Medicina Sportiva, Vol. 11 (4): 119-123, 2007
DOI: 10.2478/v10036-007-0023-1


# DAILY INTAKE OF MACRONUTRIENTS AND SELECTED MINERALS IN PHYSICALLY ACTIVE FEMALE STUDENTS IN COMPARISON WITH MALES OF MATCHED AGE AND PHYSICAL ACTIVITY

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## Abstract

**Lutosławska G, Malara M, Mazurek K, Czajkowska A.** Daily intake of macronutrients and selected minerals in physically active female students in comparison with males of matched age and physical activity. *Med Sport* 2007, 11(4): 119-123.

**Introduction:** Many female sportsmen have sub optimal energy and nutrient intakes and are at risk on compromised nutritional status. Physical education female students are highly active due to study program, which includes different sports (gymnastics, swimming, track and field). In addition, at least some of them are engaged in specific sports at the club level. However, their dietary habits were not studied.

**Aim of the study:** This study was undertaken to analyze daily intakes of energy, macronutrients and selected micronutrients (iron, copper and zinc) in male and female physical education students of matched physical activity.

**Methods:** In all subjects daily intake of energy, macronutrients, iron, copper and zinc was briefly assessed from 24 h food records taken over 4 days (2 week days and weekend) and analyzed using a computer program FOOD 2.

**Results:** In 84.5% of females and in 67.5% of males inadequate energy intake was noted. In females 52.3% of all participants were at risk of iron deficiency, 94.4 % were at risk of copper deficiency and 25.7% were characterized by inadequate zinc daily intake. The respective values in males were 0.8%, 69.9 % and 12.2% of all subjects.

**Conclusions:** High percent of females in our study were characterized by inadequate total energy intake vs. recommended for highly active women. The percent of males consuming inadequate amount of energy was lower than females. In consequence the risk of iron, copper and zinc deficiency in active females was higher than in males. However, high risk of copper deficit in the diet was noted in both sexes.

***Key words**: males, females, physical activity, diet, minerals*

## Introduction

It is well documented that nutritional demands of the body are determined by age, sex and physical activity (1). At present there is no doubts that dietary habits may affect performance and numerous studies have focused on dietary needs of elite sportsmen engaged in exhausting, high volume training and competition (2,3).

On the other hand, there is a wealth of data indicating that female athletes due to pressure to lose weight practice unhealthy weight-control methods, mainly restricted food intake, but also diet pills or appetite suppressant (4). In consequence, many female sportsmen, particularly those who participate in sports that emphasize leanness (distance running, figure skating, gymnastics), have suboptimal energy and nutrient intakes and are at risk of compromised nutritional status (5-7). This unhealthy eating practices result in low body fat content, but also bring about menstrual disturbances, decreased bone mineral density and impaired immune function (8-10).

However, even in sports, which do not focus on low body fat energy intake in female athletes, failed to meet the recommendation (11-13).

According to Torsveit and Sundgot-Borgen (14) disordered eating habits, low bone mineral density and menstrual dysfunction are observed in 12.4-15.2% of young normally active females, but are more frequent (up to 26.9 % of all participants) in high-performance female athletes.

As a result of inadequate energy intake females frequently face the deficiency of minerals. It is well documented that the prevalence of iron deficit is likely to be higher in athletic groups, especially in young female athletes, than in healthy sedentary individuals (15,16).

However, it should be stressed that limited energy intake results also in inadequate other minerals supply. Lukaski et al. (17,18) have indicated that the mean copper intake in female club level swimmers covered only 52% of the safe intake level. Similarly low daily copper intake has been reported in females engaged in different endurance sports at international and national level (12). In addition, in the cited studies copper to zinc ratio in the diet was high (8.0-8.7) suggesting depressed copper absorption (19).

Taking into account substantial role of copper in iron absorption it seems likely that low copper intake concomitantly with unfavorable zinc to copper ratio even further disturb iron homeostasis (20).

On the other hand, despite energy and minerals deficiency in the diet micronutrient status in female athletes appeared relatively unaffected, probably due to their regular use of supplements (21). In contrast, about 20% of young sedentary females not taking supplements were recognized iron deficient without anemia (22). The percent of iron deficiency was even higher (36% of all participants) in recreationally active young women (23).

It is worthy to note that the above-mentioned hazardous dietary habits and its consequences are not limited to female athletes. Excessive dieting is common among young females who do not accept their body and are aimed at leanness (24-26).

Physical education students are highly active due to study program, which includes different sports (gymnastics, swimming, track and field). In addition, at least some of them are engaged in specific sports at the club level. However, their dietary habits were not studied.

Thus, this study was undertaken to analyze daily energy, macronutrients and selected micronutrients intake (iron, copper and zinc) in female and male physical education students of matched physical activity.

