Sport Sci Health (2017) 13:373–380
DOI 10.1007/s11332-017-0368-3

ORIGINAL ARTICLE

Adequacy of dietary intake in swimmers during the general preparation phase

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Received: 27 January 2017 / Accepted: 11 May 2017 / Published online: 18 May 2017

Abstract

Purpose It is important that competitive swimmers follow adequate nutritional planning periodized according to their training program. The aim of this study was to assess daily energy and macronutrient intake, and its adequacy to the exercise sessions in high-performance swimmers.

Methods Dietary intake of 16 swimmers (11 men and 5 women; 15–25 years) was assessed using a 3-day food record in the first phase of the training program (two swimming sessions and one complementary training every day). Daily energy expenditure and energy balance were calculated using predictive equation.

Results A daily energy deficit was found in 80% ($n = 4$) of women and in 18.2% ($n = 2$) of men. Daily protein intake was higher than recommended in men (2.2, $s = 0.4$ g/kg/day; $p = 0.006$, $d = 1.25$), and a low fat intake was observed in women (1.1, $s = 0.1$ g/kg/day; $p = 0.001$, $d = 4.00$). Carbohydrate intake was low for most male and female swimmers related to training sessions. Morning training had 20% ($n = 1$) of women and 18.2% ($n = 2$) of men consuming adequate carbohydrate before training. In the afternoon, only 20% ($n = 1$) of women achieved the recommendations before training sessions, and none of the swimmers achieved the recommendations for carbohydrate plus protein intake in the afternoon post-exercise period.

Conclusions The findings of this study suggest: (1) most of these men consumed energy and macronutrient according to their daily requirements; (2) most of these women failed on daily energy and fat intake; (3) most of these swimmers did not achieve nutrient goals on meals near exercise, especially in the second exercise of the day.

Keywords Diet records · Carbohydrates · Protein · Fat · Swimming

Introduction

Swimming is a sport that requires strength and endurance, and a good performance in most of the swimming races depends on both aerobic and anaerobic systems [1]. The competition calendar determines the periodization of training, usually divided in training phases to improve specific physical and/or technical abilities [2]; each phase comprises training sessions of particular intensity, volume, and types of exercises, imposing different nutritional requirements [1]. Regarding to diet, daily requirements suggested by the literature vary from 3 to 12 g/kg of carbohydrate, 0.8 to 1.7 g/kg of protein, and 0.8 to 2 g/kg of fat, according to the training phase [1, 3–5]. This clearly shows the necessity for an individual approach that should be continuously adjusted throughout the competition season [4], since dietary deficiencies may negatively affect athletes' performance and health, leading to suppression in the metabolic, endocrine, and immune systems [6–8].

Apart from total energy intake, the diet plan should have an adequate macronutrient distribution over the day, to provide the swimmers an adequate fuel supply for exercise sessions and post-exercise recovery [1]. In this context, pre-exercise meal should contain between 1 and 4 g/kg of

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carbohydrate to maintain adequate levels of glucose and optimize glycogen storage [5]. Carbohydrate intake during exercise provides extra energy that prevents glycogen depletion and fatigue, and increases athletes' performance [5, 8]. The amount of carbohydrate needed can vary from 30 to 60 g/h—depending on the volume and intensity of exercises, or even 90 g/h in special situations [9]. In the post-exercise recovery period, it is recommended to take 1–1.2 g/kg/h of carbohydrate in the first 4 h, and 20–25 g or 0.3 g/kg of protein [3, 5, 10].

Studies on nutritional adequacy in swimmers have examined only total daily intake or only one training session [1, 11]. Besides that, studies have shown conflicting results, especially regarding macronutrient intake of female swimmers. Soares et al. [12] found protein intake of 144 g, while mean values of 80 and 90 g were reported by Ousley-Pahnke et al. [13] and Valliéres et al. [14], respectively. Considering that adequate nutrition (adequate energy distribution, carbohydrate periodization, or properly protein consumption after training session) has a direct effect on the sports performance, the aim of the present study was to assess the adequacy of energy and macronutrient intake in relation to both (1) daily requirements and (2) exercise requirements (training sessions) in high-performance swimmers.

