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Research Article

Dietary Intakes and Nutritional Status of a Greek Team of Female Volleyball Players

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Abstract

Aim: The purpose of this study was to assess the dietary intakes and nutritional status of a nationally ranked team of female volleyball players. **Methods:** The subjects completed a general history questionnaire and 7-day food and physical activity records. Anthropometric measurements included height, weight, triceps and subscapular skinfolds and mid-upper-arm circumference. Biochemical assessment included parameters for protein, lipid, and iron status. **Results:** All subjects had normal menstrual cycles and body fat values (27 %) at levels higher than for optimum performance. Most were in negative energy balance and had low energy (30 kcal/kg/d), carbohydrate (3.8 g/kg/d) and protein (1.0 g/kg/d) intakes. Fat intakes were high (39 %) and micronutrient intakes were below recommended levels, except for vitamin C, vitamin B12 and niacin. Biochemical indices were normal except for iron and lipid status of some players. **Conclusion:** These results indicate that the players of this team have dietary intakes that place them at risk for nutritional shortages and compromised performance; they need professional counseling regarding nutrition practices for optimum health and performance.

Keywords: exercise, nutrition, volleyball, anthropometry, biochemical assessment, macronutrients, micronutrients

1. Introduction

Volleyball is one of the most popular sports among females in Greece. It is one of the three main team sports included in the curriculum of Greek schools, besides soccer and basketball. Volleyball is an activity requiring combined physical and mental abilities such as explosive strength, agility, a high level of concentration and skill. As an activity, it relies mostly on the anaerobic energy system though aerobic endurance is important for recovery between points, stamina and tolerance to heat [25]. Training includes skill, strength and conditioning programs. In addition, having reduced body fat levels can

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help improve the athletes? speed and jumping ability. Volleyball players need powerful legs to assist with jumping and strong upper bodies to develop power for spiking, serving and blocking. Competitive female volleyball athletes face increased demands for energy and nutrients to support heavy training, along with a need to lower body fat to low-moderate levels for optimum performance [5].

Female athletes participating in sports that emphasize leanness (eg gymnastics, figure skating, and cross-country running) generally report energy and nutrient intakes below recommended levels and lower than those of non-athletic females. This is thought to be due to weight control practices common among these athletes while neuropsychopharmacological parameters and disorders are under investigation [1, 3, 31], (da Silva et al. 2015), and [30].

Dietary intakes and eating behaviors of female athletes participating in sports with less emphasis on low body weight (e.g. swimming, rowing, soccer, basketball and volleyball) are also reported to be sub-optimal [2, 11, 12, 18, 20, 31].

This might be due to lack of professional nutritional support of female athletes along with heavy training and improper body image perceptions [2, 28]. The main objectives of the present study were to examine the dietary intakes and nutritional status of a team of female Greek volleyball players and some of the risk factors related to their nutritional status.

2. Methodology

2.1. Subjects

The subjects were members of a female volleyball team, which was ranked in the national division. The team consisted of 15 members, 10 of which agreed to participate in the study. Five players refused to participate stating that their nutritional status was optimal. A written consent was obtained from all participating players. The age of the subjects ranged from 18 to 26 years. All were Caucasian and had been playing competitive volleyball for over 6 years. They trained 10-12 hours per week and their daily schedules included skill and strength training.

2.2. Questionnaire

The subjects completed a general history questionnaire, which was designed especially for the study in order to identify risk factors (medical, dietary and socioeconomic) related to the nutritional status of the subjects. The questionnaire was validated for Greek female athletes (pretested in a sample of Greek female athletes participating in different sports). It included 20 simple questions providing information on weight history, health status, appetite, living conditions, economic status, eating and drinking habits, drugs and supplements use, dieting, psychological status and menstrual cycle. Athletes were considered to be at risk for low nutritional status if they reported a particular risk factor on the general history questionnaire.

