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Comparison of Nutrient Intake between Japanese Female Elite and Collegiate Karate Players

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Abstract

Most published data on the physical and physiological profiles of karate athletes is based on studies of male athletes and data on female athletes is rare. The purposes of this study were: 1) to collect baseline data on nutrient intake in order to advise athletes regarding nutrition practices that may enhance performance, and 2) to compare nutrient intake of elite and collegiate karate athletes. Thirty-five female black belt karate athletes volunteered to participate in this study. They were divided into 2 groups: 20 athletes who were members of the national team (elite athletes) and 15 collegiate karate athletes (collegiate athletes). The elite athletes showed significantly higher mean lean body mass and significantly lower body fat and fat mass than the collegiate athletes. The elite athletes showed significantly higher energy intake and more nutrient intakes than the collegiate athletes. There were no significant differences in diet compositions between the elite and collegiate athletes. The elite athletes showed all micronutrient intakes were above 100% of the Estimated Average Requirement (EAR) or Adequate Intake (AIs), whereas the collegiate athletes showed micronutrient intakes below 100% of the EAR or AIs for potassium, calcium, magnesium, phosphorus, iron, vitamins A and C. Thus, we advised collegiate athletes to consume adequate amounts of carbohydrates and protein. To attain these goals, it is desirable to increase the amount of meals by increasing the intake levels of grains, vegetables, fruit, milk and dairy products, lean meat and fish.

Key words

Dietary assessment; Body composition; Karate; Female

Introduction

Karate is one of the most popular martial arts practiced both in and outside of Japan and will make its first appearance as an Olympic sport at the 2020 Summer Games in Tokyo, Japan [1]. Traditional karate training consists of practice in basic techniques, kata, and sparring. Basic techniques such as punching, kicking, blocking, and striking are practiced either in a stationary position or with body movement in various formal stances. Kata are set forms in a pre-established sequence of defensive and offensive techniques and movements. Sparring is the execution of defensive and offensive techniques while freely moving against an opponent. In addition to traditional karate training, many competitive practitioners cross-train using strenuous running and weight training programs to increase endurance, muscle development, and power.

The American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine (ADA, DC, and ACSM) [2] state that athletic performance and recovery from exercise are enhanced by optimal nutrition. The living environment of collegiate karate athletes (collegiate athletes) may be different compared to karate athletes in the national team (elite athletes). Factors such as the class and training schedules, whether they are living in a dormitory, have facilities for food preparation, and access to grocery stores influence when athletes are able to eat, as well as the type and quantity of food consumed [3]. Although the nutrient intakes of elite [4] and collegiate athletes [5,6] have been reported, these studies could not be compared directly because dietary information was collected using different methods; 1 study [4] used a Food Frequency Questionnaire (FFQ), while the other 2 studies [5,6] used a 3-weekday diet record.

Most published data on the physical and physiological profiles of karate athletes is based on studies of male athletes [7] and data on female athletes is rare. The purposes of this study were: 1) to collect baseline data on nutrient intake in order to advise athletes regarding nutrition practices that may enhance performance, and 2) to compare nutrient intake between elite and collegiate female karate athletes.

Material and Methods

The study protocol received approval from the Ethics Committee of the University. Informed consent was obtained from each subject.

Subjects

Thirty-five female black belt karate athletes volunteered to participate in this study. They were divided into 2 groups: 20 elite athletes and 15 collegiate athletes. The athletes competed in sparring or kata competitions from April to December. Regional tournaments are held from April to July, and national, international, and/or world tournaments are held from September to December. The elite athletes participated in a 3-day training camp once a month from May to August, so all anthropometric measurements and dietary information were obtained at the site of the training camp, which was considered representative of physiologic status during training for the next competition. The collegiate athletes were recruited from one university. Practice was usually for at least 90 min, 3 days per week, (Tuesday and Thursday evenings and Saturday morning), and the athletes were national level collegiate competitors in Japan.

Measurements and dietary information

Weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively. The Body Mass Index (BMI) was calculated as weight/height^2 (kg/m^2). Biceps brachii, triceps brachii, subscapular, and suprailiac skinfold thickness were measured with Harpenden calipers on the right side of the body, with the subject in a standing position. The mean of 3 consecutive measurements was used to calculate the body density [8], percent body fat (%Fat), and Lean Body Mass (LBM) [9].

