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GLYCEMIC INDEX AND GLYCEMIC LOAD IN BRAZILIAN ATHLETES' DIETS

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ABSTRACT

Background: Glycemic Index (GI) and Glycemic Load (GL) have been used as tools for choosing diet as a health reference, and especially for athletes, with the purpose of improving physical performance. However, little is known about the GI and GL in the diet of athletes from different sports. Aim: Investigate the GI and GL in the diet of Brazilian athletes. Methods: Cross sectional study conducted with 113 athletes (18.4 ± 6.6 years, 22.3 ± 3.2kg/m2, 13.6 ± 7.0 % body fat, and 12.0 ± 6.9 hours of weekly training). Bioelectrical impedance was used to assess percentage body fat and anthropometric measurements were evaluated. Food consumption was assessed through the 24-hour dietary recall, GI and GL were calculated based on previously established procedures. The Mann-Whitney U test and Kruskal-Wallis test were used for statistical analysis. Results: There was no statistical difference in training volume, macronutrient intake, total calories, GI among men and women ($P > 0.05$). The GL was lower in women´s diets and was different among sports. High GL diets presented lower percentage of body fat than moderate GL ($P < 0.05$). Conclusion: The majority of the athletes presented a diet with a low GI and high GL. Differences were found between GL classification and modalities and body fat. Further studies are required to better elucidate the effects of these dietary glycemic properties on body composition and physical performance.

Key words: Dietary intake. Body composition. Physical performance.

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RESUMO

Índice glicêmico e carga glicêmica de dietas de atletas

Introdução: Índice Glicêmico (IG) e Carga Glicêmica (CG) têm sido utilizados como ferramenta de escolha da dieta para melhorar o desempenho físico. No entanto, pouco se sabe sobre a aplicabilidade do consumo pelos atletas de diferentes modalidades. Objetivo: Analisar o IG e a CG da dieta de atletas brasileiros. Métodos: Estudo transversal conduzido com 113 atletas (18,4 ± 6,6 anos, 22,3 ± 3,2kg/m2, 13,6 ± 7,0 % percentual de gordura corporal e 12,0 ± 6,9 horas de treinamento semanal). Para avaliar o percentual de gordura foi utilizado uma bioimpedância elétrica e também foi realizado medidas antropométricas. O consumo alimentar foi avaliado por meio do recordatório de 24 horas. Calculou-se IG e CG da dieta utilizando seguindo procedimentos previamente estabelecidos. O teste Mann-Whitney U e o teste de Kruskal-Wallis foram usados para as análises estatísticas. Resultados: Não houve diferença estatisticas no volume de treinamento, na ingestão de macronutrientes, no total de calorias e no IG entre homens e mulheres ($P > 0,05$). A CG foi menor nas mulheres e diferentes entre os esportes. As dietas de alta CG apresentaram baixo percentual de gordura corporal do que as dietas de moderada CG ($P < 0,05$). Conclusão: A maioria dos atletas apresentou dieta com baixo IG e alta CG. Houve diferenças entre a classificação da CG, as modalidades e o percentual de gordura corporal. Mais estudos são necessários para elucidar os efeitos da CG e do IG na composição corporal e no desempenho físico.

Palavras-chave: Ingestão alimentar. Composição corporal. Desempenho atlético.

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INTRODUCTION

The glycemic index (GI) was proposed by Jenkins and collaborators (1981) as a method to determine the effect of carbohydrate (CHO) on postprandial blood glucose compared to a reference food (glucose or white bread). The concept of GI expanded the classification of CHO, which was previously considered only as simple or complex, allowing a more specific approach to the effects on health (Brand-Miller and collaborators, 2003; Foster-Powell and collaborators, 2002).

In addition to the information provided by the GI, the relation of this parameter to the amount (in grams) of CHO ingested can be translated by the concept of Glycemic Load (GL) (O'reilly and collaborators, 2010).