2.3. Anthropometric Measurements

Height was measured to the nearest 0.5 cm using a wall-mounted calibrated stadiometer (Ka We Measuring Instrument 44442). Weight was measured to the nearest 0.1 kg on a portable electronic beam scale (Philips Digital Bathroomscales HP 5320). Body mass index (BMI) was calculated as body weight / height^2. Body composition (fat mass and fat-free mass) was estimated via 2-site skinfold measurements (triceps and subscapular), using a Harpenden skinfold caliper and mid-upper-arm-circumference (MAC), using a flexible measuring tape according to Frisancho [10]. The same person took all measurements to the nearest 0.5 mm. Body fat mass was calculated from body density estimations according to Durnin and Womersley [8] and percent fat mass was estimated according to Siri [27]. Body fat-free mass was assessed from mid-upper-arm-muscle circumference (MAMC), which was calculated according to Frisancho from measurements of the mid-upper-arm-circumference (MAC) and triceps skinfolds [10].Anthropometric assessment was based on data for healthy American populations and used the guidelines for interpreting the age/sex percentile values for anthropometric indices proposed by Frisancho [10].

2.4. Dietary Assessment

Energy and nutrient intakes were determined from 7-day food records. Participants were given detailed instructions on how to complete food records during a group educational session, with measuring utensils and food models as instructional tools. Food records were completed during a 7-day recording period, at the time of food intake, after self-estimation of portion size according to instructions. Diet records were analyzed using Nutrition software (Version 6.4, 1998, ESHA Research). The nutrient database used, included data derived from analyses of traditional meal recopies, taken from a widely used Greek cookery book. Nutrient intake analysis did not include nutrient supplements, because the aim of the study was to evaluate the adequacy of dietary intake. Any additional use of supplements was however recorded and assessed in cases where risk to nutritional status was detected.

Total daily Energy Expenditure was estimated from calculations of Basal Metabolic Rate according to Schofield [26] and the energy expended in various daily activities including training, according to their duration and energy cost [4, 7].

Energy costs of individual physical activities were estimated from 7-day, self reported physical activity records, which were completed and collected at the same time as food records. Information collected regarding training included duration, type and intensity of training.

Nutrient intakes were assessed according to the current nutritional recommendations for athletes [7, 13–15, 17, 21].

3. Biochemical assessment

Fasting blood samples, drawn during the week of food and physical activity recording, were used for analyses. Hemoglobin and hematocrit levels and serum levels of albumin, iron, Total Iron Binding Capacity (TIBC), total cholesterol, HDL-cholesterol, LDL-cholesterol and triglycerides were assayed by a Clinical laboratory belonging to the Greek National Health System. The coefficient of variation (C.V.) of all assay methods was <5 % according to the quality control procedures of the laboratory involved. Athletes with low nutritional status were those who had values outside the reference range used by the laboratory.

4. Results

Risk factors for low nutritional status identified in the Greek team of female volleyball players included poor weight control, poor appetite, food avoidance, anemia, smoking, alcohol consumption, low blood pressure and constipation (Table 1). None of the athletes reported to be following special nutritional advice relating to health and optimum performance. All ten subjects had normal menstrual cycles and none reported being on a special diet or to be using medication. One athlete used iron and calcium supplements and two athletes were smokers and alcohol consumers. Three athletes reported recent weight gain and two athletes reported recent weight loss. Three athletes reported having anemia whereas another reported having low blood pressure. One player reported suffering from constipation. Half of the athletes reported poor appetite and food avoidance. One athlete avoided meat, another avoided vegetables and half of the athletes avoided pulses.

The age of athletes ranged from 18 to 26 years (Table 2). Mean height, weight and body mass index (BMI) were 1.75 ± 0.05 m (range 1.68 – 1.88 m), 63 ± 7 kg (range 54 – 79 kg) and 20.5 ± 1.7 kg/m^2 (range 18.2 – 22.7 kg/m^2) respectively. Eight athletes were tall (>/= 95th percentile) one was of above average height (85th percentile) and another athlete was of average height (75th – 85th percentile). Two athletes had weights above average (85th – 95th percentile) and eight athletes had average weights (25th – 75th percentile). Six athletes had average values for body mass index (25th – 75th percentile)

Nutritional Risk Factor	No of athletes at risk for low status
Menstrual cycle	0
Anemia	3
Constipation	1
Low Blood pressure	1
Drug therapy	0
Weight history	5
Alcohol consumption	2
Smoking	2
Low appetite	5
Food avoidance	5
Special Diet	0

Table 1: Nutritional Risk Factors for female volleyball players studied.

