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ORIGINAL RESEARCH

Exploring the Popularity, Experiences, and Beliefs Surrounding Gluten-Free Diets in Nonceliac Athletes

Dana M. Lis, Trent Stellingwerff, Cecilia M. Shing, Kiran D.K. Ahuja, and James W. Fell

Adherence to a gluten-free diet (GFD) for nonceliac athletes (NCA) has become increasingly popular despite a paucity of supportive medical or ergogenic evidence. This study aimed to quantify the demographics of NCA and determine associated experiences, perceptions, and sources of information related to GFD. Athletes (n = 910, female = 528, no gender selected = 5) completed a 17-question online survey. Forty-one percent of NCA respondents, including 18-world and/or Olympic medalists, follow a GFD 50–100% of the time (GFD > 50): only 13% for treatment of reported medical conditions with 57% self-diagnosing their gluten sensitivity. The GFD > 50 group characteristics included predominantly endurance sport athletes (70.0%) at the recreationally competitive level (32.3%), between 31 and 40 years of age (29.1%). Those who follow a GFD > 50 reported experiencing, abdominal/gastrointestinal (GI) symptoms alone (16.7%) or in conjunction with two (30.7%) or three (35.7%) additional symptoms (e.g., fatigue) believed to be triggered by gluten. Eighty-four percent of GFD > 50 indicated symptom improvement with gluten-removal. Symptom-based and non-symptom-based self-diagnosed gluten-sensitivity (56.7%) was the primary reason for adopting a GFD. Leading sources of GFD information were online (28.7%), trainer/coach (26.2%) and other athletes (17.4%). Although 5–10% of the general population is estimated to benefit clinically from a GFD a higher prevalence of GFD adherence was found in NCA (41.2%). Prescription of a GFD among many athletes does not result from evidence-based practice suggesting that adoption of a GFD in the majority of cases was not based on medical rationale and may be driven by perception that gluten removal provides health benefits and an ergogenic edge in NCA.

Keywords: gluten, performance, nutrition practices, gastrointestinal symptoms

For approximately 1–1.5% of the population with celiac disease (CD), and 0.1% with wheat allergies, a gluten-free diet (GFD) is a necessity, while a GFD is beneficial for an additional 5–10% of the population with clinically diagnosed nonceliac gluten sensitivity (NCGS) (Fritscher et al., 2012; Hadjivassiliou et al., 2010; Mancini et al., 2011; Sapone et al., 2012). NCGS is defined as the presence of morphological, functional, and immunological disorders that respond to gluten exclusion, without the features that define CD (Troncone & Jabri, 2011). Although these types of sensitivities to gluten are different in origin, they are all treated with a GFD (Harris & Meyer, 2013).

General public adherence to a GFD has grown rapidly in recent years illustrated by a growth rate of 28% from 2008 to 2012 in gluten-free foods and beverages sales in Canada (Packaged Facts, 2013). Adherence to a GFD has also increased in prevalence in nonceliac athletic (NCA) populations for additional reasons including: clinically or self-diagnosed NCGS, the belief that gluten-free is healthier, and/or the belief that elimination of gluten will decrease inflammation and gastrointestinal (GI) distress (Harris & Meyer, 2013). Many NCA have adopted a GFD for perceived performance and health improvements. These athletes may believe gluten removal is associated with the same health benefits as a GFD for individuals with CD, wheat allergy or NCGS, although to date there is no evidence-based research to support prescription of a GFD in nonclinical populations. Some of the perceived benefits of a GFD in NCA include decreased GI symptoms and fatigue, better performance and increased motivation to train (Fritscher et al., 2012). Fritscher et al. (2012) who surveyed 279 endurance cyclists indicated a GFD to be the most popular special diet among this group. Although approximately 12% of respondents were celiac, 43% reported following a GFD with 84% of this group commenting that deviations from a GFD created self-perceived symptoms detrimental to training. It is unknown if these reported improvements are a function of undiagnosed CD or NCGS, or attributable to the perception by athletes that a GFD benefits performance (Fritscher et al., 2012).

