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THE EVALUATION OF NUTRITIONAL HABITS AND NUTRITIONAL STATUS OF FEMALE ATHLETES USING AND NOT USING NUTRITIONAL SUPPLEMENTS

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Abstract

Introduction and aim of study: In recent years, supplement use among female athletes has increased. The aim of this study was to evaluate differences in nutritional habits, body composition, blood parameters, serum iron, and serum ferritin levels, between female athletes using and not using nutritional supplements.

Material and methods: Fifty-eight female athletes (8 rowers, 8 basketball, 16 triathlon athletes, 18 synchronized swimmers, 2 swimmers, 6 kayakers) aged 18.0 ± 2.0 y, with training periods of 5.9 ± 2.7 y and BMIs of 20.5 ± 1.5 kg/m^2, participated in the study. Each subject filled out a questionnaire that was used to assign participants to two groups (using supplements US, or not using supplements NS). Nutritional status was evaluated based on the analysis of body composition using the BIA method, yielding the percentage of adipose tissue (FM) and the fat free mass (FFM). Total Energy Expenditure (TEE) was evaluated using the HR-Flex method. Nutritional habits were estimated through the administration of 7 day dietary records and three-fold recall for the last 24 h. Moreover, hemoglobin, hematocrit, serum iron, and serum ferritin levels were measured.

Results: The US athletes reported significantly (P<0.05) longer exercise periods than NS athletes. The US athletes were characterized by significantly (P<0.05) lower serum iron and serum ferritin levels compared to NS athletes.

Conclusions: The use of supplements is highly prevalent in female athletes, and is associated with nutritional habits and nutritional status.

***Key words**: nutritional status, nutritional habits, supplements, female athletes*

Introduction

In recent years, women have increased their participation in sports at all levels [1,2]. Exercise and athletic training are considered to increase energy and nutrient needs [1,3]. Several studies have shown that young female athletes do not have adequate, properly balanced diets [1,4]. Manore [5] took notice from female athletes' undernutrition and B-group vitamin deficiencies, as well as their inadequate iron and zinc intake. Heaney et al. [6], who analyzed the nutritional habits of elite female athletes, concluded that athletes' diets are not properly balanced for folate, calcium, iron and magnesium intake. Cupisti et al. [7] also recorded similar results. Inadequate nutritional habits, nutrient deficiencies and prolonged negative energy balances can lead to many serious medical consequences, such as anemia or iron deficiency, dysfunction of the menstrual cycle or premenopausal osteoporosis [4]. In the literature, the so-called "female athlete triad" has been described, defined as disordered eating (especially inadequate energy balance), coupled with amenorrhoea and osteoporosis [2,8]. Many studies suggest that female athletes take nutritional supplements with the intention of preventing deficiencies in their daily diets and enhancing performance [9]. In addition, prevention of illness, the taste of the supplements, and obtaining the goal of improved nutritional status were also frequently cited reasons for supplement use among young female athletes [10].

Moreover, studies on supplement use in the general population and among young athletes tend to report that women are more likely to consume supplements than are men [11]. In a review study by Ziegler et al. [10], supplements are used by 55% of elite figure skaters. Froiland et al. [12] suggested that as many as 89% of female athletes use different supplements.

The aim of this study was to evaluate the differences between nutritional habits, body composition, hematological profiles, serum iron and serum ferritin levels in female athletes using and not using supplements.

Material and methods

Fifty-eight female athletes (8 rowers, 8 basketball players, 16 triathlon athletes, 18 synchronized swimmers, 2 swimmers, 6 kayakers) from different sports clubs in Poznań, aged 18.0 ± 2.0y, volunteered for this study. Participants had a minimum 2 of years training experience, with an average of 5.9 ± 2.7 y, with a mean daily exercise period of 3.8 ± 1.2 h. Each subject filled out a questionnaire covering eating habits, sport practiced and body image perception. This study was approved by the Bioethics Committee at the Karol Marcinkowski University of Medicine in Poznan (No. 334/09).

Nutritional status was evaluated based on anthropometrical indices: (height, weight and BMI) using an anthropometer coupled with a WPT 200 OC verified medical scale (Rad Wag). Participants were dressed in minimal clothing during the measurements, which were recorded accurate to 0.5 cm and 0.5 kg, respectively. The mean of three measurements was used as the representative value. Analysis of body fat mass (FM) and fat-free mass (FFM) was performed using a BODYSTAT 1500 after an overnight fast, with subjects lying in a supine position [13]. The measurements were conducted in the morning hours.