	Mean ± SD	Reference limits	No of athletes with low status	Range of values
Age (y)	22 ± 2	n.a.	n.a.	18 – 26
Height (m)	1.75 ± 0.05	1.52 – 1.74*	–	1.68 – 1.88
Weight (kg)	63 ± 7	46 – 84*	–	54 – 79
BMI (kg/m^2)	20.5 ± 1.7	17.7 – 32.1*	–	18.2 – 22.7
Body fat (%)	27 ± 7	17 – 35 **	–	21 – 32
MAMC (mm)	214 ± 22	183 – 249*	1	180 – 254

Table 2: Anthropometric characteristics of female volleyball players studied. * Reference limits are the 5th and 95th percentile values for age and sex ( ). **Upper reference limit is the 85th percentile value for age and sex ( ).

while four athletes had values below average (5th – 15th percentile). Mean body fat percentage was 27 ± 7 (range 21 – 32) and the mean value for MAMC was 214 ± 22 mm (range 180 – 254 mm). All athletes had average fat mass (15th – 75th percentile), seven athletes had average muscle mass (25th – 75th percentile), one athlete had low muscle status – wasted (<5th percentile) and two athletes had high muscle status – good nutrition (above 95th percentile). Three athletes with below average body mass index had average fat and muscle mass while the fourth athlete had more fat mass than the others and lower muscle mass-wasted.

Daily mean intakes of energy and nutrients and number of athletes with low intakes are shown in Table 3. Mean energy intake (EI) was 1861 ± 337 kcal/d (range 1450 – 2597 kcal/d) while mean energy expenditure (EE) was 2060 ± 234 kcal/d (range 1785 – 2576 kcal/d); the mean daily physical activity level (PAL) was 1.5. Daily energy intakes of five athletes were reported to be below 1800 kcal/d. Seven athletes appeared to be in negative energy balance (EI /EE < 1) while three athletes appeared to be in positive energy balance (EI / EE > 1).

Mean energy intake per kg of body weight was 30 ± 7 kcal/kg/d (range 21 – 43 kcal/kg/d) and seven athletes might be at risk for low energy status required for anaerobic/aerobic exercise according to their reported energy intakes which were below recommended levels for athletes. Only one athlete reported a level of energy intake above 41 kcal/kg/d, which is a minimum level for anaerobic/aerobic exercise.

The contribution of protein, fat and carbohydrate to total energy intake was 13 ± 3 % (range 7 – 17 %), 39 ± 6 % (range 30 – 46 %), and 48 ± 7 % (range 38 – 54 %) respectively. Eight athletes reported high fat intake, above recommendations for health, which was assessed as a possible nutritional risk. Mean protein intake per kg of body weight was 1.0 ± 0.3 g/kg/d (range 0.4 – 1.6 g/kg/d) while seven athletes might have been at risk for low protein status since they reported protein intakes below the recommended level for aerobic/anaerobic sports. Mean carbohydrate intake per kg of body weight was 3.8 ± 0.9 g/kg/d (range 2.1 – 6.1 g/kg/d) and the reported carbohydrate intakes were below recommendations in nine athletes.

Six athletes had low intakes of vitamin C with mean intake of 66 ± 35 mg/d (range 23 – 122 mg/d). Mean intake of vitamin B12 was 3.8 ± 3.9 μg/d (range 1.0 – 13.4 μg/d) and six athletes also had intakes below recommendations. Niacin mean level of intake was 22 ± 18 mg/d (range 6 – 74 mg/d) with three athletes recording low levels. None of the athletes had an adequate intake of vitamin D (range 0.3 – 1.2 μg/d), vitamin E (range 0.9 – 5.4 mg/d), vitamin B6 (range of intakes 0.3 – 0.9 mg/d) and folate (range 65 – 271 μg/d). Only two athletes had adequate vitamin A intakes (range 175 – 2756 μg/d) while eight athletes had intakes in the range 175 – 659 μg/d well below recommendations. Two athletes had adequate B1 intakes (range of intakes 0.3 – 1.3 mg/d) and three had adequate B2 intakes (range 0.2 – 1.6 mg/d). Only one athlete had an adequate intake of iron from her diet (25 mg/d) and this athlete also had an adequate intake of calcium, when the calcium supplement she was using was taken into consideration. Only one athlete had an adequate intake of calcium from her diet (1400 mg/d).