GI dysfunction is a common occurrence (15–30%) among endurance athletes and can be attributed to several mechanisms including exercise-induced gut dysfunction and high carbohydrate intake (Pfeiffer et al., 2009; Pfeiffer et al., 2012). Athletes may avoid gluten as a

The authors are with the Sport Performance Optimisation Research Team, School of Human Life Sciences, University of Tasmania, Tasmania, Australia. Address author correspondence to Dana Lis at dana.lis@utas.edu.au.

result of the perception that gluten removal reduces GI dysfunction. While the effect of gluten removal in NCA is unknown, gluten removal in irritable bowel syndrome patients does not seem to have much of an effect (Biesiekierski et al., 2011a). Biesiekierski et al. (2013), demonstrated that in a population of irritable bowel syndrome patients who believed gluten removal had improved symptoms, only 8% reported gluten-specific symptoms when fed gluten in a blinded cross-over trial. Research available on GFD in nonceliac individuals is further limited to blinded crossover trials in nonathlete clinical populations with irritable bowel syndrome, which may not accurately reflect a healthy athletic population (Biesiekierski et al., 2011a; 2013).

Some of the potential negative issues surrounding adherence to a GFD in nonceliac athletes may include: the restrictive nature of the diet; the risk of suboptimal nutrient intake; increased difficulties with obtaining optimal food abroad for the traveling athlete; the potential diminution of beneficial gut bacterial populations; and, increased food costs (on average of 242% for specialty items; (Saturni et al., 2010; Stevens & Rashid, 2008)). To our knowledge, beyond consumer reports, only one study has quantified a GFD in an athlete population (Fritscher et al., 2012). Therefore, the aim of this broad-reaching questionnaire-based study was to determine: (1) the demographics of NCAs athletes following a GFD and degree of adherence, (2) experiences and perceptions of a GFD in regards to health and exercise performance, and, (3) the sources of information and types of prescriptions provided for a gluten-free diet accessed by athletes.

Methods

Participants

Athletes (from recreational to Olympic medalists) were recruited to complete an online survey. Recruitment was via e-mail to professional and academic networks (Professionals in Exercise, Nutrition and Sport, Dietitians of Canada Sport Nutrition Network, Sport Dietitians of Australia), social media outlets, and sport governing bodies (National Sport Institutes, Provincial, State and National sport governing bodies throughout Canada, the United States of America, Australia, Europe and Asia). Informed consent was obtained through completion of the survey, withdrawal was possible at any point and questions could be passed. Participation was anonymous, self-selected and the exclusion criteria included athletes diagnosed with celiac disease (defined by a clinical diagnosis of CD) and athletes under 18 years of age. Ethics approval was obtained from the University of Tasmania, Social Science Human Research Ethics Committee (H12933).

GFD Survey and Survey Development

The 17-question survey was made available online through Survey Monkey (www.surveymonkey.com) from January 24th, 2013 to March 2nd, 2013 (38 days). The survey collected data relating to five topics (Table 1) addressing the popularity of GFD among athletes: (1) demographics (age, gender, sport, level of competition); (2) GFD adherence, if any; (3) rate of GI symptoms occurrence and additional symptoms attributed to dietary intake; (4) perceptions pertaining to a GFD and athletic performance ascribed to a GFD; and (5) sources of GFD information and advice. Survey questions allowed one or multiple responses to be selected or text to be entered where appropriate. Athletes were permitted to leave questions unanswered.

The survey was developed and refined following feedback from six registered dietitians working in sport nutrition at the National and Olympic level in North America. This feedback included expand descriptive details for questions addressing level of competition and provide further clarification on rate of GI distress and dietary triggers (see Table 1 for survey overview). These other recognized dietary triggers were incorporated intentionally to reduce the potential bias of a leading question pointing athletes to select gluten. Survey categories were initially expanded to allow for the collection of a comprehensive range of detailed responses and were subsequently collapsed for some questions upon analysis to appropriately categorize responses. Survey feedback and piloting ensured that representative information was being queried to minimize biases for or against a GFD by expanding questions and response options to include other known food triggers such as short chain fermentable carbohydrates (Biesiekierski et al., 2011b).

Data Management and Statistical Analysis

Some responses were grouped and response categories combined where appropriate before data analysis. Reponses to the sport an athlete identified with were grouped into general sport categories based on activity demands (e.g., endurance, power). GFD viewpoints were amalgamated into categories, which included *GI distress, health parameters* (immune function, inflammation, nutrient absorption), *exercise parameters* (fatigue, recovery, energy) and *only appropriate for individuals with a clinical requirement* (CD or NCGS) categories. Symptoms questions were merged into *abdominal/gastrointestinal*, *nutritional* (nutrient deficiencies, bone density loss, anemia), *physiological* (numbness, fatigue) and *skin indicators* (rash). If athletes indicated more than one symptom they were reclassified corresponding to the total number of symptoms. Dietary changes were amalgamated into *more conscientious of diet overall, less processed* (which included less sugary foods), *increased fruit and vegetable intake*, *increased gluten-free whole grains*, *more balanced nutrition intake overall* and *no known dietary changes*. Physiological changes were condensed into *improved exercise performance and health* (which included overall healthier, decreased fatigue daily and training-specific, improved recovery postexercise, decreased muscle soreness/stiffness, better training adaptations), *better body composition* (for