Total Energy Expenditure (TEE) was evaluated by the HR-Flex method, using a heart-rate monitor (Polar Sport Tester, RS 400, Finland) for two days [14]. For each subject, the relationship between HR and $\dot{V}O_2$ was established. Measurements were carried out more than 2 h after meals, and with the subject having rested for 30 minutes after arriving at the laboratory. Results were obtained by simultaneous measurement of HR and $\dot{V}O_2$ for the following activities carried out sequentially: lying in supine position, sitting quietly, standing quietly, continuous graded exercising on a treadmill and a cycle ergometer. After preliminary editing to remove spurious HR data, total energy expenditure (TEE) was calculated from HR using the HR-Flex method, which has been fully described by Kostrzewa-Tarnowska and Jeszka [15]. This method requires the definition of a so-called HR Flex for each subject: above this level there is a good correlation between HR and $\dot{V}O_2$, but below which correspondence between the two parameters is poor. The HR-Flex HR was calculated as the mean of the highest HR for the resting activities (supine, sitting and standing) and the lowest HR of the exercise activities [15].

Dietary records of 7 consecutive days were obtained under the supervision of dieticians. All meals (including cooking recipes and weight of items) and nonmeal foods, beverages, and fluids were recorded in a diary form. The three-fold recall for the last 24 h was carried out to verify the data from the dietary records. The daily diets (including these data) were analysed for their energy and nutrient levels using the *Dietetyk* computer software package, based on Polish food composition tables [16].

Serum iron and ferritin were analyzed, using a commercially available radioimmunoassay kit (Roche, Switzerland), with a Cobas Mira analyzer. Haematocrit (Ht) values were determined using the microhematocrit method and hemoglobin (Hb) levels and erythrocyte number (E) were measured using the cyanmethemoglobin colorimetric method outlined in the Sigma assay kit (Sigma Diagnostics). Blood samples were taken in the morning (07.00–09.00), before the first meal.

Statistical analysis

Statistical analyses were performed using the STATISTICA program, version 8.0, by StatSoft, Inc. (2008). Comparisons between groups were carried out using an independent t-test. The hematological indices were compared to the standard values [17], using also an independent t-test. A *P* value of less than 0.05 was considered significant.

Results

Athletes were allocated into two groups. One consisted of those female athletes (n = 38) who in the questionnaire had given a positive reply to the question of intake supplements (US). The other group consisted of athletes (n = 20), who did not add supplements to their daily diets. Moreover, all of the subjects admitted that they hadn't consulted a physician or dietician about their choice of supplements.

The most used supplements were multivitamin complexes (73.6% of supplements reported), Branch Chain Amino Acids (BCAA) (47.3%), whey protein (39.5%), L-carnitine (34.2%), β-Hydroxy-β-Methylbutyric acid (HMB) (23.7%), omega-3 fatty acids (15.8%) and creatine (15.8%) (Figure 1).

There were no significant differences between the groups in anthropometric parameters and body composition. Significant differences between groups in daily exercise periods (US: 4.5 ± 1.3 h per day, NS: 3.5 ± 1.0 h per day, $P<0.05$) and TEE (US: 12.8 ± 1.8 MJ, NS: 10.3 ± 1.4 MJ, $P<0.05$) were found (Table 1).

Moreover, significant differences in energy, protein and carbohydrate intake between groups (energy: US 11.4 ± 2.1 MJ, NS 9.9 ± 2.3 MJ, protein: US 93.1 ± 22.4 g, NS 79.6 ± 17.6 g, carbohydrate: US 350.4 ± 76.9 g, NS 300.5 ± 76.4 g, $P<0.05$) were found. Apart from that, the diets of the NS athletes were significantly better for intakes of vitamin A and folate intake (vitamin A: US 1094 ± 468 μg, NS 1415 ± 322 μg, folate: US 197.4 ± 71.1 μg, NS 216.9 ± 40.2 μg, $P<0.05$). Moreover in NS athletes, a tendency towards higher intakes of calcium, iron, vitamin B_{12}, and vitamin C were observed, but the differences between the groups were not significant (Table 2).

In the US athletes, a tendency towards an increase of negative energy balance was observed (US -1.4 ± 0.5, NS -0.4 ± 0.4, $P<0.05$) (Table 2).

