Nutritional characterization of elite amputee soccer players*

Ainá Innocencio da Silva Gomes[1], Beatriz Gonçalves Ribeiro[2] and Eliane de Abreu Soares[3]

ABSTRACT

Although soccer is a popular sport in Brazil, the amputee soccer is not known by the public in general. This sport requires an increase on the metabolic demand and with the amputation of lower limbs, the energy cost of walking and running can increase dramatically. Thus, the nutritional aspect plays an important role in the athletic performance and quality of life of these athletes. The objective of the present study was to assess the nutritional status of four amputees soccer players aged between 21 and 33 years old, members of the Brazilian Amputee Soccer Team. Dietary intake was evaluated using the six-day food records for energy, macronutrients, fibers and micronutrients. The anthropometrical evaluation consisted of weight, height, skinfold and circumferences measurements, which allowed to assess the nutritional status. Biochemical analyses were: hemoglobin, hematocrit, ferritin and transferrin to verify the nutritional iron status; urea, albumin and creatinine to feature protein status and the total cholesterol and fractions and triglycerides to evaluate the lipids profile. The results showed that athletes presented high ranges for the energetic intake (2,179 to 4,294 kcal) and the macronutrients. The athletes showed lipid intake between 25 to 30% of daily energy intake, protein intake between 1.8 to 3.9 g/kg/day and a low percentage of carbohydrates (48 to 54% of daily energy intake) and a low ingestion of vitamin E. The biochemical analyses showed no iron anemia, with adequate protein reserves and lipids profile in normal ranges. In conclusion, the amputee soccer athletes need nutritional orientation to correct inadequate food habits, observed in pre-competition period, and to improve the athletic performance.

Key words: Soccer. Amputee. Nutritional assessment. Food intake. Anthropometry. Biochemical evaluation.

INTRODUCTION

Soccer in one of the world's most popular sportive modalities[1], especially in Brazil, the only country five times world champion and where the sport is very popular. Despite not much divulged by media and hence not much known by the public in general, the amputee soccer has been played since 1985 in several countries included the performance of international championships. In Brazil the sport modality emerged in 1989. Since then, the Brazilian amputee soccer participates in international championships, being ranked among the four best teams. In the 2001 World Championship, Brazil's team was three times world champion.

The lower limbs amputee presents higher energetic expenditure for walking and running and this expenditure increases in relation to the amputation level. Thus, the higher is the amputation, the more expensive for the organism the locomotion of this individual will be[2]. Along with the soccer competitive practice – that presents moderate-high intensity trainings – the amputee athlete's metabolic demand increases significantly. This demonstrates that if the athlete does not keep adequate nutrition both quantitatively and qualitatively, he may present decrease on the muscular mass, loss of bone density and increase on the risk of fatigue, lesions and infections what certainly would hinder not only his performance in the sport but also his quality of life[3].

Amputee individuals require specific anthropometrical evaluation. According to the new body distribution given by the absence of the member or part of it, the individual must avoid overweight, once the entire body weight will be supported by only one leg. This situation ends up by increasing the risk of developing bone problems. As soccer is itself a sportive modality that causes many bone injuries[4], the maintenance of the body weight and bone health should be carefully monitored.

Despite the wide knowledge about the importance of the nutrition for the improvement of the sportive performance, not many studies can be found in literature on the nutritional assessment of amputee soccer players. Therefore, the present study had as objective to assess the nutritional status of elite amputee soccer players in the 2002 World Championship pre competition period.

METHODOLOGY

Sample

The sample was composed of four three times world champion male athletes (two fullbacks and two center forwards) of the Brazilian Amputee Soccer Team with ages ranging from 21 to 33 years.

General procedure

The present work was approved by the Ethic Research Committee of the Clementino Fraga Filho University Hospital (Rio de Janeiro Federal University) under Nr. 143/02 and by the Scientific Investigation Commission (CIC) under Nr. 136/02. The athletes were informed of the procedures and objectives and signed a consent form agreeing in participating in this study. The athletes were allowed to quit the participation at any time, being excluded from the sample.

Dietary, anthropometrical and biochemical evaluations were performed in the Niterói Handicap Association Headquarters (ANDEF) in Niterói-RJ during concentration period, one week before the beginning of the World Amputee Soccer Championship, which took place in Moscow, Russia, in November 2002.