## Materials and Methods

### *Subjects*

A total of 232 subjects (123 males and 109 females) volunteered to participate in the study. All the subjects were healthy physical education students engaged in different sports (swimming, track and field, games). None of the participants were taking mineral supplements on the regular basis. All the women participating in the study reported regular menses and were not taking hormonal contraceptives. The subjects were informed about experimental procedure and gave their written consent prior to the participation. Study protocol was approved by the Ethics Commission in the University of Physical Education.

### *Dietary records*

In all subjects daily intake of energy, macronutrients, iron, copper and zinc was briefly assessed from 24 h food records taken over 4 days (2 week days and weekend) and analyzed using a computer program FOOD 2 purchased from the Institute of Food and Nutrition in Warsaw. A set of pictures of meals and foods were shown to the subjects by an experienced interviewer. The household measures of food intake were converted into gram weights. An interviewer assigned codes to the food reported by the participants and performed computer analysis. The mean daily intake of micronutrients in males and females were compared with the respective safe intake levels. Individual data of the daily intakes were compared with 2/3 of the respective safe intake levels. Subjects consuming daily less than 2/3 of the safe intake levels were recognized as being at risk of deficiency (27).

### *Statistical analysis*

Data distribution was tested using Shapiro-Wilk test. Normally distributed data were compared using unpaired Student t-test. Data that did not fit to normal distribution were compared using nonparametric Mann-Whitney test. The significance was set at $p<0.05$. Data are presented as mean ± SD. All the calculations were performed using Statistica v. 7.1 (StatSoft, USA).

## Results

Male and female subjects did not differ with respect to age and weekly physical activity (Table 1). The mean energy intake in females covered 71.9% and in males 88.4% of recommended intake for subjects with high physical activity (Table 2). The percent of energy derived from protein did not differ in male and female students. In contrast, the percent of energy derived from fat in males was significantly higher ($p<0.005$), but percent of energy derived from carbohydrates was significantly lower ($p<0.004$) than in female participants. In females the mean daily iron intake covered 67.8%, in males - 135 % of the safe intake level. The mean copper intake covered 40.0 % and 56.0 % of the safe intake level in females and males, respectively. In female participants the mean zinc daily intake covered 83.0%, in males 96.4% of the safe intake level. Zinc to copper ratio in the diet in males was markedly higher than in females ($p<0.001$). In female group 52.3% of participants were at risk of iron deficiency, 94.4 % were at risk of copper deficiency and 25.7% were characterized by inadequate zinc daily intake (Table 3). The respective values in males were 0.8%, 69.9 % and 12.2% . Nutritional density of iron and copper in males was lower than in females ($p<0.001$). No between sex differences were noted with respect to zinc nutritional density (Table 4).

Table 1. *Subjects characteristics (mean ± SD)*

| | Females (n=109) | Males (n=123) |
|---|---|---|
| Age (years) | 20.5 ± 1.4 | 21.1 ± 1.6 |
| Body mass (kg) | 60.4 ± 9.5 | 78.7 ± 10.9 |
| Body height (cm) | 168.6 ± 6.6 | 180.8 ± 6.0 |
| BMI | 21.2 ± 3.0 | 24.1 ± 2.7 |
| Activity (h/week) | 10.2 ± 3.8 | 9.0 ± 2.1 |

Table 2. *Daily intake of energy, macronutrients and minerals in male and female subjects (mean ± SD)*

| | Females (n=109) | Males (n=123) |
|---|---|---|
| Energy (kcal) | 1763 ± 568 | 2961 ± 769 |
| | (71.9)* | (88.4)* |
| Protein (g) | 60.7 ± 17.8 | 103.9 ± 30.8 |
| | (14.5 ± 2.7)** | (14.5 ± 8.3)** |
| Fat (g) | 68.0 ± 29.5 | 120.3 ± 39.2 |
| | (33.5 ± 7.0)** | (36.0 ± 6.0)** [a] |
| Carbohydrates (g) | 240.6 ± 77.3 | 383.6 ± 110.4 |
| | (52.0 ± 7.0)** | (49.5 ± 6.1)** [b] |
| Iron (mg) | 9.5 ± 2.8 | 14.8 ± 4.7 |
| | (67.8)^ | (135)^ |
| Copper (mg) | 1.0 ± 0.3 | 1.4 ± 0.4 |
| | (40.0)^ | (56.0)^ |
| Zinc (mg) | 8.3 ± 2.6 | 13.5 ± 4.0 |
| | (83.0)^ | (96.4)^ |
| Zn/Cu | 8.8 ± 1.8 | 10.1 ± 1.9[c] |