There were significant differences between serum iron and serum ferritin levels of the female athletes. The US athletes were characterised by lower serum iron and serum ferritin levels compared to NS athletes (serum iron: US 58.9 ± 28.8 μg/dl, NS 105.2 ± 45.3 μg/dl, serum ferritin: US 19.4 ± 7.9 ng/ml, NS 24.1 ± 2.1

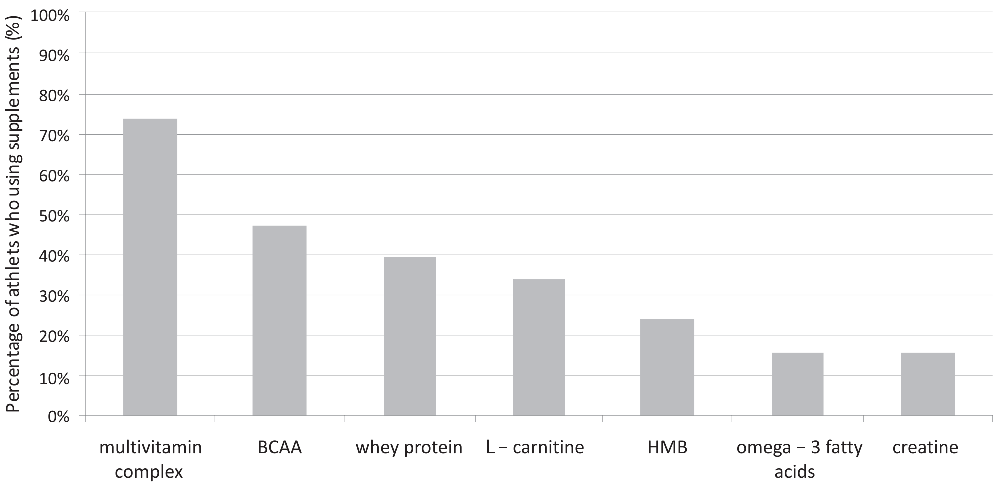

Figure 1. *Supplement use reported by supplements using athletes (n = 38)*

Table 1. *Characteristics of female athletes*

	All (n = 58)	US (n = 38)	NS (n = 20)
Age (y)	18.0 ± 2.0	18.9 ± 1.8	17.6 ± 2.3
BMI (kg/m²)	20.5 ± 1.5	20.9 ± 1.5	20.4 ± 1.5
Fat mass FM (%)	20.4 ± 4.0	19.7 ± 4.0	20.2 ± 4.0
Fat mass FM (kg)	11.7 ± 3.4	11.6 ± 1.9	11.8 ± 2.6
Fat free mass FFM (%)	80.0 ± 4.0	80.3 ± 4.0	79.8 ± 4.0
Fat free mass FFM (kg)	48.0 ± 5.2	47.7 ± 7.1	48.2 ± 3.9
Total body water TBW (%)	53.7 ± 3.4	54.9 ± 2.1	53.1 ± 3.9
Total body water TBW (l)	32.3 ± 3.0	32.6 ± 4.4	32.1 ± 2.0
Training period (y)	5.9 ± 2.7	6.9 ± 2.4	5.5 ± 2.8
Daily exercise period (h/d)	3.8 ± 1.2	4.5 ± 1.3*	3.5 ± 1.0*
TEE (MJ/d)	11.7 ± 1.7	12.8 ± 1.8*	10.3 ± 1.4*

* $P<0.05$

Table 2. *Energy and nutrient intake in female athletes*

	Recommendations [18]	All (n = 58)	US (n = 38)	NS (n = 20)
Energy (MJ)	–	10.4 ± 2.4	11.4 ± 2.1*	9.9 ± 2.3*
Energy balance (MJ/d)	–	-1.3 ± 0.5	-1.4 ± 0.5*	-0.4 ± 0.4*
Protein (g)	1.2 – 1.7 g/kg/d	84.4 ± 20.3	93.1 ± 22.4*	79.6 ± 17.6*
Fat (g)	1.0 g/kg/d	97.6 ± 26.4	105.4 ± 16.6	93.3 ±29.8
Carbohydrate (g)	min 5-10 g/kg/d	318.3 ± 79.6	350.4 ± 76.9*	300.5 ± 76.4*
Calcium (mg)	1000 - 1300	875 ± 284	869 ± 290	879 ± 285
Phosphorus (mg)	700 - 1250	1426 ± 346	1525 ± 374	1370 ± 321
Magnesium (mg)	400 – 410	324.0 ± 87.9	341.7 ± 73.3	314.2 ± 93.7
Iron (µg)	15 – 18	12.1 ± 3.0	11.9 ± 3.1	12.5 ± 2.9
Zinc (µg)	8 – 9	11.3 ± 3.3	11.9 ± 3.3	11.1 ± 3.3
Vitamin A (µg)	700	1301.2 ± 251.2	1094 ± 468*	1415 ± 322*
Vitamin D (µg)	5	2.4 ± 1.5	2.5 ± 1.4	2.4 ± 1.6
Vitamin E (mg)	15	10.1 ± 4.4	10.2 ± 2.5	10.1 ± 5.1
Folate (µg)	400	207.2 ± 64.3	197.4 ± 71.1*	216.9 ± 40.2*
Vitamin B_{12} (mg)	2.4	4.6 ± 4.7	3.9 ± 1.4	5.0 ± 5.7
Vitamin C (mg)	65 – 75	82.0 ± 49.6	76.8 ± 59.6	91.5 ± 20.7