Characterization of athletes

The athletes filled the questionnaire that had as objective the attainment of information with regard to the type and duration of the lesion and the sportive training before and during the concentration period.

* Universidade Federal do Rio de Janeiro – Centro de Ciências da Saúde, Bloco J, 2º andar – Ilha do Fundão, Cidade Universitária – 21941-590 – Rio de Janeiro, RJ.

1. Nutritionist and M.S. in Human Nutrition – Rio de Janeiro Federal University Nutrition Institute.
2. Nutritionist and Ph.D. – Rio de Janeiro Federal University Nutrition Institute.
3. Nutritionist and Ph.D. – Rio de Janeiro Federal University and Rio de Janeiro State University Nutrition Institutes.

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Correspondence to: Ainá Innocencio da Silva Gomes, Rua Gomes Carneiro, 155/1.202 – Ipanema – 22071-110 – Rio de Janeiro, RJ, Brazil. E-mail: a_isgomes@hotmail.com

Anthropometrical evaluation

Height, body mass, four skinfolds (triceps, abdomen, thorax and thigh) and upper limbs and lower limb circumferences were assessed. The athletes dressed the minimum clothes as possible at the moment of the evaluation, wearing only training trunks. All measurements were performed only once during the concentration period and by a single trained appraiser.

For height, a portable stadiometer *Seca* 208 with accuracy of tenths centimeters (mm) was used. The stadiometer was fixed to the wall with no skirting board and the athlete remained in orthostatic position, inspiration apnea, barefoot and the ankle's posterior surface, pelvic waistline, scapular waistline and occipital region in touch with the wall to which the device was fixed. The head was positioned with the eyes' external angle parallel to the ground – Frankfurt Plane. This measure was performed in duplicate.

The body mass was obtained with the employment of a digital scale *Tanita Ultimate Scale Model* 2001TFW with maximum capacity of 150 kg and accuracy of 200 grams, with athlete barefoot and in orthostatic position. As the athletes did not present one of the lower limbs, it was necessary to correct the body mass of the individual for amputation, not considering the absence of the limb. The calculation of the corrected body mass was performed through formula described by Lee & Nieman[5]. The Body Mass Index (BMI) was obtained from the corrected body mass (in kg) divided by the squared height (in meters) using the cut points according to WHO[6].

The skinfolds were taken in the hemibody in which the athlete presented no amputation, and the evaluated remained in orthostatic position with relaxed musculature. A *Harpenden* adipometer was used and measurements were performed in duplicate in each place. When the values obtained ranged in 1 mm, a third measurement was performed. The average value of the two measurements that best represented the skinfold thickness was used as final score. The sum of the skinfolds was determined according to the three-skinfolds Jackson and Pollock protocol[7].

The circumferences (brachial and thigh) were assessed at the side in which the athlete presented no amputation with inextensible tape measure with accuracy of tenths of centimeters (mm). The arm measure was performed with arm relaxed along the body and obtained at the point of highest apparent perimeter. The medial thigh evaluation was performed at the mid distance between the inguinal line and the patella upper edge. The brachial perimeter and the triceps skinfold were used in order to determine the nutritional status of athletes through estimations of the arm muscular area (AMA), arm muscular circumference (AMC) and arm fat area (AFA), according to methodology described by Frisancho[8].

Dietary evaluation

To evaluate the dietary intake of athletes during the concentration period, the six-day food records was used. These records were self-filled after previous orientation from researcher. The amount of food and beverage ingested was recorded considering the meals the athletes had at the ANDEF dining-hall (breakfast, lunch and supper) and the meals the athletes had out of the concentration place. Foods were expressed as home measures. These recordings were collected and reviewed by the responsible researcher and the athlete for further explanations with regard to doubts, thus assuring higher reliability to the evaluation instrument. The food photographic recording was also used with the same objective[9].