All subjects were interviewed by experienced dietitians using the FFQ, which is based on 29 food groups and 10 types of cooking,

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to estimate the energy and nutrient intakes of each subject over the previous 1 to 2 months [10]. The FFQ was validated by a comparison with weighed dietary records for 7 continuous days [11]. From the FFQ, the mean daily intake of total energy and nutrients was calculated according to the Japanese Foodstuff Composition Tables [12]. Each athlete was also questioned as to whether or not they were using a nutrient supplement or on a diet. The Estimated Energy Requirement (EER) for athletes was calculated according to the following formula [13]: 28.5 (kcal/LBM (kg) × PAL, where PAL is the physical activity level. The macro- and micronutrient intakes were compared using the Dietary Reference Intakes (DRIs) in Japan [14]. However, because the DRIs for Japanese were prepared for healthy individuals, the joint position stand of ADA, DC, and ACSM [2] was also used to evaluate macronutrient intakes. Micronutrient intakes less than the Estimated Average Requirement (EAR) or Adequate Intake (AI) were classified as inadequate [3].

Statistical analysis

SPSS statistical software 22.0J (Chicago, IL) was used to analyze the data. Descriptive statistics included means and SD. Because sample size in each group was small, non-parametric statistics were used. The mean differences between the elite and collegiate athletes were analyzed by non-paired Mann-Whitney U test. A two-sided $p<0.05$ was considered statistically significant.

Results

Eight of the 20 elite athletes and 9 of the 15 collegiate athletes were on a diet. Most athletes practiced a healthy diet such as eating more salad, avoiding overeating, eating fewer sweet snacks and less fat, and eating less, but well balanced food. One elite player and 1 collegiate player, however, answered to eating less protein and/or carbohydrates. No athletes took supplements. In each group, when the athletes on a diet were compared to the athletes not on a diet, the mean physical characteristics and nutrient intakes were very similar; e.g. energy intakes for elite athletes were 2592 ± 621 kcal *vs.* 2629 ± 635 kcal, respectively and for collegiate athletes were 1464 ± 350 kcal *vs.* 1430 ± 398 kcal, respectively (data not shown in tables). Thus, in the following tables, we only show the added mean values in each group and compare the mean values of elite and collegiate athletes.

The characteristics of the subjects are shown in Table 1. The elite athletes showed significantly higher mean karate experience, age, and LBM and significantly lower %Fat and fat mass than the collegiate athletes. There were no significant differences in body height, weight, and BMI (Table 1).

The energy and nutrient intakes and diet compositions (percentage of energy from carbohydrate, fat, and protein) of the subjects are shown in Table 2. The elite athletes showed significantly higher energy intake and higher intake of other nutrients than collegiate athletes. There were no significant differences in diet compositions between elite and collegiate athletes.

The micronutrient intakes expressed as percentages of the Japanese EAR or AIs are shown in Table 3. The micronutrient intakes of the elite athletes were all above 100% of the EAR or AIs, whereas the collegiate athletes showed micronutrient intakes below 100% of the EAR or AIs for potassium, calcium, magnesium, phosphorus, iron, vitamins A and C (Table 2).

Foodstuff intake is shown in Table 4. The elite athletes showed significantly higher mean intakes of green vegetables, other vegetables, soybeans and soybean products, meat, eggs, milk and dairy products, fruits, beverages, and fats and oils than the collegiate athletes.

Table 1: Characteristics of the subjects.

	Elite group (n=20)	University group (n=15)	
karate experience (years)	15.3 ± 2.7	12.3 ± 2.9	*
Age (years)	21.8 ± 2.7	19.5 ± 1.1	*
Height (cm)	159.4 ± 6.0	157.8 ± 5.5	
Weight (kg)	57.5 ± 6.8	55.5 ± 6.2	
BMI (kg/m²)	22.6 ± 1.6	22.2 ± 1.8	
Fat (%)	20.8 ± 2.8	26.6 ± 3.4	*
Fat Mass (kg)	12.0 ± 2.5	14.9 ± 3.1	*
LBM (kg)	45.5 ± 5.2	40.6 ± 3.8	*

Values are the mean ± SD.