* $P<0.05$
** BEE – Basal Energy Expenditure
***PAL – Physical Activity Level

Table 3. *Hematological profiles and serum iron and ferritin levels in female athletes*

Parameters	All (n = 58)	US (n = 38)	NS (n = 20)
Erythrocytes (3.70 – 5.10 mln/μl)	4.57 ± 0.28	4.51 ± 0.20	4.63 ± 0.31
Hemoglobin (12.0 – 16.0 g/dl)	12.9 ± 1.2	13.0 ± 0.5	12.9 ± 1.5
Hematocrit (37 – 47%)	39.3 ± 2.2	38.9 ± 1.3	39.6 ± 2.6
Serum iron (60 – 200 μg/dl)	82.1 ± 43.6	58.9 ± 28.8*	105.2 ± 45.3*
Serum ferritin (30 – 120 ng/ml)	21.8 ± 16.8	19.4 ± 7.9*	24.1 ± 2.1*

* $P<0.05$

ng/ml, $P<0.05$). Besides, results of serum iron and ferritin levels in US athletes indicated iron deficiency (Table 3).

Discussion

A study commissioned by UK Sport showed that supplement use is predominant among high-performing adult UK athletes (62%), with an average of 3.22 supplements used per athlete [19]. In other British studies, only 48.1% of emerging UK elite athletes reported that they used supplements, with an average of 2.96 supplements being used [20]. In comparison, in the present study 65.5% of female athletes reported that they took supplements, with an average of 1.9 supplements being used.

Our data clearly show that the use of supplements is associated with the daily exercise period in female athletes. It seems that female athletes, being aware of increased energy and nutrient needs resulting from a higher amount of training, take supplements in order to decrease nutritional deficiencies. A similar hypothesis was formulated by Ziegler et al. [10], that one of the major causes of supplementation was the intention to supplement dietary deficits resulting from increased energy and nutrient requirements at an increased level of physical activity. Unfortunately, in view of the size of TEE, the daily diets of female athletes taking supplements turn out to be inadequately balanced in terms of the supply of energy and of many nutrients. The opposite result was obtained by Szczepańska et al. [21]. In athletes using supplements, higher levels of energy and nutrient intake were observed, significantly exceeding the recommended values.

This study was not only limited to a comparison of nutritional habits in athletes included into two groups, but was also focused on a comparison of the nutritional status between athletes. In this study, similar values of anthropometric parameters were found, including comparable body fat percentages – this despite high percentage of supplements that are supposed to reduce fat mass (e.g. L-carnitine and HMB). These results are similar to those reported by Green et al. [22] and O'Connor et al. [23], and confirm that such supplements have an insignificant influence on body composition in athletes. Moreover, Petróczi et al. [20] showed that there was no effect on performance or physical strength from using supplements such as whey protein.

Concerning the nutritional status of athletes, higher iron status and serum ferritin levels were observed in athletes not using supplements. Moreover, the data of blood parameters in US athletes indicate a serious threat of iron deficiency and it consequently show that inadequate eating habits influence blood parameters. Chatard et al. [24] also observed that there was a significantly higher risk of anemia in athletes using supplements, in comparison to athletes using only adequately balanced daily diets as a preventative measure against iron deficiency and anemia. Furthermore, based on these results, it can be supposed that the choice of supplements by female athletes is not appropriate, and athletes should consult their physician, dietician, and coach on the subject of supplement choice in order to improve their blood parameters and physical performance.

Conclusion

The use of supplements is highly prevalent in young female athletes and is associated with nutritional habits and nutritional status. The results of this study emphasize the need to provide nutritional education. However, it is very important for young athletes, their parents, and their coaches to realize that even the most popular supplements are not adequate substitutes for good nutritional habits. Athletes must be able to make a sound decision based on knowledge and after consulting an expert.

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