The home-made measures were carefully converted into grams and milliliters[10] for the quantitative analysis of energy and nutrients ingested through the Nutrition Support Program – NutWin – of the Health Information Center – São Paulo Medical Scholl version 1.5/2002. Foods and preparations not included in the roll provided by the Program were included with the aid of complementary table[11] or nutritional information presented by the label of industrialized products. Besides energy, carbohydrates (CHO), proteins (PTN) and lipids (LIP) were selected for the analysis according to recommendations of the American College of Sports Medicine (ACSM)[3], hydrosoluble vitamins (thiamine, riboflavin, niacin, piridoxine, ascorbic acid) and liposoluble vitamin E (α-tocopherol). Among minerals, calcium, iron, magnesium and zinc were analyzed. The ingestion of alimentary fibers was also determined. The value found for each nutrient was compared with the current American recommendations[12-16].

Laboratorial evaluation

Full blood count with dosages of iron, ferritin and transferrin; urea, creatinine and albumin (to assess the mass free of fat) and tests related to the lipemic profile (total cholesterol, HDL_C, LDL_C and triglycerides) were conducted.

All samples collecting were performed by technicians of the Clinical Analyses Laboratory – Rio de Janeiro Federal University Pharmaceutics Scholl (LACFAR-UFRJ), at the ANDEF headquarters in the morning, with athletes in fast. Venous blood samples (10 ml) were collected, labeled properly, packed in a thermal box and transported to the laboratory for further analysis.

Fresh blood was collected in tube with EDTA, transferred into microcapillaries and centrifuged for five minutes in microhematocrit centrifuge *Fanem* Mod. 207. The hematocrit reading was conducted. The hemoglobin concentration was analyzed through the kit *Cellmlise II* in cell counter – CC-530 *Celm*. After homogenization, another portion of the samples was placed in the device *Celm* DA-500 in isotonic solution for white series with dilution of 1/10 for leukocyte counting and 1/20 for erythrocyte counting. Hemolysing solution was used (*Cellmlise II* surfactant solution and KCN) in the white series tubes to remove erythrocytes and to keep hemoglobin and leukocytes only. About 20 minutes later, the material was transferred into another device *Celm* CC-550 for red series counting and white series counting shortly after.

Shortly after coagulation, the serum was centrifuged at 1,500 rpm during 10 minutes for the biochemical evaluation. Only the supernatant (serum) was removed for the analyses and the kits from the *Analisa Diagnóstica* were used in each analysis. The triglycerides, total cholesterol and fractions dosages were performed through the Trinder methodology, which is based on the colorimetric analysis with the measurement of the antipyril-chinonimine final product in absorbance at 500 nm. The creatinine analysis was developed with the alkaline picrate methodology, while for the urea analysis, the determination of the urease activity was used as method, being both based on the colorimetric analysis with absorbance around 500 nm. The colorimetric analysis was employed according to the bromocresol green (BCG) methodology for albumin, with the absorbance employment around 600 nm. *Celm* spectrophotometer E-2250 was used for the reading of results and the spectrophotometer *Spectronic* – Bausch & Lomb was used for creatinine only.

RESULTS

Sample characterization

The soccer players presented average age of 29.3 ± 5.6 years with osteo-articular lesion that lasted as long as 15.5 years (± 5.3 years). Three athletes presented high amputations (above knee) and one presented low amputation (below knee). All amputations presented traumatic causes. Two athletes presented smoking habit.

With regard to the sportive practice, the athletes practiced the sport modality for 7.8 years on average (± 5.3 years). During the seven days of preparation for the world championship, the training sessions were given in two shifts (morning and afternoon) with average duration of 1 hour and 30 minutes a period. From all participants, two athletes are three times world champion and one of them was elected as the world best player in the 2001 championship. Three athletes were recovering from muscle-articular lesions.

In the evaluation, one player reported constipation and three players reported "ghost" pain (feeling the presence of the absent limb). One of them was making use of antibiotic and another of antiinflammatory. Nobody made use of the alimentary supplement. Only one athlete had received alimentary orientation from a nutritionist.

Anthropometrical evaluation

The descriptive and body composition characteristics of the athletes are expressed in table 1. The athlete A1 presented the highest body mass index, being considered with overweight, according to WHO[6]. The athlete A1 also presented the highest value of the folds and abdominal skinfolds summation, the highest arm fat area (percentiles 75 and 90) and the highest arm muscular area and circumference (percentiles 75-90), according to Frisancho[8]. Athlete A2 presented the lowest skinfolds and arm fat area (percentiles 5-10), but the protein stores, evaluated through AMA and AMC seemed to be adequate (percentiles 50-75).