Table 1 Survey Topics Covered and Information Queried

Topics	Question Focus
1. Demographics	age
	gender
	sport
	level of competition
2. GFD adherence	description of GFD adherence.
3. Rate of GI and other symptoms attributed to dietary intake	rate of GI issues during exercise.
	viewpoints about a GFD (e.g., reduced inflammation)
	experience of symptoms perceived to be associated with dietary intake (e.g., abdominal bloating)
	dietary components perceived to cause symptoms (e.g., dairy)
	elimination of perceived dietary trigger and result
4. Perceptions of a GFD	dietary changes perceived concurrent with a GFD (e.g., increased fruit and vegetable intake)
	physiological changes perceived concurrent with a GFD (e.g., less fatigue from training)
	perceived effect of GFD on performance
5. Sources of GFD information and advice	description of basis of GFD and advice provided
	source of GFD information

sport-specific performance), *decreased GI distress* and *only for individuals with CD or NCGS* (do not experience any gluten-related symptoms, not informed about GFD). Sources of GFD information were combined into *online* (online forums, online academic journals, own research, celiac disease or gluten-free websites), *trainer/coach* (trainer, coach, chiropractor and physiotherapist), *naturopath*, *other athletes* and *nutritionist/dietitian*. *Dietitian/nutritionist* were merged into a single group, as the distinction between the two professional titles is not clearly delineated worldwide.

Although the survey design targeted GFD adherence in three subcategories (adherence to a GFD 50–75%, 75–89% and 90–100% of the time) responses frequencies were analogous among all three groups to support grouping 50–100% of GFD adherence into one group for analysis. Athletes were categorized into two distinct groups for GFD adherence: GFD < 50 athletes who adhered to a GFD less than 50% of the time and GFD > 50 athletes who adhered to a GFD over 50% of the time. Logistic regression (STATA version SE12; Statacorp LP, College Station, TX) was used to compare two sets of data, the GFD < 50 and GFD > 50 groups, for rates of GI distress and physiological/dietary beliefs between the GFD < 50 and GFD > 50 groups. Comparison results are presented as odds ratio (OR) and 95% confidence intervals (CI), where appropriate.

Results

Study Participants and Demographics

Nine hundred and twenty-four athletes completed the survey. Twelve athletes were removed due to not meeting the inclusion criteria. Analysis was conducted on 910 athletes (female = 528, male = 377, no gender selected = 5), between the ages of 18 to over 50 years. The athletes were from a broad-range of sports and competitive levels, including 18 World and Olympic medalists. Total responses for sport categories, competitive level and age categories are represented in Table 2.

GFD Adherence

Fifty-nine percent of athletes followed a GFD less than 50% of the time (GFD < 50). Of the GFD < 50 group, 10.7% *purchased gluten-free products once in a while*, 9.3% followed a GFD *sporadically* (a few days per month), 0.7% followed a GFD *1–2 weeks before competition* and 38.8% *did not follow this diet at all*. Of the 41.2% (n = 375) of athletes that followed a GFD > 50, 50% adhered to a *GFD 90–100% of the time*, 7.5% adhered *75–89% of the time* and 42% adhered *50–74% of the time*. Athletes in the GFD > 50 were endurance sport athletes from all competitive levels (Table 2). Of the athletes in the GFD > 50 group, 70% were endurance sport athletes (n = 262) at the recreational level (32.3%, n = 121), with most between the ages of 31–40 years of age (29.1%, n = 109).

Information Sources

The most prevalent source of GFD information for the GFD > 50 athletes were *online* (28.7%, n = 290), *trainer/coach* (26.2%, n = 264), *other athletes* (17.4%, n = 176), *registered dietitian/nutritionist* (14.4%, n = 171), *naturopath* (7.4%, n = 75), *other persons with CD* (5.4%, n = 36) and *medical professionals* (0.5%, n = 3). Athlete