GL reflects the concentration of this nutrient in relation to the amount consumed in the meal by measuring the glycemic impact of the diet (Portero-Mclellan and collaborators, 2010). Thus, GL allows comparison of glycemic responses of portions consumed from different foods, while the GI allows comparison of the glycemic responses of different foods but belonging to the same category and with the same GL (Wolever, 2013). In this sense, it is possible to obtain a more tangible response regarding the consumption of CHO through both the quality and quantity consumed in a portion (Brand-Miller and collaborators, 2003).

The importance of adequate carbohydrate consumption (CHO) is highly evidenced in sports nutrition. Current recommendations suggest that athletes should consume more CHO than the general population, ranging from five to 10 g per kilogram of body weight daily (Thomas and collaborators, 2016).

A recent systematic review demonstrated that in 71.4% of the included studies the athletes consumed CHO below the recommended levels (Rodrigues, Ravagnani and Nabuco, 2017). Moreover, there has been little investigation on the determination of a CHO profile that an athlete should eat to ensure better physical performance and training adaptation (Donaldson and collaborators, 2010).

Few studies have verified the effect of GI and GL on the health and performance of athletes with conflicting results (Brown and collaborators, 2013; Burdon and collaborators, 2017; Gonçalves and collaborators, 2015; Wu and Williams, 2006).

Gonçalves and collaborators (2015) showed that in female soccer players the CHO intake was insufficient with a GI alternating between low and moderate and high GL. Brown and collaborators (2013) demonstrated that low GI and high GI present different fat and CHO oxidation rates and this may be a factor when considering post-exercise meals, however, the authors observed no impact on performance of cyclists.

A recent meta-analysis, about the effect of GI of a pre-exercise meal on endurance exercise performance, found no clear benefit of consuming a low GI meal pre-exercise for endurance performance regardless of CHO ingestion during exercise (Burdon and collaborators, 2017).

However, Wu and Willians (2006) showed that the ingestion of a low GI meal three hours before exercise resulted in a greater endurance capacity than after the ingestion of a high GI meal.

Taken together these results suggest further research is needed to elucidate this question, since it is important to evaluate and study the GI and GL of athletes to determine specific nutritional guidelines aiming at better athletic performance and improvement in health status. In addition, more studies on GL are necessary.

Therefore, the objective of the present study was to identify, describe, and compare the GI and GL in the diet of Brazilian professional athletes.

MATERIALS AND METHODS

Participants

This is a cross-sectional study carried out at the Núcleo de Aptidão Física, Informática, Metabolismo, Esporte e Saúde (Nafimes, Center for Physical Fitness, Informatics, Metabolism, Sports, and Health) from 2013 to 2016. The sample was composed of 113 athletes of both genders, aged from 12 to 49 years, who competed in six different sports (soccer = 40, volleyball = 20, bodybuilding = 06, combats = 28, track and field = 13, and swimming = 6).

Athletes were contacted directly through phone or e-mail and through indications from coaches or sporting federations. Convenience sampling was used, i.e., the participant athletes were selected based on availability and accessibility after contacting sports federations/clubs and

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coaches. Individuals who trained with competitive objectives, participated in regional and international events, and with a weekly training load equal to or greater than six hours were considered athletes (Araujo and Scharhag, 2016).

Athletes who did not respond to two 24-hour recalls (R24h) were excluded. All athletes and those responsible for athletes under the age of 18 years were informed of the study objectives and signed an Informed Consent Form. Demographic (age and sex) and training (type of sport, volume, and training phase) information were obtained through a questionnaire. This investigation was conducted according to the Declaration of Helsinki and approved by Research Ethics Committee of the Julio Muller Hospital (under number 488.198).

Body composition

Body mass was measured to the nearest 0.1 kg using a calibrated electronic scale and height was measured using a stadiometer to the nearest 0.1 cm. The participants wore light clothing without shoes. Body mass index (BMI) was calculated as the body mass in kilograms divided by the square of the height in meters.