Methods

This cross-sectional study was carried out during the general preparation period, after summer break. Trainings were held in a 50-m-long swimming pool (~9000 m/daily, two sessions of 2 h each) and on dry land (one session of 30–40 min/daily of resistance, running, and/or stretching training). Pool training sessions were carried out from 8 to 10 a.m., followed by dry-land training sessions, from 4 to 6 p.m. Training schedule is detailed in Table 1. In addition, swimmers had no access to dietitian during this period.

Subjects

Nineteen competitive swimmers (11 males, 8 females) aged between 15 and 25 years volunteered to participate in the study. All participants had at least 4 years of experience in competitive swimming training for national and/or international competitions. Most of them (90%) were or had been part of the Brazilian national swimming team. All participants or parents/guardians of underage swimmers signed the informed consent form after being informed about the procedures and risks involved in the study. This study was approved by the local ethics committee and conducted according to the Declaration of Helsinki (1964).

Anthropometric measures

Weight (kg), height (cm), and skinfold thickness (triceps, subscapular, abdominal, iliac crest for both genders), adding thigh for women were obtained; data presented as sum of skinfolds (mm), were measured by the same experienced researcher according to standard protocols.

Energy expenditure

Individualized average of total energy expenditure (TEE), during 1 week (6 days of training and 1 rest day), was determined by summing basal metabolic rate (BMR), occupational activity (OA) (calculated according to the factorial method, excluding hours of training) [15], and exercise energy expenditure (EEE) (swimming and complementary training), calculated using the metabolic equivalent table (MET) [16]. This strategy is represented by the equation $TEE = [(BMR \times OA / 24) \times (24\text{-}ht)] + EEE$, where ht is the hours of training.

Table 1 Training schedule from basal phase monitored during 1 week

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Morning session	Dry land: aerobic circuit training	Land: warm up Pool: A1 and technique (3100–5100 m) Dry land: resistance exercise	Land: warm up Pool: A1 and A2 (5000–8250 m) Dry land: resistance exercise	Dry land: running Pool: A1 (3200 m) Dry land: resistance exercise	Dry land: aerobic circuit training Pool: A1 (3560–4800 m) Dry land: aerobic circuit training	Land: warm up Pool: A1 (4160–6160 m)	Rest day
Evening session	Pool: A1 and technique (3950 m)	Pool: A1 and technique (5740 m)	Pool: A1 and technique (3470–5900 m)	Pool: A1 and A2 (3000 m)	Pool: A1 (3100 m)	Rest	

A1 aerobic training, regenerative, low intensity, lactate concentration <1, fat as main source of energy. *A2* aerobic training, intensity greater than A1, lactate concentration ≈1, fat and carbohydrate as main energy source [1]

Detailed information on the exercises was obtained from the training plan and by direct observation. The time spent on each exercise was measured using a stopwatch. The mean time between observations, the swimming stroke, and the distance swam, the intensity of the sessions, and the number of repetitions were recorded.

Food records

The participants recorded the amount of all foods and supplements consumed during/along 3 days (2 weekdays and Sunday), after having received detailed instructions and a photographic material with food portion sizes. This diet monitoring period is considered adequate for the estimation of habitual energy and macronutrient consumption [17]. Each food record was individually reviewed by dietitians together with each participant. Food records were analyzed using the Avanutri online® (Avanutri & Nutrição Serviços e Informática Ltda, Brazil) software.

Energy adequacy, based on the average of 3-day food record, was assessed using the energy balance/adequacy equation: energy intake minus total energy expenditure (kcal/day); a result between 95 and 105% of total energy expenditure was considered adequate. Daily macronutrient intake was assessed according to the distribution proposed by Stellingwerff et al. [4]—6.0 to 12.0 g/kg of carbohydrate, 1.5–1.7 g/kg of protein, 1.5–2.0 g/kg of fat, and by Burke et al. [5]—3.0 to 7.0 g/kg of carbohydrate.

