Dietary intakes of elite female athletes in Greece

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Abstract

Background Although there is a great interest in sports in Greece, there are very few data regarding dietary intakes and habits of Greek elite female athletes. The present study assesses the dietary intakes and the energy balance of elite female athletes of four different sports (volleyball, middle distance running, ballet dancing, and swimming) and a non-athletic control group.

Methods Data were collected over two seasons, the training and the competitive, using 7-day weighed dietary records. Energy expenditure was calculated from 7-day activity records. Anthropometric measurements were also taken for all athletes.

Results Athletes and controls had similar BMI values. Per cent body fat was lower for athletes compared with controls. Between sports, middle distance runners had the lowest per cent body fat. No significant differences were found between mean energy intake of athletes and controls. Mean energy intake was found lower than calculated energy expenditure, for all four teams.

Macronutrient and micronutrient intakes of the athletes were not statistically different from those of the non-athletic control group. Mean micronutrient intakes were found above the recommended values with the exception of iron. Both athletes and controls had a high intake of vitamin C that is a characteristic of the population of the Mediterranean countries.

Conclusions Energy intakes varied between sports and between athletes of the same sport. Calculated energy expenditure was higher from the reported energy intake for most athletes. Athletes with the lowest energy intakes reported menstrual abnormalities.

Introduction

Interest in sports has increased greatly over the last decades. Athletic competition is no longer restricted to men but enthusiasm has developed also among women. Individual sports have gained in popularity among women and this has led to a greater interest in the specific nutritional needs of female athletes. A number of investigators have reported that female athletes often show poor dietary behaviour that can affect their successful physical performance.

Studies of female athletes have revealed low reported energy intakes in comparison to high levels of energy expenditure (Calabrese *et al.*, 1983; Brotherhood, 1984; Duester *et al.*, 1986). These low reported energy intakes have been associated with marginal intakes of several important nutrients such as calcium, iron and vitamins. The low energy intakes reported by researchers have also been related to eating disorders and tendencies towards eating disorders that have been found to be prevalent among female athletes (Sundgot-Borgen, 1994). The prevalence of eating disorders is higher in athletes of sports such as gymnastics and running where leanness is emphasized.

In Greece, although there has been a long interest in sports, information about dietary practices and nutritional status of athletes today is scarce. The present study aimed to examine anthropometric characteristics and to assess dietary intakes and energy balance of elite female athletes over a long period. Women athletes from four different sports (volleyball, middle distance running, ballet dancing and swimming) participated in the study as well as a non-athletic control group. Data were collected over the competitive as well as the non-competitive seasons for all athletes.

Methodology

Subjects

Women athletes were recruited on a volunteer basis from four athletic teams in Thessaloniki. The control group was students at the Technological Educational Institution of Thessaloniki.

The final sample consisted of 35 athletes (eight volleyball players, 11 middle distance runners, nine swimmers and seven ballet dancers) aged 18–26 years and 10 controls aged 18–25 years.

Data were collected twice over the non-competitive (training) and the competitive seasons of the athletic teams. In the non-competitive season athletes were practising but not competing, whereas during the competitive period athletes were both practising and competing in events.

Ballet dancers reported practising 1.5–2 h per day during the non-competitive season and 3 h per day during the competitive season plus performance time. Swimmers practised 2–3 h per day during the non-competitive season and 0.5 h during the competitive season plus competition time. Runners had 2–3 h of practice during the non-competitive season and 1 h during the competitive season, whereas volleyball players reported practising 2–4 h per day during the non-competitive season and 1.5–3 h per day (one or two training sessions) plus competition in games during the competitive season.

Anthropometric data

Height was measured to the nearest centimetre and weight was recorded to the nearest 0.1 kg with a portable metric scale that was calibrated daily. Weight was measured twice during the non-competitive and the competitive seasons. Body mass index (BMI; wt/ht^2) was calculated for all athletes.

Per cent body fat was determined in both seasons, using skinfold measurements. Four skinfolds were taken, triceps, abdomen, suprailliac and thigh. Body density was calculated using the formula of Jackson *et al.* (1980). Body density was converted to per cent body fat using the Siri equation (McCardle *et al.*, 1994). Fat-free mass was computed by subtracting the value for fat mass, from body weight.

Dietary intake

All subjects kept weighed dietary records for seven consecutive days. A total of 14 records were collected, seven for the non-competitive and seven for the competitive seasons. Subjects had to weigh, according to instructions given to them, all foods and drinks consumed during the day. Scales were provided to the athletes as well as cups and plates with known weight. Dietary intakes were analysed using the Microdiet computer program. Foods were coded using McCance and Widdowson's food tables. Greek food recipes were added in the basic database according to Trichopoulou (1992).