A bioelectrical impedance device (Inbody® S10) was used to estimate percentage of body fat. All measurements were performed during the morning period. Before measurement the participants were instructed to remove all objects containing metal. Participants were instructed to lie in a supine position, legs abducted at an angle of 45º relative to the body midline, and hands pronated.

After cleaning the skin with alcohol, two electrodes were placed on the surface of the right hand and two on the right foot in accordance with procedures described by Sardinha and collaborators (1998). Prior to the test, participants were instructed to refrain from ingesting food for 8h and drinking water for two hours, avoid strenuous physical exercise for at least 24 h, and refrain from consumption of alcoholic and caffeinated beverages for at least 48 h.

Dietary intake

Food intake was assessed by the 24-hour dietary recall method applied on two non-consecutive days of the week, with the aid of a photographic record taken during an interview (Monego and collaborators, 2013).

The homemade measurements of the nutritional values of foods and supplementation were converted into grams and milliliters by the online software Virtual Nutri Plus (Keeple®, Rio de Janeiro, Rio de Janeiro, Brazil). Some foods were not found in the program database and therefore items were added from food tables (Pinheiro and collaborators, 2009).

Participants who used dietary supplements were instructed to report the brand and quantity consumed in order to ensure a higher accuracy of the macronutrient values present in each product.

Calculation of dietary glycemic index and glycemic load

For GI determination, the protocol proposed by the Food and Agriculture Organization (FAO, 1998) was followed according to the following steps: 1) identification of total glycemic CHO (in grams) of each food meal; 2) determination of the proportion of glycemic CHO of each food in relation to the total glycemic CHO of each meal; 3) location of the GI of each food (using glucose as reference) in a specific table (Foster-Powell and collaborators, 2002); 4) determination of the contribution of each food to the GI of the meal (GI of the food for the proportion of its glycemic CHO, in relation to the glycemic CHO of the meal); and 5) determination of the GI of each meal, through the sum of the values obtained in the previous item. The glycemic index of the diet was categorized as low, medium, or high GI, according to the classification of Brand-Miller and collaborators (2003), who define: low GI ≤55, moderate GI>55 and <70, and high GI ≥70.

The GL of the meal was determined by multiplying the CHO of the food, in grams, by its GI, divided by 100 (Lau and collaborators, 2005). After this procedure, the GL of the food was summed to determine the total of the meal, and finally, the GL of all meals was added to obtain the total GL value of the diet. Glycemic load of the diet was categorized as low, medium, or high, as follows: low GL<80, moderate GL≥80 and ≤120, and high GL>120 (2).

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Statistical analyses

The Shapiro Wilk test was used to verify data distribution. Descriptive statistics are presented as median and interquartile range. Differences in general characteristics, eating habits, and average training time according to sex were determined using the Mann-Whitney U test and to evaluate the other analyses the Kruskal-Wallis test was performed. For all statistical analyses, significance was accepted at P < 0.05. The data were analyzed using SPSS software version 20.0 (SPSS, Inc., Chicago, IL, USA).

RESULTS

Table 1 presents the anthropometric characteristics, eating habits, and training volume of athletes. The women were younger, with lower weight, BMI, and GL, and a higher percentage of fat mass when compared to the men (P<0.001). There was no statistical difference in training volume, macronutrient intake, total calories and GI among men and women (P> 0.05).

Table 1 - Anthropometric characteristics, eating habits, and average training time of the athletes according to sex (n=113).