The adequacy of carbohydrate and protein intake before, during, and after exercise, based on the average of 2-day food record (2 week days coincident with training days), was analyzed according to current recommendations by sports nutrition experts [3, 5, 9]—1.0 to 4.0 g/kg, 30 g/h, and 1.0–1.2 g/kg/h of carbohydrates before, during, and after exercise, respectively, and 0.3 g/kg of protein in the post-exercise period. The possibility of underreporting energy intake (Ei) was accessed by calculating the mean reported Ei in relation to the predicted basal metabolic rate (BMR; Ei:BMR) [18] over 3 days of dietary intake according to the method of Goldberg et al. [19]. It was used the physical activity level (PAL) calculated according to swimmers' occupational activity and exercise (1.58 for both genders) as described by Black [20]. Ei:BMR <1.39 for men and <1.35 for women was considered underreporting.

Statistical analysis

Data were described as mean and standard deviation (s), and percentage. The single-sample *t* test was used to compare the mean of food records with reference ranges of carbohydrate, protein, and fat intake, as well as differences between energy intake and expenditure. Effects size for single-sample *t* test was calculated applying the equation $d = x - x0/s$, where d is the effect size, x the sample mean, $x0$ the null value, and s standard deviation; we confederated criteria of classification according to Hopkins [21], where: 0–0.2 trivial, 0.21–0.6 small, 0.61–1.20 moderate, and 1.21–2 large and greater than two very large. Analyses were performed using IBM SPSS 22.0, and statistical significance was set at alpha <0.05. Separate analyses were conducted for male and female swimmers. No statistical analysis was performed for samples smaller than five.

Results

Initially, the sample would be composed for 11 men and 8 women. However, analyzing the possibility of energy intake underreporting, we observed Ei:BMR values of 1.74, $s = 0.3$ for men ($n = 11$) and 1.53, $s = 0.7$ for women ($n = 8$). Five female swimmers had Ei:BMR <1.35. We excluded three of them from study; however, the other two swimmers presented high skinfold sum and they were kept in the analysis (possibly they were trying to lose weight). Therefore, the final results included 16 swimmers, 11 men and 5 women. Anthropometric, dietetic, and training swimmerś characteristics are presented in Table 2. Exercise energy expenditure accounted

Table 2 General and dietetic swimmers' characteristics

Characteristics	Male ($n = 11$)	Female ($n = 5$)
Age (year)	20.5 ± 2.8	19.8 ± 2.5
Height (cm)	180.0 ± 5.0	170.0 ± 2.0
Body mass (kg)	74.8 ± 6.2	64.8 ± 5.8
Sum of skinfolds[a] (mm)	39.4 ± 13.8	67.7 ± 19.8
Training experience (year)	11.0 ± 4.0	11.2 ± 3.3
Daily training volume[b] (min)	285.0 ± 6.0	283.0 ± 6.0
Total energy expenditure (kcal/day)	2908.4 ± 145.8	2359.9 ± 138.0
Total energy intake—TEI (kcal/day)	3227.5 ± 694.2	2202.8 ± 501.3
Carbohydrate (g/day)	401.5 ± 98.1	297.5 ± 109.0
Carbohydrate (g/kg/day)	5.4 ± 1.3	4.7 ± 2.0
Protein (g/day)	163.5 ± 40.3	97.5 ± 24.6
Protein (g/kg/day)	2.2 ± 0.4	1.5 ± 0.5
Fat (g/day)	107.7 ± 31.9	69.2 ± 7.2
Fat (g/kg/day)	1.4 ± 0.4	1.1 ± 0.1
Fat (% TEI)	28.5 ± 6.5	29.2 ± 5.4

Daily training volume was the average duration of training in a regular week of general preparation (includes swimming, dry-land aerobic conditioning, and resistance training)

Values are mean ± SD

[a] Triceps, subscapular, abdominal, and iliac crest for both sexes, adding thigh for female

[b] Daily training volume

for 32 and 34% of total energy expenditure for male and female swimmers, respectively.