Table 2 Demographic Characteristics of Athletes

	GFD < 50 (*n* = 575)	GFD > 50 (*n* = 375)
Age	***n* (%)**	***n* (%)**
18–24 years	169 (31.7%)	95 (25.3%)
25–30 years	127 (23.8%)	98 (26.1%)
31–40 years[a]	126 (23.6%)	109 (29.1%)
41–50 years	64 (12.0%)	48 (12.8%)
>50 years	29 (5.4%)	20 (5.3%)
Sport category		
endurance[a]	335(62.6%)	262 (70.0%)
power	40 (7.5%)	26 (7.0%)
skill	10 (1.9%)	11 (3.0%)
swim/rowing	38 (7.1%)	19 (5.1%)
intermittent	77 (14.4%)	28 (7.5%)
weight classified/ aesthetic	19 (3.6%)	7 (1.9%)
winter	9 (1.7%)	9 (2.4%)
fitness	7 (1.3%)	13 (3.5%)
Level of competition		
recreational[a]	116 (21.7%)	121 (32.3%)
recreational competitive	122 (22.8%)	9 (24.3%)
provincial/state	62 (11.6%)	26 (7.0%)
national	104 (19.4%)	60 (16.0%)
international	57 (10.7%)	33 (8.8%)
world/Olympic qualifier	35 (6.6%)	21 (5.6%)
world/Olympic medalist	29 (5.5%)	18 (4.8%)
professional	10 (1.9%)	5 (1.3%)

Note. GFD < 50: athletes adhering to a GFD less than 50% of the time; GFD > 50: athletes adhering to a GFD over 50% of the time. [a]Endurance athletes, at the recreational level between the ages of 31–40 years most adhere to a GFD over 50% of the time.

level influenced GFD primary information sources. Recreational competitive athletes accessed information primarily from *trainers/coach* (26.9%, *n* = 71) and World/Olympic medalist accessed GFD information primarily from *other individuals with CD* (34.0%, *n* = 18).

Prescription of GFD

Of the GFD > 50 athlete group a GFD was prescribed for the following reasons: *self-diagnosed NCGS based on symptoms or no symptoms* (56.7%, *n* = 211), *clinically diagnosed NCGS through gluten-challenge test* (9.9%, *n* = 37) or *irritable bowel syndrome with symptoms thought to be triggered by gluten* (8.9%, *n* = 33), *recommended by coach, trainer, chiropractor, physiotherapist or paleo diet* (8.9%, *n* = 33), *naturopath bloodwork* (7.0%, *n* = 26), *family history of CD* (3.2%, *n* = 12), other (4.8%, *n* = 18) and *recommended by nutritionist/registered dietitian* (0.5%, *n* = 2) (Figure 1).

Experiences/Symptoms

Gluten removal was reported to resolve physical symptoms including abdominal bloating, gas, diarrhea and fatigue thought to be triggered by gluten in 80.7% (*n* = 303) of GFD > 50 athletes. For 1% gluten removal did not resolve symptoms, and 6.5% had not removed gluten for long enough to determine a change. *Abdominal/gastrointestinal symptoms* alone (16.7%, *n* = 49) and in conjunction with two (30.7%, *n* = 90) or three (35.7%, *n* = 105) additional symptoms were the most highly reported to be triggered by gluten in GFD > 50 athletes.

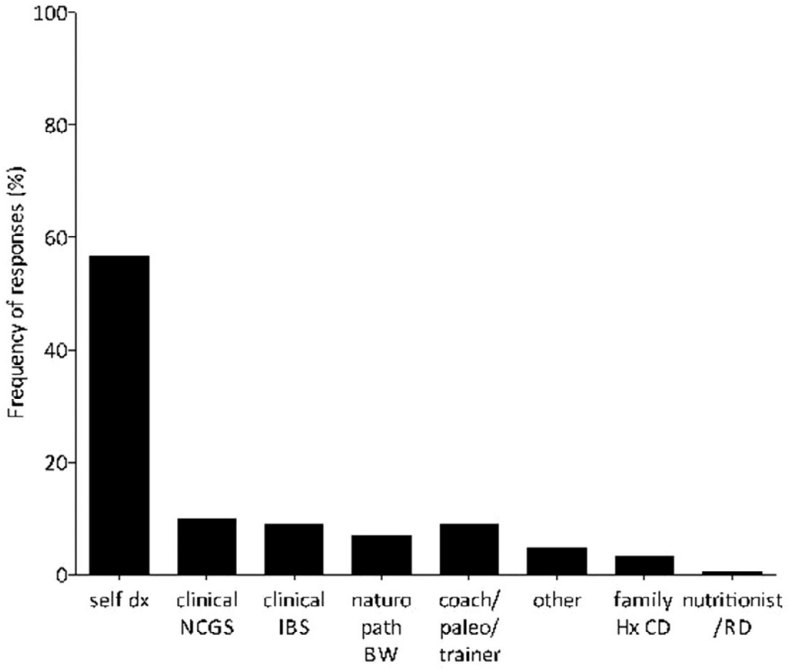

Figure 1 — GFD > 50 basis of prescription for adherence to a GFD. NCGS = nonceliac gluten sensitivity, IBS = irritable bowel syndrome, BW = bloodwork, dx = diagnosis, hx = history, CD = celiac disease, RD = registered dietitian.