*p<0.05

Abbreviations=BMI: Body Mass Index; %Fat: Percent Body Fat; LBM: Lean Body Mass

Table 2: Nutrient intake of the subjects.

	Elite group (n=20)	University group (n=15)	
Energy (kcal)	2614 ± 613	1450 ± 356	*
(kcal/kg)	45.7 ± 10.5	26.7 ± 8.7	*
(mj)	10.94 ± 2.57	6.07 ± 1.49	*
(mj/kg)	0.19 ± 0.04	0.11 ± 0.04	*
Protein (g)	90.7 ± 22.3	50.4 ± 14.8	*
(g/kg)	1.6 ± 0.4	0.9 ± 0.3	*
(%E)	14.0 ± 2.4	13.8 ± 2.0	
Fat(g)	89.9 ± 21.9	46.1 ± 16.2	*
(g/kg)	1.6 ± 0.4	0.9 ± 0.4	*
(%E)	31.7 ± 7.8	28.2 ± 4.7	
Carbohydrate (g)	349.5 ± 114.8	201.2 ± 44.7	*
(g/kg)	6.1 ± 2.0	3.7 ± 1.0	*
(%E)	54.3 ± 9.7	57.9 ± 5.4	
Potassium (mg)	3125 ± 776	1494 ± 377	*
Calcium (mg)	902 ± 329	398 ± 127	*
Magnesium (mg)	343 ± 103	157 ± 39	*
Phosphorus (mg)	1415 ± 363	733 ± 201	*
Iron (mg)	10.6 ± 3.5	5.1 ± 1.2	*
V.A (μgRE)	705 ± 202	345 ± 100	*
$V.B_1$(mg/1000kcal)	0.50 ± 0.11	0.51 ± 0.13	
$V.B_2$ (mg/1000kcal)	0.60 ± 0.10	0.60 ± 0.19	
V.C (mg)	130 ± 52	50 ± 21	*
Dietary Fiber (g)	16.9 ± 5.2	7.7 ± 2.1	*
Salt (g)	9.6 ± 2.9	5.2 ± 1.8	*

Values are the mean ± SD.

*p<0.05, Abrribiations=V: Vitamin; %E: percentage of energy

Discussion

Anthropometric data

Although there were no significant differences in the mean body height, weight, and BMI between elite and collegiate athletes, the elite athletes showed significantly higher mean LBM (45.5 ± 5.2 *vs.* 40.6 ± 3.8 kg, respectively) and significantly lower %Fat (20.8 ± 2.8 *vs.* 26.6 ± 3.4%, respectively) and fat mass (12.0 ± 2.5 *vs.* 14.9 ± 3.1 kg, respectively) than the collegiate athletes. The mean %Fat of the elite athletes was also lower than the values reported for Japanese female highly competitive (24.1 ± 5.5%) [5], and competitive collegiate karate

Table 3: Nutrient intakes expressed as a percentage of the Estimated Average Required（EAR）and Adequate Intake (AI).

		Elite group (n=20)	University group (n=15)
Potassium (mg)	AI 2600	120.2 ± 29.8	57.5 ± 14.5
Calcium (mg)	EAR 550	164.0 ± 59.8	72.4 ± 23.0
Magnesium (mg)	EAR 230	149.0 ± 44.8	68.4 ± 17.0
Phosphorus (mg)	AI 800	176.9 ± 45.4	91.6 ± 25.1
Iron (mg)	EAR 8.5	124.1 ± 40.7	59.9 ± 13.7
V.A (μgRE)	EAR 450	156.7 ± 44.8	76.8 ± 22.3
$V.B_1$ (mg/1000 kcal)	EAR 0.45	110.9 ± 25.5	112.5 ± 29.4
$V.B_2$ (mg/1000 kcal)	EAR 0.50	120.6 ± 20.3	119.4 ± 37.7
V.C (mg)	EAR 85	153.3 ± 60.8	59.3 ± 24.3
Values are the mean ± SD.			

Table 4: Foodstuff intake of subjects (g).