Adequacy of daily energy and macronutrient intake

Two men (18.2%) and four women (80.0%) presented energy balance/adequacy lower than 95% of total energy expenditure, ranging deficit was −13.8 to −20.3% in female and −13.0 to −20.5% in male swimmers. Figure 1 shows macronutrient daily intake. Male and female swimmers were consuming into the ranges recommended by Burke et al. [5], which suggest lowest ranges of carbohydrate consumption. However, one female swimmer was consuming according to greatest ranges proposed by Stellingwerff et al. [4]. Mean carbohydrate intake were 5.4, $s = 1.3$ g/kg for men and 4.7, $s = 2.0$ g/kg for women. Two women did not reach the minimum recommended protein intake (1.5 g/kg), and other two women exceed the upper limit (1.7 g/kg), although the mean protein intake (1.5, $s = 0.5$ g/kg) was not significantly different compared with the lower ($p = 0.86$; $d = 0$) or upper limit ($p = 0.50$; $d = 0.40$) of the reference range. On the other hand, 100% of men had a mean protein intake (2.2, $s = 0.4$ g/kg) significantly higher ($p = 0.001$; $d = 1.25$) than the upper limit (1.7 g/kg) of the reference range. Regarding fat intake, all female swimmers failed to reach the minimum recommended value of 1.5 g/kg (mean intake 1.1, $s = 0.1$ g/kg; $p = 0.001$; $d = 4.00$). Among men, six (54.5%) did not reach the minimum recommended fat intake, although mean intake (1.4, $s = 0.4$ g/kg) was not statistically different ($p = 0.63$; $d = 0.25$) from the minimum recommended levels.

Adequacy of macronutrients before, during, and after exercise

Macronutrient intake from foods and supplements by meal and training session is shown in Table 3. Swimmers consumed on average three meals and three snacks daily, and carbohydrate supplements during pool training sessions, with or without the addition of small amounts of protein (BCAA, beta alanine, and/or glutamine). In the mornings, 80% ($n = 4$) of women and 100% ($n = 11$) of men had a snack between in-water and dry-land trainings. Assessment of macronutrient and energy intake adequacy was performed in relation to exercise requirements, rather than resting conditions, since there was no rest period between in-water and dry land sessions.

Discussion

The present study assessed the adequacy of daily energy and macronutrient intake of competitive swimmers in relation to training sessions during the general preparatory phase of the training program. The main results showed deficient energy intake in most of female swimmers, as well as inadequacy of carbohydrate intake before both training sessions and after afternoon training for men and women. Most protein intake was concentrated in two meals (lunch and dinner), being inadequate in the post-afternoon training period.

Adequacy of daily energy and macronutrient intake

The energy deficit in this general preparation phase of training may be related to a desire to lose weight, especially among some female swimmers with greater body fat; it also may be related to the difficulty in following a diet plan while managing a routine of high training load and job/study activities—we identified the consumption of unhealthy snacks and skipping of meals. Therefore, our findings further support that swimmers undertaking a high training load should be educated and aware of the necessity of frequent eating and continuous use of nutrient supplements [1], possibly, if swimmers had a better nutrition knowledge, results relative to food intake could lead to better physical fitness results [22].