Energy balance

Energy intake was calculated from the dietary data records. Data for energy expenditure were collected through the use of activity records. Seven-day activity records were kept in parallel to the diet records, twice, during the non-competitive and competitive seasons. Athletes were provided with forms for recording information and were given written and oral instructions on how to record activities. All activities were converted to their caloric equivalent using the tables proposed by Ainsworth *et al*. (1993).

Resting metabolic rate (RMR) for all athletes and controls was calculated using the equation of Owen *et al*. (1986). Energy balance was calculated by subtracting calculated energy expenditure from reported energy intake. All the results were statistically analysed using the SPSS computer program.

Results

Table 1 shows the anthropometric characteristics of the athletes and controls. There were no statistically significant differences found for BMI between athletes of different sports, or between athletes and controls. Volleyball players were taller and heavier, followed by swimmers, whereas middle distance runners and ballet dancers were shorter and weighed less. Middle distance runners had the lowest per cent body fat. Athletes had significantly lower per cent body fat when compared with controls. After comparing the two seasons it was shown that athletes, in total, decreased their weight, per cent body fat and BMI although these changes were not statistically significant.

Table 2 shows the results for energy and macronutrient intakes. Volleyball players increased their energy intakes in the competitive season. No significant difference in energy intake was found for all other sports between the two seasons. Furthermore, no statistically significant differences were found between the athletes and the controls in both seasons.

Energy expenditure was significantly higher for athletes vs. controls. The highest mean calculated energy expenditure was found for swimmers in both seasons. When looking at individual athletes, only two out of the 12 middle distance runners were on energy balance in both the non-competitive and the competitive season. None of the volleyball players was on energy balance during the non-competitive season but all of them increased their energy intake during the competitive season and six of them were found to be on energy balance during this period. Six of the eight participating swimmers were in energy balance during the non-competitive season and only two during the competitive season, whereas one ballet dancer was on energy balance during the non-competitive season and two during the competitive season. The above results show that most athletes were on negative energy balance during both athletic seasons. All athletic groups, with the exception of volleyball players in the competitive season, were in negative energy balance. No statistically significant difference was found for controls, between energy intake and expenditure in both seasons.

Macronutrient intakes are also given in Table 2. This shows that 44.2–52.7% of energy comes from carbohydrates. The lowest carbohydrate intake was found for the ballet dancers and the highest for the volleyball players in the training period. Protein

Table 1 Anthropometric characteristics of the athletes and controls

Athletic team	Age (years)	Height (cm)	Weight (kg)		% Body fat		BMI	
			Training	Competition	Training	Competition	Training	Competition
Volleyball players	21.5 ± 2.3	177.5 ± 6.2	64.6 ± 5.5	65.3 ± 5.6	19.4 ± 3.4	19.7 ± 3.7	20.5 ± 1	20.6 ± 1.2
Middle distance runners	22.7 ± 2	163.5 ± 8.1	53.8 ± 6	53.7 ± 6.8	14.3 ± 2.7	13.5 ± 2.7	20.3 ± 1.3	19.9 ± 1.3
Ballet dancers	22.5 ± 2.3	163 ± 5.2	54.5 ± 3.9	51.5 ± 4.8	18.6 ± 2.5	17.8 ± 3.6	20.1 ± 1.3	19.7 ± 1.3
Swimmers	18.5 ± 1.1	171 ± 5.1	62 ± 5.9	61.3 ± 5.6	19.1 ± 3.5	18.9 ± 2.9	21.2 ± 1.8	21.1 ± 1.8
Total (all athletes)	21.1 ± 2.6	168.7 ± 8.4	59.1 ± 7	57.8 ± 7.9	17.8 ± 3.7	17.3 ± 3.9	20.6 ± 1.5	20.3 ± 1.5
Control group	22.1 ± 2.1	159.6 ± 5.3	53.3 ± 3.7	51.8 ± 3.2	23.5 ± 3.4	24.1 ± 4.2	20.7 ± 1.2	20.2 ± 1.2

Table 2 Energy and macronutrient intakes of athletes and controls in the two athletic seasons