Variables	Female (n = 29)	Male (n = 84)	p
Age (years)	15.4 (14.2 – 18.8)	19.2 (17.1- 21.5)	<0.001
Body mass (kg)	53.2 (50.3 – 55.6)	70.2 (63.5 – 76.0)	<0.001
BMI (kg.m^{-2})	20.9 (18.9 – 21.7)	22.7 (21.4 – 24.7)	<0.001
Body fat (%)	19.8 (17.7 – 23.5)	10.4 (7.9 – 14.5)	<0.001
Training volume (hours/week)	12 (8 – 18)	12 (10 – 20)	0.109
TEI (kcal/kg/day)	36.8 (29.7 – 47.2)	39.1 (33.6 – 47.4)	0.478
Carbohydrates (g/kcal/day)	4.9 (3.5 – 5.6)	5.1 (4.0 – 6.9)	0.305
Protein (g/kg/day)	1.5 (1.1 – 2.1)	1.6 (1.3 -2.1)	0.718
Lipids (g/kcal/day)	1.2 (0.8 – 1.7)	1.2 (0.9 – 1.5)	0.884
Glycemic index	52.7 (47.3 –55.2)	53.0 (49.5 – 57.8)	0.797
Glycemic load	142.9 (72.4 – 459.0)	189.3 (50 – 903.2)	<0.001

Legend: Data are expressed as median and interquartile interval. BMI = body mass index; TEI = Total energy intake.

Table 2 - Anthropometric characteristics, eating habits, and average training time of the participants according to modalities (n=113).

	Modalities						
Variables	Track and field	Bodybuilding	Soccer	Combat	Swimming	Volleyball	p
Age (years)	19.4 (17.5 – 23.7)	25.1 (23.3 – 25.7)	19.0 (17.5 – 20.3)^{b}	20.2 (15.7 – 25.1)	15.7 (14.0 -18.5)^{a,b}	15.0 (14.3 – 16.1)^{a,b,c,d,e}	<0.001
Body mass (kg)	68.1 (57.6 – 71.0)	74.4 (64.7 – 85.5)	69.6 (63.7 – 75.8)	59.9 (52.3 – 75.7)^{c}	61.4 (52.5 – 75.7)	60.0 (53.0 – 68.5)^{b,c}	<0.001
BMI (kg.m^{-2})	22.4 (21.3 – 22.8)	24.9 (22.2 – 24.6)	23.0 (21.5 – 24.6)	22.3 (19.9 – 25.1)	20.2 (19.6 – 24.0)^{b}	20.6 (19.0 – 21.7)^{a,b,c,d}	<0.001
Body fat (%)	10.0 (7.8 – 14.4)	15.6 (14.7 – 18.4)	11.3 (8.8 – 14.6)^{b,d}	17.6 (11.2 – 21.1)^{a,e}	7.8 (5.6 – 15.2)	11.4 (4.6 – 19.0)^{a,e}	<0.001
Hours of training per week	18.0 (15.0 – 24.0)^{b,d,f}	9.0 (6.0 – 12.0)	11.5 (10.0 – 24.0)	13.0 (9.5 – 18.0)	18.0 (12.0 – 18.0)	9.0 (8.0 – 11.0)^{d,e}	<0.001
TEI (kcal//kg/ day)	36.4 (29.7 – 46.6)	46.2 (28.5 – 60.5)	39.1 (33.2 – 50.6)	39.9 (32.5 – 47.4)	39.1 (37.3 – 41.7)	38.1 (28.5 – 45.0)	0.694
Carbohydrates (g/kg/day)	4.8 (4.3 – 6.1)	5.5 (4.5 – 6.2)	5.8 (4.0 – 7.7)	4.8 (3.3 – 6.7)	4.9 (4.4 – 5.5)	4.8 (3.3 – 5.3)	0.296
Protein (g/kg/day)	1.0 (1.1 – 2.0)	3.0 (1.6 – 7.1)	1.4 (1.1 – 1.9)	1.7 (1.3 – 2.3)	1.9 (1.4 – 2.6)	1.6 (1.4 – 2.0)	0.171
Lipids (g/kg/day)	1.2 (0.8 – 1.4)	0.6 (0.5 – 3.1)	1.1 (0.9 – 1.5)	1.3 (0.9 – 1.8)	1.2 (1.1 – 1.4)	1.3 (0.9 – 1.6)	0.758
Glycemic index	52.5 (51.1 – 55.7)	55.0 (50.1 – 59.7)	54.2 (50.7 – 58.1)	53.7 (48.1 – 59.1)	47.2 (45.2 – 49.5)	51.4 (47.4 – 55.3)	0.118
Glycemic load	135.6 (100.0 – 382.6)^{c}	182.5 (119.0 – 309.5)	215.4 (97.0 – 903.24)^{d,f}	160.0 (50.7 – 540.8)	184.2 (130.0 – 360.3)	140.8 (75.8 – 283.5)	<0.001