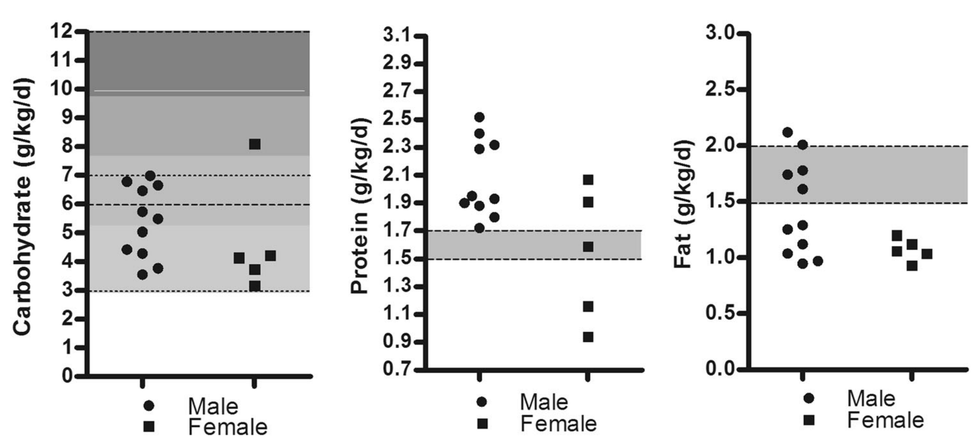

Fig. 1 Daily carbohydrate (cho), protein (ptn), and fat intake. Each figure shows individual's ingestion represented by the points in the graphic. Recommended ranges are shown in *dotted* or *dashed horizontal lines* according to the following authors, respectively 3–7 g/kg/day of carbohydrate (Burke et al. [5]), 6–12 g/kg/day of carbohydrate, 1.5–1.7 g/kg/day of protein, and 1.5–2 g/kg/day of fat [4]

Table 3 Prevalence of consumption, macronutrient intake distribution throughout the day, and comparison with recommendations

Meal	*n* (%)	CHO (g/kg)	CHO (g/h)[a]	PTN (g/kg)	FAT (g/kg)	Meal timing	Athletes with adequate intake (%)[b]	*p* value CHO (lower–upper) [effect size]	*p* value PTN [effect size]
Female athlete ($n = 5$)									
BRK	5 (100)	0.9 ± 0.9		0.2 ± 0.1	0.1 ± 0.1	Before	20	0.83–***0.002*** [0.11–3.44]	
DPT	2 (40)	0.6 ± 0.2	17.4 ± 6.6	0	0	During	0	–	
APT	4 (80)	0.2 ± 0.2	20.1 ± 17.4	0.1 ± 0.2	0.02 ± 0.02	During	0	–	
ADLT	2 (40)	0.3 ± 0.3		0.02 ± 0.01	0.04 ± 0.02	After	0	–	
Lunch	5 (100)	1.0 ± 0.3		0.6 ± 0.1	0.3 ± 0.1	After	80	0.98–0.19 [0–0.67]	**0.005** [3.00]
Snack	5 (100)	0.7 ± 0.5		0.1 ± 0.1	0.08 ± 0.02	Before	20	0.022–***0.001*** [0.60–6.60]	
DPT	2 (40)	0.7 ± 0.4	20.9 ± 11.4	0	0	During	0	–	
APT	5 (100)	0.8 ± 0.1		0.2 ± 0.1	0.1 ± 0.05	After	0	***0.012–0.001*** [2.00–4.00]	***0.018*** [1.00]
Dinner	8 (100)	0.7 ± 0.4		0.4 ± 0.2	0.3 ± 0.2				
Snack	2 (25)	0.2 ± 0.02		0.04 ± 0.02	0.1 ± 0.1				
Male athlete ($n = 11$)									
BRK	11 (100)	0.9 ± 0.4		0.2 ± 0.1	0.2 ± 0.1	Before	18,2	0.22–***0.001*** [0.25–7.75]	
DPT	8 (72.73)	0.3 ± 0.2	12.7 ± 6.2	0.01	0	During	0	***0.001*** [2.79]	
APT	11 (100)	0.4 ± 0.2	47.7 ± 4.3	0.1 ± 0.1	0.04 ± 0.04	During	45,5	0.036 [4.12]	
ADLT	1 (9.1)	0.1		0.1	0.01	After	0	–	
Lunch	11 (100)	1.4 ± 0.6		0.9 ± 0.2	0.5 ± 0.1	After	72,7	0.082–0.41 [0.67–0.33]	**0.001** [3.00]
Snack	11 (100)	0.6 ± 0.2		0.1 ± 0.1	0.1 ± 0.1	Before	0	***0.001–0.001*** [2.00–17.00]	
DPT	7 (63.64)	0.4 ± 0.2	16.6 ± 8.7	0.01	0	During	18,2	***0.001*** [1,54]	
APT	11 (100)	0.6 ± 0.2		0.2 ± 0.2	0.1 ± 0.1	After	0	***0.001–0.001*** [2.00–3.00]	0.224 [0.50]
Dinner	11 (100)	1.3 ± 0.4		0.6 ± 0.3	0.5 ± 0.2				
Snack	5 (45.5)	0.2 ± 0.2		0.2 ± 0.2	0.04 ± 0.04				