Less frequently reported symptoms included *self-prescribed physiological* (2.4%, $n = 7$), *nutritional* (3.3%, $n = 8$), *skin* (0.3%, $n = 4$) and more than 4 symptoms (10.2%, $n = 30$).

The GI distress occurrence rates were similar (all $p > .121$) between the GFD > 50 and GFD < 50 groups in all categories (Figure 2). At the GI distress incidence rate of *less than 25%* of the time both groups reported similar frequencies (84.5%, $n = 452$ vs. 80.8%, $n = 303$). In addition, comparable between the two groups were reported GI distress rates within the incidence range of *26–50% of the time* (13.6%, $n = 66$ vs. 12.3%, $n = 51$) and *over 50% of the time* (3.2%, $n = 21$ vs. 5.6%, $n = 17$).

Beliefs (Dietary Habits)

The key differences between the GFD > 50 and GFD < 50 groups in perceived dietary changes that occur alongside a GFD included *more conscientious of overall nutrition intake* (77.9 vs 58.5%; OR 2.50, 95% CI 1.85–3.36, $p < .001$), *less processed food choices* (43.7 vs. 64.5%; OR 0.43, 95% CI 0.32–0.57, $p < .001$) and *no dietary changes known* (6.9 vs. 8.8%; OR 0.34, 95% CI 0.16–0.71, $p = .005$) (Figure 3a). There were no differences between GFD < 50 and GFD > 50 groups concerning the beliefs that a GFD may also incorporate *increased fruit and vegetable intake* (58.7 vs. 57.8%; OR 1.03, 95% CI 0.70–1.35, $p = .784$), *increased gluten-free whole grain intake* (41.1% vs. 37.8%; OR 1.14 95% CI 0.87–1.5, $p = .314$) and *more balanced nutrition intake overall* (33.1 vs. 29.3%; OR 1.19, 95% CI 0.89–1.58, $p = .232$).

Beliefs (Physiological)

Key differences between the GFD > 50 and GFD < 50 groups in perceived physiological changes that occur alongside a GFD. The GFD > 50 compared with the GFD < 50 group believe more frequently that *improved exercise performance* (56.3 vs. 23.9%; OR 4.09, 95% CI 3.08–5.44, $p < .001$); *decreased inflammation/illness* (73.3 vs. 30.3%; OR 6.33, 95% CI 4.72–8.50, $p < .001$), *decreased GI distress* (61.1 vs. 30.8%; (OR 3.82, 95% CI 2.87–5.10, $p < .001$), *improved body composition for sport performance* (74.4 vs. 43.2%; OR 3.52, 95% CI 2.67–4.64, $p < .001$) and *no physiological effects* (2.4 vs. 6.7%; OR 0.34, 95% CI .016–0.71, $p = .005$) occurred alongside a GFD (Figure 3b). There were no differences between the GFD < 50 and GFD > 50 groups in the belief that *physiological effects were only applicable to CD or NCGS* (0.3 vs. 1.5%; OR 0.18, 95% CI 0.02–1.41, $p = .102$).

Discussion

Our survey is the first to determine the prevalence of a GFD across a variety of sports and in world-class athletes, which included ~10% former world or Olympic qualifiers and/or medalists. Of these we found that 41.2% of athletes adhered to a GFD over 50% of the time and that this diet was most prominent within the endurance sport community among athletes at the recreational level (70% of GFD > 50) between 31–40 years of age. This high frequency of adherence to a GFD over 50% of the time is surprising considering that researchers estimate