Legend: Data are expressed as median and interquartile interval. Different letters indicate statistical difference between groups, where aTrack and field, bBodybuilding, cSoccer, dCombat, eSwimming, and fVolleyball. BMI = body mass index; TEI = Total energy intake.

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Table 2 displays the anthropometric characteristics, eating habits, and training volume of the athletes as stratified by sport modality. Volleyball athletes were younger when compared to other sports (p< 0.05) and presented lower weight than soccer athletes and bodybuilders (p< 0.05). Volleyball athletes had lower BMI compared to track and field, bodybuilding, soccer, and combat athletes pP< 0.05).

Soccer players had a lower percentage of fat mass compared with bodybuilders and combat athletes (p< 0.05). Soccer players had a higher GL than track and field, combat and volleyball (p<0.05). Combat athletes presented a higher percentage of fat mass when compared to track and field and volleyball participants (p< 0.05). Volleyball players had a higher percentage of fat mass compared to track and field and swimming athletes (p< 0.05).

Track and field participants showed a higher volume of weekly training than bodybuilding, combat, and volleyball athletes (p< 0.05), while volleyball players had a lower weekly training volume compared to combat and swimming athletes (p< 0.05).

General characteristics and modalities of athletes according to glycemic index are shown in Table 3. No differences were found between GI classification and general characteristics and modalities (p> 0.05).

General characteristics and modalities of athletes according to GL are shown in Table 4. Athletes with high GL diets presented lower percentage of body fat when compared with moderate GL (p< 0.05).

Table 3 - General characteristics and modalities of athletes according to glycemic index (n=113)

Variables	Low GI (n = 70)	Moderate GI (n =43)	High GI (n =0)	p
General characteristics[a]				
Age (years)	18.6 (15.7 – 21.7)	18.1 (16.6 – 20.7)	-	0.845
Body mass (kg)	64.6 (55.6 – 72.8)	68.2 (59.9 – 73.3)	-	0.404
BMI (kg.m^{-2})	21.9 (20.3 – 24.0)	22.5 (20.9 – 24.4)	-	0.442
Body fat (%)	14.2 (8.8 – 18.4)	11.1(8.0 – 15.9)	-	0.178
Hours of training per week	12.0 (9.0 – 18.0)	12.5 (9.2 – 20.2)	-	0.453
Modalities[b], n (%)				0.597
Track and field	07 (53.8)	06 (46.2)	-	
Bodybuilding	05 (83.3)	01 (16.7)	-	
Soccer	22 (55.0)	18 (45.0)	-	
Combat	19 (67.9)	09 (32.1)	-	
Swimming	03 (50.0)	03 (50.0)	-	
Volleyball	14 (70.0)	06 (30.0)	-	

Legend: Data are expressed as median and interquartile interval. Modalities are presented as absolute number and frequency. GL = glycemic index; BMI = body mass index. a = Mann-Whitney; b = chi-square test.

Table 4 - General characteristics and modalities of athletes according to glycemic load (n=133).