All mean values of the biochemical indices studied and the number of players with low status are shown in Table 4. One athlete had low hemoglobin and three athletes had low serum iron and low transferrin saturation. Low iron and low transferrin saturation are indices of low iron stores while low hemoglobin is an index of more advanced deficiency of iron. All athletes had adequate protein status as shown by serum albumin levels. All athletes had normal levels of total cholesterol, HDL-cholesterol, LDL-cholesterol and triglycerides, showing normal risk to cardiovascular disease, except one athlete who might have slightly increased risk, indicated by slightly elevated levels of total cholesterol and LDL-cholesterol (204 mg/dl and 153 mg/dl respectively).

	Mean ± SD	Recommended values *	No of athletes at risk for low nutritional status	Range of reported values
Energy intake (kcal/d)	1861 ± 337	2060 ± 234**	7	1450 – 2597
Energy intake (kcal/kg/d)	30 ± 7	37 – 41	7	21 – 43
Carbohydrate intake (g/d)	234 ± 50			167 – 366
Carbohydrate intake (g/kg/d)	3.8 ± 0.9	5.0 – 10.0	9	2.1 – 6.1
% energy from carbohydrate	48 ± 7			38 – 54
Protein intake(g/d)	61 ± 19			26 – 95
Protein intake (g/kg/d)	1.0 ± 0.3	1.2 – 2.0	7	0.4 – 1.6
% of energy from protein	13 ± 3			7 – 17
Fat intake (g/d)	80 ± 20			48 – 116
% of energy from fat	39 ± 6	20 – 30	8	30 – 46
Vitamin A intake(μg)	825 ± 922	1000	8	175 – 2756
Vitamin D intake (μg)	0.7 ± 0.3	10	10	0.3 – 1.2
Vitamin E intake(mg)	2.7 ± 1.3	10	10	0.9 – 5.4
Vitamin C intake(mg)	66 ± 35	65	6	23 – 122
Vitamin B1 intake(mg)	0.7 ± 0.2	1.0	8	0.3 – 1.3
Vitamin B2 intake(mg)	0.8 ± 0.4	1.0	7	0.2 – 1.6
Vitamin B6 intake(mg)	0.6 ± 0.2	1.2	10	0.3 – 0.9
Vitamin B12 intake(μg)	3.8 ± 3.9	2.4	6	1.0 – 13.4
Niacin intake(mg)	22 ± 18	14	3	6 – 74
Folate intake (μg)	137 ± 57	400	10	65 – 271
Iron intake (mg) ***	10 ± 5	18	9	5.7 – 25.2
Calcium intake (mg) ***	688 ± 349	1300	9	249 – 1400

Table 3: Energy and nutrient intakes of female volleyball players studied. *Recommended Dietary Allowances or Dietary Reference Intakes (9, 15, 16, 17, 25, 26). **This is the reported level of Mean Energy Expenditure. ***Mineral supplements were not included in the analysis.

5. Discussion

Athletes are generally considered to be at risk for low nutritional status because of the extra demand for energy and nutrients imposed by the increased physical activity involved in daily training and competition, unless their energy and nutrient intakes are adequately increased.

Self-reported physical activity records collected in the present study showed a mean daily level of physical activity close to the levels expected for sedentary females and lower than the levels of physical activity derived from DLW energy expenditure

Index	Mean ± SD	Reference range*	No of athletes with low status	Range of assayed values
Hematocrit (%)	39 ± 2	36 – 47	0	37 – 41
Hemoglobin (g/dl)	12.7 ± 1.2	12 – 16	1	11 – 15
Serum iron (μg/dl)	60 ± 17	60 – 145	3	36 – 86
Serum TIBC (μg/dl)	297 ± 29	250 – 350	0	254 – 340
Transferin saturation (%)	20 ± 5	>16	3	12 – 27
Serum albumin (g/dl)	4.0 ± 2	3.5 – 4.5	0	3.6 – 4.4
Serum total cholesterol (mg/dl)	159 ± 31	100 – 200	1**	109 – 204
Serum HDL cholesterol (mg/dl)	47 ± 8	35 – 55	0	38 – 60
Serum LDL cholesterol (mg/dl)	98 ± 32	<150	1**	51 – 153
Serum triglycerides (mg/dl)	66 ± 19	30 – 220	0	38 – 102