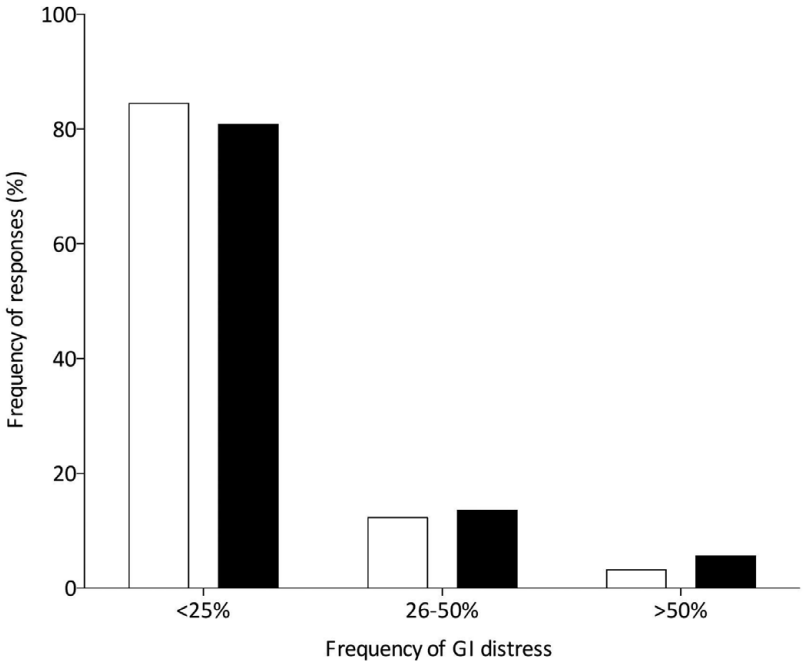

Figure 2 — Frequency of gastrointestinal (GI) distress between gluten-free diet adherence 50–100% of the time (GFD > 50 = filled-in square) and gluten-free diet adherence less than 50% of the time (GFD < 50 = square) groups. Frequency of GI distress are categorized as occurring less than 25% of the time (<25), 26–50% (26–50) of the time and more than 50% (>50) of the time.