TABLE 1
Descriptive and anthropometrical characteristics of elite amputee soccer players

Variables	Athletes			
	A1	A2	A3	A4
Age (years)	33.0	31.0	32.0	21.0
Height (cm)	176.5	178.7	171.5	178.4
Body mass (kg)	66.6	61.4	51.4	58.2
Corrected body mass (kg)	81.7	64.8	63.1	71.4
BMI (kg/m²)	26.2	21.6	21.4	22.4
Skinfolds (mm)				
Triceps	11.1	5.6	6.2	11.5
Abdomen	21.7	9.1	10.3	13.2
Thorax	13.0	6.0	6.0	8.8
Thigh	16.8	6.9	6.6	12.7
Σ Skinfolds	63.1	27.6	29.1	46.2
Circumferences (cm)				
Thigh	57.5	53.6	52.5	53.4
Right arm	33.8	30.0	28.6	29.5
AMC (cm)	303.1	282.4	266.5	258.9
AMA (mm²)	7,316.7	6,350.2	5,656.0	5,336.1
AFA (mm²)	1,778.6	815.2	856.0	1,592.8

BMI: body mass index; AMC: arm muscular circumference; AMA: arm muscular area; AFA: arm fat area.

Dietary evaluation

The average values and standard deviation of energy, macronutrients and fiber and of micronutrients, resulting from the average of the food records of athletes are found in tables 2 and 3, respectively.

TABLE 2
Dietary intake of energy, macronutrients and alimentary fibers of elite amputee soccer players (X ± SD)

Variables		Athletes			
		A1	A2	A3	A4
Energy	kcal	2,179 ± 680	4,416 ± 794	2,257 ± 771	4,294 ± 651
	kcal/kg	32.7 ± 10.2	71.9 ± 12.9	43.9 ± 15.0	58.0 ± 16.3
Proteins	g/d	120.5 ± 78.2	240.5 ± 56.4	117.9 ± 65.7	231.9 ± 30.0
	%	21	22	19	21
	g/kg	1.8 ± 1.2	3.9 ± 0.9	2.3 ± 1.3	4.0 ± 1.24
Carbo-hydrates	g/d	263.2 ± 83.5	533.7 ± 103.5	281.3 ± 96.7	596.0 ± 189.7
	%	49	48	51	54
	g/kg	4.0 ± 1.3	8.7 ± 1.7	5.5 ± 1.9	10.2 ± 3.3
Fibers	g/d	15.9 ± 5.6	73.8 ± 29.1	20.0 ± 13.4	41.8 ± 14.6
Lipids	%	30	30	30	25

TABLE 3
Average dietary intake of vitamins and minerals of elite amputee soccer players (X ± SD)

Nutrients (mg)	Athletes			
	A1	A2	A3	A4
Vitamin C	86.1 ± 94.8	222.2 ± 352.3	85.5 ± 69.5	189.7 ± 151.1
Magnesium	276.8 ± 128.3	735.2 ± 153.3	328.0 ± 233.4	585.9 ± 186.8
Thiamine	10.0 ± 11.5	34.5 ± 29.2	20.5 ± 14.4	22.5 ± 18.9
Riboflavin	61.5 ± 104.0	98.2 ± 107.7	94.4 ± 112.5	124.8 ± 200.9
Niacin	33.8 ± 26.5	48.2 ± 23.1	16.8 ± 12.2	52.5 ± 17.2
Vitamin B6	1.9 ± 1.5	3.2 ± 1.2	1.4 ± 1.1	3.1 ± 1.2
Vitamin E	6.0 ± 1.8	8.8 ± 3.0	4.4 ± 2.1	6.5 ± 2.3
Calcium	469.3 ± 139.2	1,362.6 ± 228.9	711.7 ± 422.0	1,306.2 ± 334.7
Iron	17.8 ± 6.9	34.0 ± 7.6	14.1 ± 9.1	36.0 ± 12.7
Zinc	13.4 ± 7.1	25.9 ± 3.9	11.6 ± 7.8	22.6 ± 9.4

All athletes ingested hyperproteic diets both in g/kg/day and the percentile in relation to the total energetic value (daily energy intake). Three athletes (A1, A2 and A3) presented lipids intake above the maximum limit recommended by the ACSM[3] in relation to the percentile of the daily energy intake. Despite the low CHO percentile ingestion, two athletes (A2 and A4) presented adequate ingestion levels in relation to the gramature (8.7 g/kg/day and 10.2 g/kg/day, respectively)[3]. Two athletes (A1 and A3) ingested fibers below the amount recommended by the Food and Nutrition Board (FNB)[16].