Sports activity	Energy intake (kcal)		Energy expenditure (kcal)			Proteins		Carbohydrates		Fat	
	Training	Competition	Training	Competition		Training	Competition	Training	Competition	Training	Competition
Volleyball players	1541 ± 311	2346 ± 766	2211 ± 191	2396 ± 190	g	53 ± 11	74 ± 16	195 ± 33	294 ± 104	65 ± 22	104 ± 43
					%	13.7 ± 1.5	13.2 ± 1.9	51.3 ± 7	50 ± 6.3	37.2 ± 6.2	39.3 ± 6.6
Middle distance runners	1816 ± 549	1679 ± 546	2159 ± 284	2188 ± 239	g	65 ± 17	58 ± 16	218 ± 77	217 ± 80	80 ± 27	70 ± 27
					%	14.6 ± 2.7	14 ± 2.1	48.4 ± 7.4	51.3 ± 8.3	39.5 ± 5.7	37.7 ± 6.8
Ballet dancers	1701 ± 580	1506 ± 468	2344 ± 126	2221 ± 254	g	68 ± 16	51 ± 13	168 ± 65	199 ± 77	78 ± 35	62 ± 30
					%	16.7 ± 2.7	13.9 ± 2.5	44.2 ± 7.6	52.7 ± 12.5	40.6 ± 7.3	36.6 ± 10.8
Swimmers	2015 ± 542	1890 ± 709	2520 ± 304	2550 ± 210	g	78 ± 20	74 ± 29	236 ± 68	237 ± 106	91 ± 29	78 ± 24
					%	15.6 ± 2.4	15.6 ± 1.9	47 ± 7.4	49 ± 5.4	40.2 ± 6.7	38.4 ± 4.9
Total	1816 ± 537	1868 ± 681	2311 ± 340	2338 ± 362	g	68.3 ± 19.3	64.5 ± 21	213 ± 66	239 ± 95	81.4 ± 30	78.8 ± 34
					%	15.3 ± 2.5	14.2 ± 2.2	47.4 ± 7.5	50.8 ± 8.2	39.6 ± 6.4	38 ± 7.2
Control group	1700 ± 493	1558 ± 508	1829 ± 112	1633 ± 32	g	61 ± 21	61 ± 23	188 ± 50	170 ± 44	80 ± 29	72 ± 29
					%	14.2 ± 1.8	15.5 ± 1.8	45 ± 7	45 ± 6.5	41.6 ± 5	40.2 ± 4.4

intakes ranged from 13.2 to 16.7% of energy intakes. Volleyball players increased their protein intakes in the competitive season, whereas ballet dancers decreased it. The highest protein intake was found for swimmers in the training season. Fat intake ranged from 36.6 to 41.6% of energy intake. Only volleyball players increased their fat intake in the competitive season. No statistically significant differences were found in the macronutrient intakes between athletes and controls.

The micronutrient intakes of individual teams and controls in the training and the competitive seasons are shown in Table 3. Mean micronutrient intakes are above the recommended values (Department of Health, 1991) with the exception of iron. Iron intakes were low for all teams and controls. It should be noted that athletes and controls had a very high intake of vitamin C that is a characteristic of the population of Mediterranean countries.

Discussion

In the present study the dietary intakes of females athletes, of four different athletic teams, have been determined. The study was carried out in two seasons, the training and the competitive. Anthropometric measurements were carried out for all athletes. The mean training and competitive measures of BMI were in the range of 20–25 considered to be desirable for adult females (Lee & Nieman, 1993). The mean per cent body fat, obtained from skinfold measurements, for both athletes and controls were in the range of 16–24% considered to be optimal for women (Lee & Nieman, 1993). All athletes had lower per cent body fat compared with the control group. Per cent body fat varied greatly between athletes. Middle distance runners had the lowest per cent body fat (14.3 ± 2.7) whereas volleyball players had the highest (19.4 ± 3.4). Body weight decreased from the training to the competitive season for athletes. This is in accordance with the negative energy balance observed for most subjects.

The mean energy intakes of teams varied from 1541 ± 311 kcal for volleyball players to 2015 ± 542 kcal for swimmers in the training period and from 1506 ± 468 kcal for ballet dancers to

Table 3 Vitamin and mineral intakes of the athletes and controls in the two athletic seasons