Variables	Low GL (n = 4)	Moderate GL (n =16)	High GL (n = 193)	p
General characteristics[a]				
Age (years)	16.0 (14.0 – 21.0)	17.1 (12.0 – 49.0)	18.5 (13.0 – 48.0)	0.424
Body mass (kg)	58.3 (53.0 – 82.8)	59.3 (45.9 – 121.2)	67.5 (47.7 – 95.0)	0.234
BMI (kg.m^{-2})	22.1 (20.5 – 26.7)	21.4 (17.3 – 39.8)	22.3 (16.8 – 28.6)	0.579
Body fat (%)	17.1 (12.9 – 34.4)	18.3 (6.9 – 31.5)	11.5 (3.0 – 36.8)*	<0.001
Hours of training per week	15.0 (8.5 – 19.0)	15.5 (6.0 – 24.0)	12.0 (6.0 – 36.0)	0.869
Modalities[b], n (%)				0.067
Track and field	0	3 (23.1)	10 (76.9)	
Bodybuilding	0	1 (16.7)	5 (83.3)	
Soccer	0	2 (5.0)	38 (95.0)	
Combat	3 (10.7)	4 (14.3)	21 (75.0)	
Swimming	0	0	6 (100.0)	
Volleyball	1 (5.0)	6 (30.0)	13 (65.0)	

Legend: Data are expressed as median and interquartile interval. Modalities are presented as absolute number and frequency. GL = glycemic load; BMI = body mass index; TEI = Total energy intake. a = Kruskal-Wallis; b = Fisher's Exact test. *P<0.05 from moderate GL.

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DISCUSSION

The main finding of this study was that Brazilian athletes consume low GI and high GL diets; there were differences in the GL of the diets according to sports modalities and sex. The glycemic load was higher in men than in women. Our findings (including the glycemic index and glycemic load) are consistent with those from previous studies in the general population (Mendez and collaborators, 2009) and corroborate a study with female soccer players, which showed low to moderate GI and high GL in their diets (Gonçalves and collaborators, 2015).

The fact that athletes consumed low/moderate GI diets and high GL may be related to, at least in part, the high intake of CHO from low-GI foods (e.g. fruits, beans and legumes) and/or high protein intake at meals, which contribute to a reduction in the hyperglycemic effects of the diet (Brand-Miller and collaborators, 2003). The high GL of their diet also suggests that, even if the CHO consumption from each meal was low, it may come from few meals, with a high concentration of carbohydrate (Gonçalves and collaborators, 2015).

Most athletes from our study consumed a rich protein diet (1.6 ± 1.1 g/kg/day), but normal according to current recommendations for athletes (Thomas and collaborators, 2016). However, when we analyzed the median CHO consumption (4.9 ± 2.0 g/kg/day), it was observed that it was slightly lower than that recommended for athletes training at least one hour per day (Thomas and collaborators, 2016). These findings are in line with those of other studies that also evidenced the low consumption of CHO (<5 g/kg/day) among athletes (Burke and collaborators, 2011; Rodrigues, and collaborators, 2017).

It should be noted that different sports have different requirements and/or dietary approaches. Furthermore, female athletes generally adopt different nutritional behaviors frequently based on aesthetic and psychological concerns, which may be result in a female athlete triad (Hinton and collaborators, 2004; Thomas and collaborators, 2016).

Besides all groups from our study had consumed high glycemic load diets, soccer players and bodybuilders had the highest values. On the other hand, women and track and field male groups presented lowest GL from their diets, with CHO consumption of 4.7 ± 1.8 g/kg/day (for track and field), that is, below the 6 to 10g/kg/day recommended for endurance modalities (Thomas and collaborators, 2016). Our findings confirm the differences in the quantitative and qualitative profile of CHO consumption by sex and different sports.

Based on our results, it is too early to assume that athletes' diets with high GL necessarily mean sufficient intake of CHO and also that these diets have the same repercussions in terms of physical performance when compared to diets rich in this nutrient, but with low GI (Brand-Miller and collaborators, 2003; Chen and collaborators, 2008).

If an athlete consumes foods with high GI, but in small quantities, there will be only a small increase in blood glucose, due to the small amount of food, especially CHO (Wolever, 2013). On the other hand, if the athlete eats low-GI foods, but in high quantities, it is likely that the replacement of glycogen stores will be ensured through a sufficient supply of CHO (Beck and collaborators, 2015; Burke and collaborators, 2011).

Low glycemic index meals before exercise (2 hours) favor the availability of CHO during and after prolonged exercise. In contrast, high-GI meals should be consumed immediately after exercise in order to increase muscle glycogen resynthesizes (Slater and Phillips, 2011).