The average values of micronutrients intake, presented in table 3 indicate that all athletes presented ingestions below values recommended for vitamin E[14]. Two athletes (A1 and A3) also presented insufficient ingestion of vitamin C, magnesium and calcium, according to current American recommendations[12-15].

Biochemical evaluation

The results of the biochemical evaluation are expressed in table 4. Athlete A1 presented erythrocyte and hematocrit values below normality. The hemoglobin was found at the minimum limit and the transferrin close to the minimum limit recommended. Athlete A2 also presented erythrocyte and hematocrit values below reference values. The other two athletes presented values within standards recommended. With regard to the protein indicatives, athlete A4 presented urea concentrations above the reference values. Athlete A1 presented the highest indexes of total cholesterol, LDL cholesterol and triglycerides; on the other hand, all athletes were found within adequate values.

TABLE 4
Reference and biochemical variables values of elite amputee soccer players

Variables	Reference values	Athletes			
		A1	A2	A3	A4
Erythrocytes (millions/mm³)	4.60 a 6.20	4.46	4.45	4.69	4.72
Hemoglobin (g/dl)	13.3 a 18.0	13.3	13.6	14.2	14.5
Hematocrit (%)	40 a 54	38.2	38.4	40.3	42.1
Transferrin (mg/dl)	200 a 360	205	224.0	241	251.0
Ferritin (ng/ml)	24 a 336	146.6	154.9	94.5	102.5
Urea (mg/dl)	15 a 40	39	38	24	44
Creatinine (mg/dl)	0.4 a 1.3	0.8	1.0	0.9	0.9
Albumin (g/dl)	3.5 a 5.5	4.6	5,3	4.9	5.0
Total cholesterol (mg/dl)	< 200	198	137	166	131
HDL cholesterol (mg/dl)	> 35	53	56	50	49
LDL cholesterol (mg/dl)	< 130	123	70	104	64
Triglycerides (mg/dl)	< 200	110	55	60	88

DISCUSSION

The athletes evaluated presented amputation on the lower limbs, being three of them above knee. The fact of all amputations were of traumatic causes seems to contribute for a higher adhesion to the sportive practice, increasing the self-esteem and the quality of life[17].

In athletes with disabilities, the body composition is a parameter difficult to be evaluated. There are no predictive equations and methodologies developed to evaluate this population. However, the body composition determination is vital for the observation of the individual evolution of each athlete, according to the nutritional intervention and the sportive training. Weight and body fat should be controlled due to the overload that the lack of the limb brings to the remaining limb[4,18].

The muscular mass may be characterized based on AMC and AMA. In the amputee soccer, the arm works effectively in the locomotion of the athletes by means of the use of crutches. The athletes studied presented musculature within normality range with AMC and AMA between percentiles 25-50. Athlete A1, who plays in fullback position, presented the highest body protein store (percentiles 75-90). According to Ramadan and Byrd[19], in a soccer team, the fullbacks should be stronger than the forwards probably due to the functions demand, what would explain the higher protein store in these athletes. The other players did not present distinct characteristics.

There are no specific recommendations on the nutrition of the handicap[20] and athletes with disabilities. For these individuals, the nutritional requirements should be evaluated taking into consideration the physical activity level, the alterations on the metabolic processes, the chronic use of remedies and the alimentary habits.

The use of crutches for walking and running is considered as an exhausting exercise itself[21]. With relation to the competitive soccer practice, one supposes that the energetic expenditure increases significantly. In amputees, it was observed that the ergometric training causes an increment on the physical conditioning comparable to non-handicap individuals[22].

The present study found a daily consumption of 3,333 kcal/day that, despite being within the value usually found for soccer players[23-33], cannot be considered as adequate for amputee athletes. Considering the alterations on the energetic expenditure caused by walking inefficiency – it is not known if the individual undergoes adaptation to this activity – the individual starts requiring lower oxygen intake, lower energetic expenditure and hence lower energy necessity or if the exercise adaptation is not sufficient to decrease significantly the walking energetic expenditure.