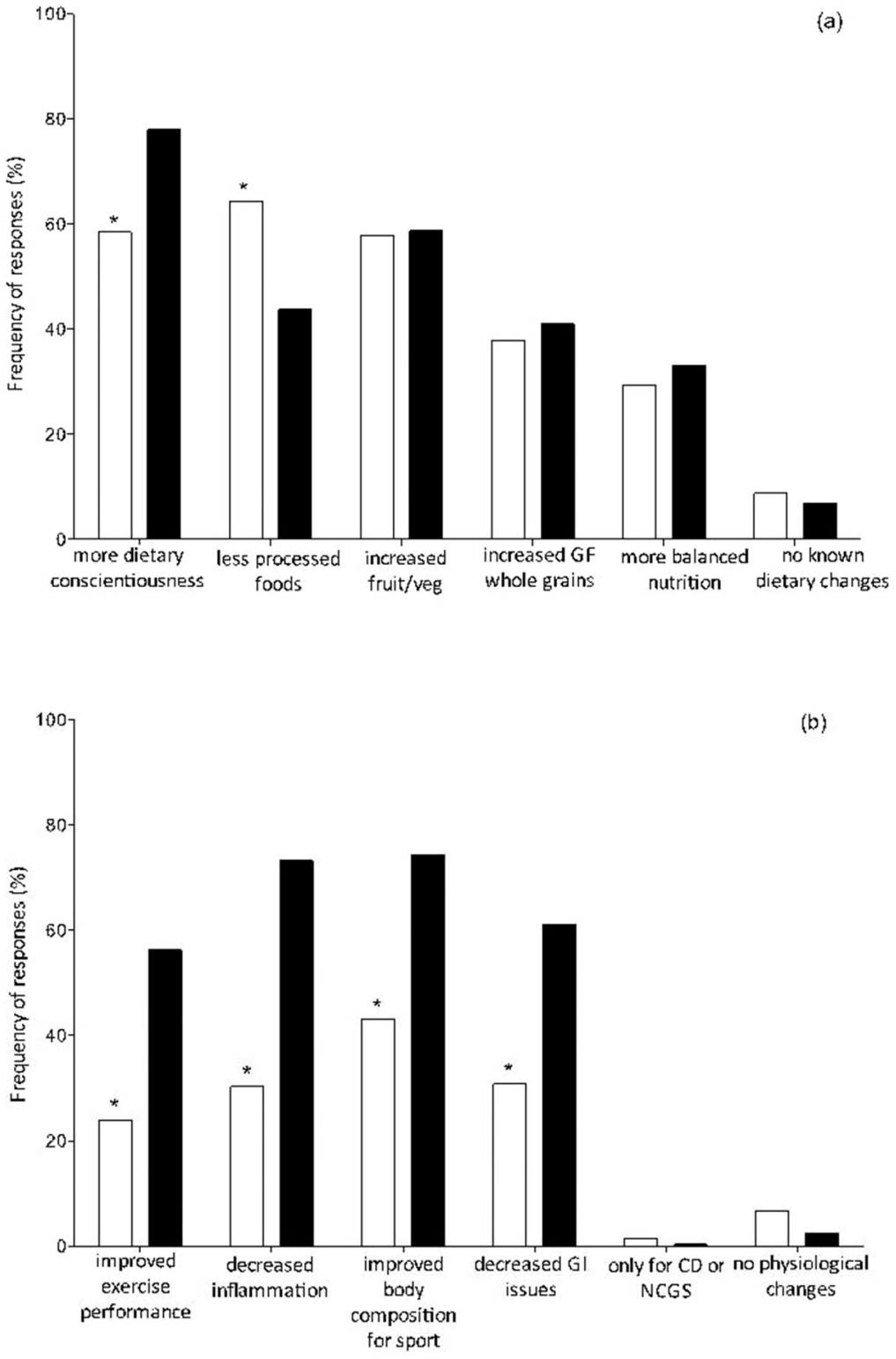

Figure 3 — (a) GFD > 50 and GFD < 50 athletes perceived dietary changes that occur with adherence to a GFD. (b) GFD > 50 and GFD < 50 perceived physiological changes that occur with adherence to a GFD. *Significantly different from GFD > 50 to GFD < 50. CD = celiac disease, NCGS = nonceliac gluten sensitivity. *Gluten-free diet adherence 50–100% of the time (GFD > 50 = filled-in square); less than 50% of the time (GFD < 50 = square).

only 5–10% of the population may benefit medically from a GFD (Hadjivassiliou et al., 2010). Our survey results further highlight that the decision to adhere to a GFD over half of the time was often not made based on clinical recommendations, but mostly as a result of a self-diagnosed gluten issue (57%). Adherence to a GFD varied from occasionally to all of the time; however, of the group that followed a GFD over 50% of the time, the largest cohort followed this diet 90–100% of the time. Reasons for adhering to a GFD in NCAs include perceived reductions in GI distress, reduced inflammation, improved exercise performance and that the diet supports a favorable body composition for sport.

This survey shows that primarily athletes involved in endurance-based sports adopt a GFD. Fritscher et al. (2012) also found that a GFD diet was the most popular "special diet" among endurance cyclists with similar reports that a GFD improved GI symptoms in approximately 80% of survey respondents. The attraction of gluten elimination may be prominent within this subgroup due to the higher frequency of GI dysfunction reported by endurance sport athletes (15–30%) compared with other types of athletes (Jeukendrup et al., 2005; Pfeiffer et al., 2009, 2012). While exercise may increase intestinal permeability, due to reduced splanchnic perfusion, dietary factors such as high carbohydrate intake may also contribute to GI dysfunction (Pfeiffer et al., 2009, 2012; van Wijck et al., 2011). There was belief among this athlete-group that gluten removal decreased the rate of GI symptoms (Figure 3b). Increased rates of GI distress and a greater awareness of nutrition information may also contribute to the increased popularity of a GFD within this demographic (Heaney et al., 2011; Worme et al., 1990).

The GFD > 50 athletes reported reductions in abdominal/GI distress to be the primary outcome of gluten-elimination. Abdominal/GI symptoms along with two to three other symptoms, including physiological, nutritional and skin-related symptoms, were perceived to be triggered by gluten and resolved with gluten-avoidance in the majority of GFD > 50 respondents. Clinical and case-report data confirms a list of symptoms, such as nutrient deficiencies, abdominal boating, and fatigue to resolve with GFD adherence in athletes diagnosed with CD (Black et al., 2012). However, alongside CD, a spectrum of gluten-related disorders have been defined. The most well-known of these is NCGS with over 100 associated symptoms, including gluten ataxia, which due to reductions in neurological and muscular coordination would be detrimental to athletic performance (Hadjivassiliou et al., 2010). According to Gibson and Shepard (2010) functional GI disorders are common and can be worsened with the intake of dietary triggers. The rise in gluten as a dietary trigger for a range conditions and the upsurge in NCGS and CD may be due to increased awareness and diagnosis of GI and related disorders. However, self-prescription of a GFD based on symptoms or no symptoms was the dominate rationale for gluten-avoidance (~57%) which may or may not be concomitant with gluten itself (Gibson and Muir, 2013). The rate of GI distress reported in both the GFD < 50 and GFD > 50 groups was similar and this further demonstrates that the removal of gluten itself may not be the key modulating factor in a GFD and perceived symptom improvements. Given the complexity and importance of an athletes' diet, diagnosis of CD or NCGS should be established before removing gluten from the diet (Harris & Meyer, 2013). The appropriate diagnoses of NCGS or the medical requirement for a GFD is of significant importance to athletes as this diet can be time-consuming, complex and compromise optimal energy and carbohydrate intake.