However, these recommendations are based only on acute effects resulting from the administration of different types of CHO on glycemic responses, and the associations between GI or overall GL of a daily diet with body composition, recovery, or physical performance remain unclear (O'reilly and collaborators, 2010).

Interestingly, our study showed that athletes with high GL diets presented lower percentage of body fat when compared with moderate GL. The available literature on the association of diets with different GI and GL and body composition of the athletes is limited but our results corroborate with those observed for the Spanish adults (Mendez and collaborators, 2009) where a negative relation between GL and BMI was observed. As postulated by the authors, we believe that the relatively higher intakes of fruits and beans by our athletes (data not showed) had contributed with high GL and low GI of their diet, since

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these foods tend to be high in fiber and low in energy density resulting in large positive loadings for the GL but large negative loadings for the GI factor.

Contrary to our findings, it has been showed that there may be a positive relation between glycemic load of diet and obesity (Cornejo-Monthedoro and collaborators, 2017; Maki and collaborators, 2007). One potential explanation for our conflicting results can be the specificities of the athletic population. We believe that training under high volume and energetic demand can act as protective factors against gains of body fat, despite the high glycemic load of the diet. However, more research in this area is necessary.

It also should be noted that most studies on this issue involve isolated foods with limited food types (Brand-Miller and collaborators, 2003), as Cornflakes with semi-skimmed milk (GI: 72) and Muesli with semi-skimmed milk (GI: 40) in a crossover, single blinded study approaching the effects of low/high glycaemic index (GI) meals on the physiological responses to a 3-h recovery period and subsequent 5-km cycling time trial (Brown and collaborators, 2013).

Lentils (LGI) and potatoes (HGI) are inserted as standard foods in investigation about the effect of different GI foods on exercise performance (Donaldson and collaborators, 2010), but some of food used in others protocols studies are unknown, that impairs further knowledge about the glycemic index food (Chen and collaborators, 2008).

Furthermore, considering exclusively the GI and GL as a way of expressing the impact to the CHO organism and using this as the only criterion for choosing the food, may not be indicated, since one must take into account the amount of fat, protein, and other nutrients present in food (Wolever, 2013).

This study presents new data on the intake of macronutrients, GI and GL of the athletes' diets from different sports in Brazil, which could aid future research on this theme.

However, some limitations must be highlighted. First, the 24-hour recall as a method of measuring food consumption of the athletes. Accurate completion of the 24-hour recall requires good memory and accuracy regarding the amounts and types of food consumed, and it is important to consider underreporting as a major limitation in the application of this method. Despite the limitation by reporting from a 24h recall, all the investigators were trained to being following up the validate protocol, also trying to get the information by memory cues and standardized words in order to collect all food as possible and reduce underreporting risks (Moshfegh and collaborators, 2008).

The methods used to assign and calculate GI and GL values can also be considered as a limitation of this study, since they depend on the availability of standardized tables containing varied foods. The tables contain a limited number of foods and many of them belong to the habitual consumption of a particular region or country or are not compatible with the reality of consumption of athletes that need specific recommendations.

Thus, some foods had to be adapted to the specific group, such as dietary supplements, which were considered to be of the same GI as other supplements that are not specific to the sport, but with similar nutritional qualities, inducing the subjective interpretation of the evaluator in the standardization of the final GI of the meal.

In addition to the aforementioned aspects, the GI and GL classifications were established for the general population and, therefore, these categorizations may not be appropriate for athletes, since it is a differentiated population regarding dietary recommendations.

CONCLUSION

The majority of the athletes in this study presented a diet with a low GI and high GL. Differences were found between GL classification and sports modalities. Considering the GL and GI can support the dietary planning of athletes, further studies using experimental designs and longitudinal data are required to elucidate the effects of dietary glycemic properties on body composition and performance outcomes in this population.

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Conflict of interests

The authors declare that they have no conflict of interests regarding the publication of this paper.

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