TABLE 4: Biochemical indices for female volleyball players studied. *Reference range used by the laboratory, which carried out the tests. ** Low status indicates high risk for cardiovascular disease.

studies of athletes [4]. Apparently our athletes either under-reported their levels of physical activity due to systematic errors in recording despite instructions, or had lower daily physical activity levels than other athletes. One generally assumes that training increases the daily level of physical activity in all athletes, and that it has no effect on the level of physical activity during time not spent in exercise. Athletes usually spend variable lengths of time to rest after strenuous training, depending on their nutritional status and time allowances of their daily schedule.

Based on physical activity records, energy expenditure of seven athletes in the present study was not matched by their reported energy intakes. These athletes appeared to be in negative energy balance during the week of data collection. Discrepancies between reported energy intakes and energy requirements in female athletes have been reported in the literature, and might indicate under-reporting [4, 9]. These discrepancies might not correspond to habitual dietary intakes and long-term nutritional status. The weight changes reported by five athletes in this study indicate a long-term energy imbalance at least in these athletes. Reported energy imbalances however do not correspond to reported weight changes or anthropometric nutrition indexes of the athletes concerned. This suggests that the reported dietary data might not reflect long term nutrition of the athletes, either because of changes in dietary habits during the period of data collection or under-reporting of food intake by some athletes [4]. Two athletes in the present study were suspect for under-reporting (they had a low ratio of EI / EE of 0.7). It is worth noting that these athletes had high muscle status, indicating adequate habitual dietary intake. These athletes obviously did not report habitual dietary intake, probably led by misconceptions regarding appropriate nutrition and body composition of athletes.

The mean energy intake of the team (30 ± 7 kcal/kg/d) was below the levels reported by American female athletes [2] but similar to the levels reported by Greek female athletes [9, 20]. Mean protein intake in the present study (1.0 ± 0.3 g/kg/d) was similar to the level reported by Greek female volleyball players [20] but lower than the level reported by Greek female aquatic athletes [9]. Mean carbohydrate intake in the present study (3.8 ± 0.9 g/kg/d) was similar to the levels reported by Greek female volleyball and aquatic athletes [9, 20]. Mean protein and carbohydrate intakes were lower than those reported by American female volleyball and soccer players [2, 18]. Seven players were at risk for low protein status according to their reported protein intakes (Table 3). If the reported low intakes of energy and protein reflect habitual intakes, they might lead to failure to sustain desirable muscle mass. Muscle mass status was average for most athletes in our study, at similar levels to sedentary individuals. One athlete, who reported avoiding meat and pulses, had significantly low muscle mass status indicating muscle wasting**.** Her reported levels of energy and protein intakes were, however, similar to the mean values of the team. Serum levels of albumin show long-term changes in protein status and are insensitive to short-term changes, due to the relatively long half-life (14 – 20 days) of albumin. Short- term changes due to stress and short-term dietary changes cannot influence serum albumin levels.

Adequate carbohydrate intakes are essential for maintaining athletic performance. The recommended levels for carbohydrate intakes for high intensity endurance male athletes are 5 – 10 g/kg/d respectively [21].

Nine athletes in the present study reported carbohydrate intakes below the recommended level suggesting that they were at risk for low performance. Low carbohydrate intakes may result in low glycogen stores and inability of the athlete to sustain high intensity energy demands.

Mean fat intake was similar to the intake reported by Greek female volleyball players [20], higher than that reported by Greek female aquatic athletes and American female volleyball athletes [2, 9] and higher than the recommended levels for optimum health [7, 22]. Eight athletes had fat intakes higher than 30 % of total energy intake. High fat intake might be related to poor weight control, which was reported by five athletes. The long-term negative effects of high fat diets on health are well known. One athlete faced increased risk for cardiovascular disease indicated by slightly elevated levels of total and LDL-cholesterol. Athletes should follow the general recommendations for health regarding fat intake. Typically diets containing 20-25 % energy from fat have been recommended to facilitate adequate carbohydrate intake and to assist in weight management where necessary [21].