CHO carbohydrate; *PTN* protein; *BRK* breakfast; *DPT* during pool training; *APT* immediately after pool training; *ADLT* immediately after dry-land training

Breakfast about 1 h before morning training and lunch 45 min after dry-land training

Text in bold italics indicates where macronutrient intake is significantly ($p < 0.05$) less than and text in bold indicates where intake is significantly ($p < 0.05$) greater than lower end or upper end of recommendation. Recommendation: before 1–4 g/kg of carbohydrate; during 30 g/h of carbohydrate; after 1–1.2 g/kg of carbohydrate and 0.3 g/kg of protein [3, 5, 9]

[a] Carbohydrate from food and/or supplementation intake during training sessions per hour

[b] Athletes whose met or exceeded recommended amounts of CHO and PTN

Sports nutrition experts recommend that the reduction in energy intake for athletes who need to lose fat mass should not be higher than 500 kcal/day due to the energy requirements for exercise [6]. Most of our female swimmers had a deficit in energy intake below 500 kcal/day, which would be acceptable for losing weight. This result is in agreement with that found by Sato et al. [23] who reported an adequate energy intake in Japanese swimmers, evaluated in similar training phase. On the other hand, male swimmers had an adequate energy intake, in this way, our findings distinguish from the previous studies on high-performance athletes of different sports [24], including swimmers [25–27]. However, it is important to emphasize that general training phase demands low intensities of exercise, which helped the adequacy of caloric intake.

Results interpretation depends on cut-off recommendations. According to Stellingwerff et al. [4], daily carbohydrate intake was inadequate to the most of swimmers. Burke et al. [5] propose less carbohydrate to low-intensity or skill-based activities, so all the assessed swimmers reach recommendations values; but if we analyze data according to moderate exercise program recommendation, only seven swimmers would be adequate. Carbohydrate needs depend on daily exercise and on physiological gains expected with training, and needs to be adjusted each week and according to training phase. This approach was not found by Kabasakalis et al. [28], when top-level swimmers did not adjust their consumption along training phases. A normal carbohydrate intake among swimmers has also been reported by Sato et al. [23], but the deficient intake of this macronutrient has been evidenced in the literature [27, 29, 30]. It is important to point out that these studies did not show information about training phase, and uses different carbohydrate cutoffs (7–10 g/kg, >6 g/kg or 55–65% of TEI, respectively). A carbohydrate deficiency affects muscle glycogen resynthesis, decreasing its availability for training sessions. In athletes that have two or more training sessions per day, this condition may increase the risk of overtraining [31].

The intake of protein exceeded 2 g/kg/day in men, higher than recommended levels, which is in agreement with the previous findings [27–29]. It is worth mentioning, however, that an intake exceeding recommendations is not associated with increased protein synthesis [32]. Protein intake in women was within normal range, similar to the previous studies [23, 27, 33].

While some studies have assessed and reported fat intake in absolute values, others have expressed it in percentage of total energy intake, making comparison, and interpretation difficult. According to Thomas et al. [8], some nutrients should be expressed in gram per kg of body mass to allow analysis related to body size. In our study, fat intake related to the body weight was lower than recommended levels among the women. A deficient fat intake may affect the absorption of liposoluble vitamins, synthesis of hormones, and cell membrane composition, and be associated with low intake of essential fatty acids [34]. However, if we considered analyzing fat intake in percentage of TEI, the swimmers had adequate intake according to the most recent position stand [8], and main values were similar to Sato et al. [23], that also reported results from basal training phase. On the other hand, Farajian et al. [27] and Kabasakalis et al. [28] have reported a high fat intake (%TEI) in swimmers.