	Elite group (n=20)	University goup (n=15)	
Cereals	492.1 ± 217.2	367.3 ± 106.5	
Green vegetables	87.5 ± 45.3	40.6 ± 24.8	*
Other vegetables	163.0 ± 92.8	89.2 ± 68.0	*
Soybeans & Soybean products	148.3 ± 157.2	39.5 ± 28.7	*
Fish (Raw & Processed)	44.6 ± 31.8	34.3 ± 32.9	
Meat (Raw & Processed)	119.4 ± 53.8	77.0 ± 42.1	*
Eggs	46.6 ± 26.4	31.9 ± 15.9	*
Milk & Daily products	238.8 ± 123.5	121.6 ± 77.2	*
Fruits & Fruit juices	182.2 ± 141.7	40.0 ± 33.3	*
Sugars & Confectionaries	100.4 ± 88.2	46.6 ± 28.1	
Beverages	217.2 ± 231.9	48.4 ± 58.1	*
Fats & Oils	16.8 ± 8.8	7.6 ± 4.3	*
Values are the mean ± SD.			
*p<0.05			

athletes (23.9 ± 4.1%) [15], but was higher than the value reported for Botswanan female national karate athletes (18.6 ± 3.2%) [16].

Nutrient intake

The ADA, DC, and ACSM [2] state that low energy intake can result in loss of muscle mass, menstrual dysfunction, an increased risk of fatigue, injury, and illness as well as a prolonged recovery process. The mean energy intake for the elite athletes (2614 ± 613 kcal) was not different from the EER for female athletes (2525 ± 229 kcal), whereas the energy intake for the collegiate athletes was approximately 800 kcal below the EER (2261 ± 199 kcal) [13]. The low energy intake in the collegiate athletes may be a result of under-reporting, which is a recurrent problem in determining nutrient intake. The doubly labeled water technique is the gold standard for measuring energy expenditure by which energy intake data are evaluated. According to a review article by Livingstone and Black [17], in using the doubly labeled water technique, the majority of self-reported dietary intakes are biased towards underestimation of energy intake. The mean magnitude of the underestimation was 20%. In the present study, even if the mean energy intake for collegiate athletes was increased by 20%, the value would still be approximately 500 kcal lower than the EER.

It is stated that carbohydrate recommendations for athletes range from 6 to 10 $g\bullet kg^{-1}\bullet bw^{-1}$ to maintain blood glucose levels during exercise and to replace muscle glycogen [2]. According to these standards, the mean carbohydrate intake of the elite athletes was marginal (6.1 ± 2.0 $g\bullet kg^{-1}\bullet bw^{-1}$) and that of the collegiate athletes was low (3.7 ± 1.0 $g\bullet kg^{-1}\bullet bw^{-1}$). Many studies reported that athletes from various sports may not consume enough carbohydrates to meet current performance recommendations [18-21].

The recommended intake of protein for endurance and strength-trained athletes ranges from 1.2 to 1.7 $g\bullet kg^{-1}\bullet bw^{-1}$ [2]. Tarnopolsky et al. [22], using the leucine kinetic and nitrogen balance methods, investigated the dietary protein requirements of strength athletes compared with sedentary subjects. They reported that the protein intake for zero nitrogen balance in sedentary subjects was 0.69 g/kg body weight per day and for strength athletes was 1.41 g/kg body weight per day; with a safety margin of ± 1 SD, the suggested recommended intakes were 0.89 and 1.76 $g\bullet kg^{-1}\bullet bw^{-1}$ per day, respectively. Because many competitive karate athletes follow a strenuous weight-training program to increase muscle development and power, and sparring athletes spar quite often, which may cause muscular damage [6], highly competitive karate athletes may need 1.4 to 1.7 g/kg body weight per day of protein intake. From this assumption, the mean protein intake of the elite athletes was within the range (1.6 $g\bullet kg^{-1}\bullet bw^{-1}$), but was below it in the collegiate athletes (0.9 $g\bullet kg^{-1}\bullet bw^{-1}$).

It is stated that fat intake should range from 20% to 35% of total energy intake (%E) [2]. The mean fat intakes of %E for the elite and collegiate athletes (31.7 ± 7.8% and 28.2 ± 4.7%, respectively) were within the recommended range and were similar to the fat intakes reported in previous studies using highly competitive Japanese female elite [4] and collegiate karate athletes [5]. Similar results were reported in female athletes participating in various sports at a National Collegiate Athletic Association in the US [3,23]. On the other hand, a higher intake of fat was reported in elite female athletes (volleyball, middle distance running, ballet dancing, and swimming) in Greece [24], with mean fat intakes of %E 39.6%. Similar results were reported in female elite flat-water paddlers [25].