	Volleyball players		Middle distance runners		Ballet dancers		Swimmers		Control group	
	Training	Comp.	Training	Comp.	Training	Comp.	Training	Comp.	Training	Comp.
Vitamin A (μg)	894 ± 192	995 ± 114	961.8 ± 560	975 ± 952	937.4 ± 662	995 ± 814	1134 ± 180	1273 ± 130	873 ± 646	900 ± 499
Thiamin (mg)	1.2 ± 0.4	1.6 ± 0.6	1.1 ± 0.3	1.2 ± 0.4	1.1 ± 0.2	1.1 ± 0.2	1.4 ± 0.5	1.3 ± 0.8	1.4 ± 0.3	1.2 ± 0.3
Vitamin B2 (mg)	1.4 ± 0.4	2 ± 0.4	1.4 ± 0.4	1.8 ± 0.6	1.4 ± 0.5	1.5 ± 0.3	1.9 ± 0.8	2.2 ± 1.5	1.4 ± 0.5	1.4 ± 0.8
Folic acid (μg)	219 ± 35.5	247 ± 45	206 ± 18.5	195 ± 54	244 ± 42	220 ± 86	275 ± 101	201 ± 164	202 ± 36	217 ± 34
Fe (mg)	14.2 ± 1.6	14.8 ± 3.2	11.4 ± 3	13.8 ± 3	12.6 ± 2.9	11.4 ± 2.7	14.5 ± 3.8	13.2 ± 5.6	10.3 ± 2.1	11.2 ± 28
Ca (mg)	838 ± 199	1272 ± 406	876 ± 341	878 ± 252	958 ± 312	832 ± 293	1063 ± 287	1149 ± 475	814 ± 269	877 ± 346
Vitamin C (mg)	109.7 ± 43	120.4 ± 25	98.3 ± 60.7	100.2 ± 57	101.8 ± 58.1	110.4 ± 62	134.5 ± 81.8	120.2 ± 64	64.2 ± 32.7	82.4 ± 40

2346 ± 766 kcal for volleyball players in the competitive season. These values fall within the range of 1600–2400 kcal reported as energy intakes of female athletes by other investigators (Duester *et al.*, 1986; Barr, 1987; Edwards *et al.*, 1991). It should be noted though that in this study a large variation was found in energy intakes between athletes. Energy intakes for individual athletes ranged from 1293 to 2373 kcal in the training season and from 1528 to 2760 kcal in the competitive season. No significant difference has been found between energy intakes of athletes and controls, although the energy expenditure of athletes was significantly higher.

Calculated energy expenditure was higher from the reported energy intakes for most athletes. This discrepancy between energy intake and energy expenditure in female athletes has been reported by investigators in other countries (Mulligan & Butterfield, 1990; Myerson *et al.*, 1991). Athletes tended to lose weight, but the reported weight loss was not great enough to explain the discrepancy in energy balance. It should be noted that the athletes with the lowest energy intakes (< 1800 kcal) reported menstrual abnormalities. Chronic energy deprivation has been shown in many studies to be one of the strongest factors contributing to menstrual dysfunction (Williams *et al.*, 1995; Dueck *et al.*, 1996a). In studies on energy balance, energy deficits in amenorrheic athletes have ranged from − 148 to − 881 kcal day^{-1} (Dueck *et al.*, 1996b; Kopp-Woodroffe *et al.*, 1999).

Another explanation can be found, in the errors inherent in the methodology for assessing food intake and for estimating energy expenditure. One of the main errors associated with diet records is under reporting of food intake (Schoeller, 1983; Mertz, 1992). Under reporting can occur because subjects fail to record portions of food correctly, omit foods eaten or restrict their food intake during the study period. Edwards *et al.* (1991) believe that under reporting may be unconscious and may be related to perceived body image.

Furthermore, it should be mentioned that energy expenditure has been calculated based on equations for RMR and activity records and it has not been accurately measured. This is a limitation of the method used and a factor that may have influenced the accuracy of the results found.

It is generally recommended that athletes should consume a diet rich in carbohydrates (~60% of energy) and low in fat (~30% of energy intake). None of the athletic teams that participated in this study met these recommendations. In order to do so, they should increase their carbohydrate intake and decrease their fat intake. It is also recommended that female athletes should consume 1.0 g protein per kg of body weight (Economos, 1993). All teams with the exception of volleyball players in the training period met this recommendation.

Although the diets of the athletes were low in energy, they appeared to be fairly dense in vitamins. This is mainly due to the high intake of vegetables and fruits, which is a characteristic of the Mediterranean diet.

The only nutrient found to be consumed in amounts less than RDA was iron. Women athletes are very vulnerable to iron deficiency due to increased iron losses through sweat and menstruation. Many scientists have reported low iron intakes and anaemia in female athletes (Newhouse & Clement, 1988).

In conclusion, the four teams of women athletes that participated in this study were not in energy balance in both athletic seasons studied, the training and the competitive, and their energy, macronutrient and micronutrient intakes were not statistically different from those of the non-athletic control group. The study showed that there is a need for providing nutritional information to the athletes in Greece in order to improve their diet and consequently their athletic performance.

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