Adequacy of macronutrients before, during, and after exercise

Carbohydrate intake in the pre-exercise period may enhance performance by increasing energy availability for exercise [35]. In our study, both male and female swimmers had adequate carbohydrate intake (1 g/kg) before morning training, but not before the afternoon training in the case for men. However, it is under research that carbohydrate restriction in specific training sessions, aiming to lowering glycogen stores, would enhance physiological adaptation to exercise [2, 5, 36, 37]. Thus, an individualized assessment of the athletes' food intake and their training programs are required to achieve the goals without affecting their performance or health.

The intake of carbohydrates during exercise is closely related to benefits including sustaining of rhythm, greater time spent at high intensities, maintenance of skills, and concentration. This carbohydrate availability is important for sufficient supply of exogenous glucose and energy for exercise, to avoid hypoglycemia and its effects on the central nervous system, including glycogen depletion and fatigue [5, 6, 38]. This is particularly important for athletes whose training plans include more than one training sessions per day, as occurs with our study group, who would benefit from an adequate intake of carbohydrates during the afternoon training. Jeukendrup [9] suggested that carbohydrate requirements during exercise depend on its intensity, i.e., in lower intensity exercise, the intake should be adjusted downwards. In this regard, since our swimmers were following a high volume, but low-intensity training program, their requirements may have been lower than recommendations.

As with most of the athletes who had training sessions scheduled in two shifts, our swimmers had an approximately 5-h recovery period between morning and afternoon sessions. Therefore, attention should be given to the early restoration phase, by providing a carbohydrate and protein combination for body recovery, good performance in the next training session, and adaptation to the training program [3].

In our study, the majority of the swimmers eat lunch (~0.3 g/kg of protein) as their post-morning training meal approximately 40 min after the exercise. This practice cannot be considered as inadequate, since it is normally expected to have a relatively higher load of protein at lunch. In addition, dividing the amount of daily protein intake into 20 g doses (0.3 g of protein/kg for a 70 kg athlete) throughout the day, including one post-training meal, is more effective than consuming higher amounts of protein in one single meal to produce a positive response to exercise and increase of muscle mass [8, 39]. After the afternoon training, the swimmers have a longer recovery period (>12 h) until the next training session, which increases the options to consume the carbohydrates in different amounts and timing along the day, as long as the recommended daily intake of the nutrient is achieved [3, 5]. Nevertheless, the recommendation to consume protein right after the exercise bout was not achieved by the swimmers regarding the afternoon training session.

The current study identified important eating patterns of competitive swimmers; however, two main limitations should be noted: (1) total energy expenditure was obtained by predictive equation, which is not accurate. Indirect calorimetry for BMR and pedometer or accelerometry to identify PAL would be more reliable; (2) anthropometry data have included few skinfolds, which hinders the better interpretation of whole body subcutaneous fat distribution.

Conclusion

This study provides information about high-level swimmer's daily macronutrients intake and their distribution over the day. Results suggest that 9 out of 11 male swimmers adjusted their food intake to daily energy requirements, despite an excessive intake of protein. However, four out of five female swimmers failed on adjusting their daily energy intake and all of them failed on adjusting their fat intake. In relation to the meals near exercise bouts, most of swimmers showed an inadequacy, especially in the second training session. Since energy availability and muscle repair/adaptation lead to better training responses, this study calls attention to the importance of a nutritional follow-up of swimmers, for the adjustment of food intake to nutritional needs, especially meals before and after exercise sessions. Future studies to assess dietary intake versus nutritional recommendations in different phases of training would be helpful to understand long-term eating habits and its consequences to the health and performance of swimmers.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments.

Financial support The authors declare that they have no financial support.

Informed consent Informed consent was obtained from all individual participants included in the study.

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