In addition to the belief that a GFD reduces GI dysfunction the current study has shown perceptions among athletes that a GFD improves exercise performance, decreases inflammation, and improves body composition (Figure 3b). NCA further indicated that other positive dietary factors were believed to simultaneously result from a change to a GFD, such as an increase in conscientiousness of nutrition intake, increased fruit, vegetable and gluten-free whole grains and decreased processed food consumption (Figure 3a). According to our survey results a small number of athletes believe that decreased energy and carbohydrate intake may result with a GFD which may compromise energy and fuel availability for athletes (Loucks, 2004). Given that other dietary factors known to positively affect heath and performance were believed to occur concurrently with the adoption of a GFD in NCA it is unknown if reported performance improvements identified were simply perceived, a function of undiagnosed CD, NCGS, other dietary factors, or related to the GFD itself (Maughan & Shirreffs, 2011; Meyer et al., 2007; Van Duyn & Pivonka, 2000). Other dietary changes may occur alongside a GFD and evaluation of any effects of a GFD must take into account other dietary variations and possible placebo effects (Meissner et al., 2007).

Currently there is a lack of diagnostic criteria for NCGS, where no allergic or autoimmune mechanisms are involved, and NCGS diagnosis is confirmed by gluten-exclusion and followed by monitored reintroduction of gluten-containing foods (Sapone et al., 2012). However, this approach lacks specificity and is subject to the risk of placebo if not blinded (Sapone et al., 2012). The effect size of ergogenic aids and belief in an intervention are both similarly estimated to improve performance by 1–3% (Halson & Martin, 2013). With the findings that many athletes believe that GFD adherence improves performance for NCAs it is important to consider that belief may influence performance outcomes with this dietary intervention (Halson & Martin, 2013). Results from this survey will assist nutrition practitioners to better understand the scope of the GFD movement, to consider the psychological aspects of the NCA athlete following or considering this diet, and the potential placebo affects; all of which are principal nutrition counseling tools to comprehend and apply when working with athletes.

Self-prescription of a GFD among athletes may be reinforced by nonpeer reviewed literature or opinions from coaches/trainer of a GFD being overall healthier and

improving performance. Nonpeer reviewed or anecdotal GFD information was primarily sourced from online resources, other athletes and from coaches/trainers. Nutritionists/registered dietitians were reported much less often as sources of GFD information, a theme common in sport nutrition practice which further highlights that sources of GFD advice may be from nonqualified nutrition professionals (Hornstrom et al., 2011). Since the avoidance of gluten restricts a range of foods, it has the potential of causing nutrient deficiencies (B vitamins, fiber and iron), compromising gut health by reducing beneficial gut bacteria, especially without appropriate nutrition counseling (Gaesser & Angadi, 2012; Saturni et al., 2010; Shepherd & Gibson, 2012). Further, reduced enjoyment, ease of eating and increased food cost, estimated to be up to 242% higher for a number of gluten-free replacement items, are also an important consideration for the appropriateness of a GFD for NCA (Heaney et al., 2008; Stevens & Rashid, 2008). Although more nutrient dense GF foods are introduced to grocery shelves almost daily, the long-term effects of a strict GFD in NCAs is unknown and it is preferable to assess the necessity of this diet before assigning unnecessary food restrictions.

While our survey excluded individuals with celiac disease, self-selection may have biased an unproportional number of responses from athletes interested in or following a GFD. However, the proportionately high rate of athlete respondents that did not follow a GFD, or were unfamiliar with a GFD, support that our findings are most likely representative of an athletic population. Overall, our survey data indicated a high proportion of athletes adhere to a GFD without evidence-based necessity. It is possible that athletes follow a GFD due to perceived physiological improvements that may coincide simultaneously with other dietary changes and/or the perception that gluten elimination will provide the same health benefits and even an ergogenic edge in NCA.

An athlete's diet is a key element to training adaptations and athletic performance and all elements affecting nutrition intake must be considered when deciding to adopt a GFD for nonmedical reasons. Our survey results indicate that many NCA have adopted a GFD due to perceived, yet unconfirmed, health and performance benefits resultant from gluten removal. Given the restrictive nature of this diet and the unknown effects of long-term adherence to a GFD in NCA, further research in this area is essential to determine the effects of a GFD on parameters of exercise performance and gut health.

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