Regarding the micronutrient intakes, they were all above 100% of EAIs or AIs for the elite athletes, whereas the collegiate athletes were less than 100% for potassium, calcium, magnesium, phosphorus, iron, vitamins A and C. To increase mineral and vitamin intakes, the Ministry of Health, Labour, and Welfare in Japan [14] recommends the daily consumption of 200 g of milk and dairy products, 120 g of green vegetables and 230 g of other vegetables. The mean intakes of milk and dairy products in elite athletes were higher, while those in collegiate athletes were lower, than the recommendation. Although mean intakes of green vegetables and other vegetables in the elite athletes were significantly higher than collegiate athletes, mean intakes in both groups were lower than the recommendations.

Feedback

The results of the present study indicate that the elite athletes in general showed adequate energy and nutrient intakes, whereas the collegiate athletes showed inadequate energy, macro- and micro-nutrient intakes in terms of EER, current recommendations for carbohydrates and protein, EAIs or AIs for micronutrient intake. Thus, we advised the collegiate athletes to consume adequate energy for the heavy demands of training and competition, and to consume adequate protein to increase muscle development and power and to repair muscular damage. Although approximately half of the athletes in the present study were on a diet, most athletes practiced a healthy diet. However, 1 elite player and 1 collegiate player answered to eating less protein and/or carbohydrates. Thus, we emphasized the importance of consuming an adequate amount of carbohydrates and protein for the reasons mentioned above. To attain these goals, it is

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desirable to increase the amount of meals by increasing the intake levels of grains, vegetables, fruit, milk and dairy products, lean meat and fish.

One limitation of our study needs to be mentioned. Because the FFQ was developed to determine the most common food items for the population as a whole, its applicability for assessing the nutrient intakes of people whose eating patterns deviate considerably from those of the mainstream is limited. It is reported that the FFQ may overestimate at low energy intakes and underestimate at high energy intakes [26]. It is also reported that a 7-day dietary record increases the reliability of collected data [26]. However, the members of the national team were selected from many regions in Japan, so it is very difficult to instruct them in the procedure involved in accurately recording dietary intake. In the present study, FFQ was chosen because it is much less burdensome than the 7-day dietary record. Even with this limitation taken into consideration, it seemed worthwhile to collect dietary assessments of these athletes because the subjects in the present study were highly competitive in world and international competition, and the trends in Japanese highly competitive karate athletes' dietary habits, which differ considerably from Western countries, could be shared with others interested in sports nutrition in the region.

In summary, the elite athletes showed significantly higher mean LBM and significantly lower %Fat and fat mass than the collegiate athletes. The elite athletes showed significantly higher energy intake and intake of other nutrients than the collegiate athletes. The elite athletes in general showed adequate energy and nutrient intake, whereas the collegiate athletes showed inadequate energy, macro- and micronutrient intake. Thus, we advised the collegiate athletes to consume an adequate amount of carbohydrates and protein. To attain these goals, it is desirable to increase the amount of meals by increasing the intake levels of grain, vegetables, fruit, milk and dairy products, lean meat and fish.

