete had not reported lactose intolerance. In an athletic population it is important to note that lactose intakes may be greater than the general population (Barrett & Gibson, 2010; Halmos et al., 2014) due to heavy dependence on dairy as a source of high quality protein and to replace sweat calcium loses (Haakonssen et al., 2015). Reliance on dairy protein has also been shown to support an increase or maintenance of lean body mass and support bone collagen formation during period of energy restriction (Josse et al., 2012). Low energy availability (33.4 kcal/FFM) reported by this athlete may point toward dairy consumption as a means to reduce the catabolic effects of an energy deficit or a contributing factor to gastrointestinal symptoms (Melin et al., 2014). In conjunction with a short-term low FODMAP diet before races or key running training sessions, self-administration of low doses of lactose containing foods (e.g., 1/2 cup of cow's milk) were subsequently recommended assess tolerance.

Several factors should be considered with the implementation of a low FODMAP dietary approach in athletes pertaining to assessment, counseling strategies and execution of the diet. Counseling strategies that curtail a "placebo effect" are integral to measuring real symptom change and the magnitude of change verses the influence of the belief in an intervention (Beedie et al., 2015). Before implementing a low FODMAP diet, integration of appropriate dietetic and medical practitioners is imperative, particularly with severe or persistent cases of GI distress, to rule out functional GI disorders and other triggers (e.g., nutritional, physiological or psychological). Similarly, a low FODMAP diet for athletes should be administered by a dietitian experienced in sport nutrition and low FODMAP diet administration. This intervention is also best tested in the off-season and trialed under conditions where symptoms occur. For athletes that respond positivity to a low FODMAP diet the intervention length should be minimized to reduce unnecessary dietary restriction. Food choice is key to the successful implementation of low FODMAPs diet as it has the potential to be lower in prebiotics, which may influence the microbiome composition (Wu et al., 2011). Limited research regarding the nutritional adequacy of a low FODMAP diet and long-term effects raises concern surrounding the nutritional suitability of this diet, especially for athletes, if appropriate variety and quantity is not integrated (Staudacher et al., 2012). An objective of the intervention should also include identifying, via strategic reintroduction of foods, specific high FODMAP foods that trigger symptoms, as not all FODMAPs may be culprits. Therefore, our recommendation to the athlete was to follow a low FODMAP diet 2–3 days before events or critical training sessions to alleviate symptoms, namely; bloating, intestinal cramps, flatulence, urge to defecate.

Psychological stresses also conceivably influence GI symptoms and were therefore additionally monitored. DALDA responses of "worse than normal" were higher during the habitual dietary period alongside more severe GI symptoms compared with the low FODMAP period, plausibly indicating a perceived reduction in gut distress. Several studies have found unique gut-brain axis relations associating psychological stress with increased GI disorders and symptoms (Bermon et al., 2015; Koloski et al., 2012; Tache et al., 2001). The reverse may also occur, as psychological stress levels are likely to increase with GI symptoms, especially in competitive situations. Therefore, monitoring stress triggers and stress response should correspondingly be part of an athlete nutrition plan relating to GI distress.

Overall, a reduced FODMAP diet led to a successful resolution of GI symptoms that were predominantly triggered during running for the athlete. These results provide a foundation and practical approach to initiate extended research investigating the effects of FODMAPs in athletes with persistent exercise-induced GI symptoms.

Acknowledgments

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