Individuals who practice intermittent activities such as soccer, require adequate CHO ingestion to optimize the physical performance. However, the alimentary habits of soccer players do not seem to provide adequate CHO amounts[23-33]. In the present study, athletes A2 and A4 presented CHO ingestion in g/kg/day within recommendation limits for athletes in intense training, although CHO intake of athletes A1 and A3 was found below recommendations. An ingestion of 6-10 g of CHO/kg of body weight/day is recommended with the objective of maintaining the hepatic and muscular glycogen stores[3,34-36].

The present work observed a high protein intake (% and g/kg/day) as reported in literature[23-33]. The average ingestion of 3.0 g/kg/day was approximately twice as the recommendations[34]. Only athlete A1 presented average ingestion within limits expected (table 2). Guerra[37] studied non-handicap Brazilian soccer players and observed protein percentile above 20% of the daily energy intake in one of the teams. Protein ingestion above recommendations does not improve the performance[38,39] and it may rather cause damage to hepatic and renal systems in long-term[40].

An excessive lipid intake is not recommended for athletes, once the accumulation of fat tissue impairs high-velocity running and sprints frequently performed in soccer. The quality of life of individuals with disabilities may also be impaired, once the risk of occurring non-transmissible chronic diseases and bone overload is increased. Three out of the four athletes evaluated presented lipids intake above recommendations[3]. Literature emphasizes that many times the lipid intake of soccer players is above recommendations[23-33], and reaching CHO ingestion according to recommendations becomes more and more difficult[36].

Athletes in high-intensity training may need special attention in relation to the ingestion of iron, calcium and antioxidant vitamins[41].

Vitamins C and especially E reduce the increase of the exercise-induced lipidic peroxidation. Furthermore, vitamin C acts as electrons donor to regenerate vitamin E at the cell membrane during oxidative stress[42]. Despite soccer training presents increase on the plasma antioxidant amount when athletes are compared with inactive individuals[43], it is vital that diet would favour foods that are sources of these nutrients. All athletes presented vitamin E ingestion below recommendations. Vitamin C intake was found below recommendations in two athletes (A1 and A3), who also presented low calcium ingestion. The vitamin C intake depends especially on the fruits ingestion. Studies on the dietary intakes and plasma concentration of this vitamin in individuals with disabilities have demonstrated that these individuals present a lower concentration, which is related to dietary intake significantly lower of fruits and vegetables when compared to a control group[44]. It is possible that the inadequacy of these nutrients is related with a lower energy intake, which is insufficient to provide the nutrients required, as observed in athletes A1 and A3.

The biochemical analyses provided more objective and quantitative results, emphasizing possible deficiencies that the anthropometrical evaluation and the dietary intake would be able to detect some time later[45]. Although athletes A1 and A2 presented erythrocytes and hematocrit values below reference, the ferritin, which demonstrates good correlation with body iron stores[46], was found adequate in all athletes. The serum albumin, which is used to evaluate the nutritional status of individuals with disabilities[47], presented values close to maximum limits, suggesting adequate protein store. The high urea concentration in one of the athletes (A4) may be the reason of the high protein intake (table 2).

Kaznacheev *et al.*[48] analyzed the lipids profile of 108 amputee men and found high triglycerides concentrations and low HDL cholesterol concentrations when compared with individuals with no amputation. The study demonstrated that the limbs amputation followed by decreased mobility, insufficient physical activity and psychological stress are atherogenic risk factors in young amputees who present alterations on the lipids profile. However, the high HDL cholesterol values of the athletes studied is in agreement with values reported in literature for athletes with no disabilities. Therefore, one may consider that the physical activity was able to change this lipids standard.

CONCLUSION

The present study observed that the elite amputee soccer players need specific nutritional evaluation with the objective of correcting wrong dietary practices to improve performance. The lack of works with individuals with disabilities, especially with amputees emphasizes the need to delineate the nutritional profile of these athletes and to help them to achieve a better performance and quality of life. The athletes presented distinct individual dietary characteristics. Further works must be developed with a larger number of individuals to better characterize the nutritional status of amputee soccer players as well as to observe intra-groups differences, according to their position in the game.

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