Mean micronutrient intakes were similar to those reported by Greek female volleyball players [20] and lower than the intakes reported by Greek female aquatic athletes (Farajian et al. 004) and American female volleyball and soccer players [2, 18].

Most athletes reported low intakes of antioxidant vitamins. Although a well-trained athlete may have a more developed endogenous antioxidant system than a sedentary person, athletes should meet the general recommendations for health [21].

An inadequate intake of antioxidant vitamins could place athletes at greater risk for damage resulting from oxidative stresses and result in slower recovery from exercise-induced damage.

The reported intakes of the B-complex vitamins were also low for most athletes with the exception of niacin. Taking into account that exercise may slightly increase the need for these vitamins, low intakes may impair energy production during exercise, production of red cells, protein synthesis and tissue repair and maintenance [21].

Low calcium and iron dietary intakes were reported by nine athletes. One athlete used iron supplementation when her dietary intake was already adequate. The same athlete managed to meet recommendations for calcium intake by using calcium supplementation. Inadequate calcium intake found in eight athletes increases the risk for low mineral density and stress fractures [29].

Low iron intake is one of the causes for low iron status. Iron deficiency anemia was diagnosed in one athlete and iron depletion (low iron stores) was found in three athletes according to biochemical indices (Table 4). All three athletes reported avoiding pulses, a very important food source for iron in many areas and diets [24]. Iron depletion is one of the most prevalent nutrient deficiencies, mostly observed in female athletes. No significant impact of iron depletion on exercise performance has been observed, but iron deficiency anemia as a result of iron depletion can certainly affect exercise performance negatively [21]. Early detection and supplementation may improve performance [6].

The reported low energy intake of most athletes in the present study might partially explain their low intake of micronutrients. Beside sufficient energy intake however, a large variety of foods consumed in appropriate amounts as defined by the Food Pyramids is essential to ensure adequate macronutrient and micronutrient intake.

The anthropometric assessment in the present study showed that mean height, weight and body mass index was similar to Greek and American female volleyball players [2, 20]. Mean body fat however was above the level reported for female athletes participating in similar sports and the levels reported for American female volleyball players [2, 21]. The estimated minimal level of body fat compatible with health is 12 % for females. However, optimal body fat percentages for an individual athlete may be much higher than this minimum and should be determined on an individual basis [21]. It should be born in mind however that reduced body fat levels could help volleyball players optimize speed, agility and jumping ability [5].

Mid-upper-arm muscle-circumference can be used to assess total muscle mass and is frequently used for this purpose in field surveys. It can also be used to assess large changes in total body muscle mass, but is insensitive to small changes. Reduction in MAMC is indicative of muscle degradation in order to provide essential amino acids and is seen in chronic dietary deficiency of protein and energy [10].

The low muscle status that was diagnosed in one athlete might be interpreted as a result of chronic dietary deficiency of protein and energy. Only two athletes in the present study were assessed, according to their muscle mass, as having high muscle status- good nutrition, as would be expected for athletes engaged in sports that emphasize strength. Muscle mass estimations corresponding to female athletes, were not found in the literature for comparison. Because of possible errors associated with body composition assessment methods (validity of prediction equations used), body composition values should be interpreted with caution.

6. Conclusion

Reported energy, protein and carbohydrate intakes of most volleyball players in the present study were at levels lower than recommended. Under-reporting might have affected the dietary assessment of some players but poor weight control, low muscle status and low iron status in some players, indicate long-term energy and nutrient imbalances. High fat intake was probably related to poor weight control and increased risk for cardiovascular disease. Low micronutrient intake was partly due to low energy intake and partly to avoidance of nutrient dense foods. Low protein status was assessed in one athlete, (low muscle mass, low dietary intakes of energy and protein, and avoidance of meat and pulses), low iron status was assessed in three athletes, (low iron stores, low intake of iron, and avoidance of pulses) and elevated risk for cardiovascular disease was assessed in one athlete, (high serum cholesterol, high serum LDL-cholesterol and high intake of dietary fat). There is an urgent need for nutrition counseling of athletes, based on individual needs for optimum health and performance.

7. Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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