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References

1. Kurihara S (2017) Karate will make its first appearance at the Tokyo Olympic. Research J Karatedo 18: 1 (in Japanese).
2. Rodriguez NR, DiMarco NM, Langley S (2009) Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. J Am Diet Assoc 109: 509-527.
3. Hinton PS, Sanford TC, Davidson MM, Yakushko OF, Beck NC (2004) Nutrient intakes and dietary behaviors of male and female collegiate athletes. Int J Sport Nutr Exerc Metab 14: 389-405.
4. Miyahara K, Iide K, Yoshimura Y, Tai K, Miyamoto N, et al. (2013) Nutrient intake and blood iron status of elite Japanese karate practitioners. Gazz Med Ital-Arch Sci Med 172: 471-478.
5. Teshima K, Imamura H, Yoshimura Y, Nishimura S, Miyamoto N, et al. (2002) Nutrient intake of highly competitive male and female collegiate karate players. J Physiol Anthropol 21: 205-211.
6. Imamura H, Yoshimura Y, Tanaka A, Uchida K, Komatsu Y, et al. (1997) Nutrient intakes and serum enzyme activities in collegiate karate players. J Exerc Sports Physiol 4: 1-8
7. Chaabène H, Hachana Y, Franchini E, Mkaouer B, Chamari K (2012) Physical and physiological profile of elite karate athletes. Sports Med 42: 829-843.
8. Durnin JV, Rahaman MM (1967) The assessment of the amount of fat in the human body from measurements of skinfold thickness. Br J Nutr 21: 681-689.
9. Siri WE (1956) In: Sawrence JH, Tobias CA, eds, Advances in biological and medical physics. Academic Press, London and New York, 239-280.
10. Yoshimura Y, Takahashi K (2001) Excel Eiyo-kun (nutrition) Food Frequency Questionnaire Based on Food Groups FFQg (computer manual and software). Tokyo: Kenpakusya (in Japanese).
11. Takahashi K, Yoshimura Y, Kaimoto T, Kunii D, Komatsu T, et al. (2001) Validation of a food frequency questionnaire based on food groups for estimating individual nutrient intake. Jpn J Nutr 59: 221-32.
12. The Resources Council of the Science and Technology Agency (ed.) (2015) The 7th Revised Edition of Tables of Japanese Foodstuff Composition. Tokyo: Ishiyaku Press.
13. Koshimizu T, Yanagisawa K, Higuchi M (2005) Estimated energy requirement for athletes. J Training Sci Exerc Sport 17: 245-250.
14. Ministry of Health, Labour, and Welfare, Japan (2014) Dietary Reference Intakes for Japanese, 2015. Tokyo: Daiichishuppan.
15. Imamura H, Yamauchi Y, Hori H, Nishimura C, Sakamoto K (2002) Maximal oxygen uptake and body composition of female competitive karate practitioners. Res J Karatedo 7: 1-5.
16. Amusa LO, Onyewadume IU (2001) Anthropometry, body composition and somatotypes of Botswana national karate players: a descriptive study. Acta Kines Univ Tart 6: 7-14.
17. Livingstone MB, Black AE (2003) Markers of the validity of reported energy intake. J Nutr 133: 895-920.
18. Burkhart SJ, Pelly FE (2016) Dietary Intake of Athletes Seeking Nutrition Advice at a Major International Competition. Nutrients 8: 638
19. García-Rovés PM, García-Zapico P, Patterson AM, Iglesias-Gutiérrez E (2014) Nutrient intake and food habits of soccer players: analyzing the correlates of eating practice. Nutrients 6: 2697-2717.
20. García-Rovés PM, Terrados N, Fernández S, Patterson AM (2000) Comparison of dietary intake and eating behavior of professional road cyclists during training and competition. Int J Sport Nutr Exerc Metab 10: 82-98.
21. Lun V, Erdman KA, Reimer RA (2009) Evaluation of nutritional intake in Canadian high-performance athletes. Clin J Sport Med 19: 405-411.
22. Tarnopolsky MA, Atkinson SA, MacDougall JD, Chesley A, Phillips S, et al. (1992) Evaluation of protein requirements for trained strength athletes. J Appl Physiol 73: 1986-1995.
23. Clark M, Reed DB, Crouse SF, Armstrong RB (2003) Pre- and post-season dietary intake, body composition, and performance indices of NCAA Division I female soccer players. Int J Sport Nutr Exerc Metab 13: 303-319.
24. Hassapidou MN, Manstrantoni A (2001) Dietary intakes of elite female athletes in Greece. J Hum Nutr Diet 14: 391-396.
25. Garciá-Rovés PM, Fernández S, Rodríguez M, Pérez-Landaluce J, Patterson AM (2000) Eating pattern and nutritional status of international elite flatwater paddlers. Int J Sport Nutr Exerc Metab 10: 182-198.
26. Magkos F, Yannakoulia M (2003) Methodology of dietary assessment in athletes: concepts and pitfalls. Curr Opin Clin Nutr Metab Care 6: 539-549.

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