* percent of recommended intake; ** percent of energy derived from the respective macronutrient; ^ - percent of the safe intake level; [a] $p<0.005$ – significantly higher vs. females; [b] $p<0.004$ – significantly lower vs. females; [c] $p<0.001$ – significantly higher vs. females

Table 3. *Percent of subjects at risk of micronutrient deficiency*

| | Females (n=109) | Males (n=123) |
|---|---|---|
| Iron | 52.3 (57)* | 0.8 (1) |
| Copper | 94.4 (103) | 69.9 (86) |
| Zinc | 25.7 (28) | 12.2 (15) |

*- in brackets – number of subjects

Table 4. *Nutritional density (mg/1000 kcal) of iron, copper and zinc in the diet of male and female subjects (mean ± SD)*

| | Females (n=109) | Males (n=123) |
|---|---|---|
| Iron | 5.5 ± 1.2 | 5.0 ± 0.9[a] |
| Copper | 0.6 ± 0.1 | 0.5 ± 0.1[a] |
| Zinc | 4.9 ± 1.0 | 4.6 ± 0.9 |

[a] $p<0,001$ – significantly lower vs. females

## Discussion

Our study indicated that both female and male subjects consumed excess of protein providing 14,4 – 15,3 % of energy against recommended 10-11% (28). This is in agreement with others data which indicated too high protein intake in Polish adolescents and students (29,30). In addition, diet of our subjects contained too much fat providing more than 30% of total energy (31). It is worthy to note that similar fat intake have been found by Gilis-Januszewska et al. (32) in male and female Cracow residents aged 45- 64 years.

However, in the present study dietary habits of females were more favorable since the percent of energy from fat was slightly, but significantly lower and percent of energy from carbohydrates – slightly but significantly higher than in males.

It should be stressed that the percent of energy derived from carbohydrates in males of our study (less than 50%) was similar to that reported by Pardo et al. (33) for Warsaw residents aged 35-64 years. However, in both male and female subjects were lower than recommended (34).

Thus, it could be postulated that dietary habits of our subjects were typical for Polish population with excess of protein and fat and inadequate carbohydrate consumption.

The mean iron intake in females of the present study covered 67.8% of the safe intake level (14 mg/day) and was by 17% lower than reported in female adolescents and by 47% lower than in female medical students (35,36). However, the mean daily intake of iron in our females were similar to that reported by Poprzęcki et al. (37) in female endurance athletes with high incidence (62.5% of all subjects) of iron deficiency.

Taking into account high physical activity of our participants and their low daily iron intake it could be postulated that they are at risk of depleted iron stores in the body. This assumption was strengthened by the analysis of individual iron daily intake of our females indicating that 52.3% of all females were at risk of iron deficiency consuming daily less than 2/3 of the safe intake level. It is worthy to note that only one male subject consumed inadequate amount of iron in the diet (i.e. less than 2/3 of the safe intake level - 11 mg/day).

Both female and male participants were characterized by low copper intake since it covered only 40% and 56% of the safe intake level (2.5 mg/day) in females and males, respectively and was lower that reported by others in Polish students and adolescents (35,36), however was similar to that reported by Grooper et al. (38) in sedentary young females.

The risk of copper deficiency in females (94.4% of all women) was much higher than in males (69.9% of all men). On the other, hand it should be pointed out that in both males and females high zinc to copper ratio (>6.0) in the diet could adversely affect copper absorption contributing to the depletion of its stores in the body (19,39,40).

Moreover, potential copper deficiency due to inadequate intake in the diet and adverse effect of zinc excess may be detrimental for iron homeostasis.

It is well documented that in copper-deficient mice and rats pronounced disturbances in iron absorption was noted due to depressed activity of copper containing ferroxidases – ceruloplasmin and hephaestin (41,42).

The mean zinc intake in female students covered 83% of the safe intake level (10 mg/day), in males covered 96.4% of the safe intake level (14 mg/day) and was similar to that reported by Ball and Ackland (43) in young men and women. In consequence, the risk of zinc deficiency was observed in 25.7% of female and only in 12.2% of male participants consuming less than 2/3 of the respective safe intake level.

The above data indicated that physically active females are at greater risk of iron, copper and zinc deficiency in comparison with males of matched physical activity. However, it is worthy to note that nutritional density of iron and copper in females was greater than in males indicating that females consumed more of these elements per each 1000 kcal than their male counterparts. Thus, diet quality in females was more favorable than in males.

On the other hand, high percent of females in our study (84.5%) were characterized by inadequate total energy intake recommended for highly active women (2450 kcal/day) (1). Therefore it could not be excluded that they were on low caloric diets.

It should be stressed that among young Polish women aged 18.5-23.0 years about 60% are on low caloric diets to reduce body mass (44) and the same could not be excluded in female subjects of the present study.

Taking into account high physical activity of our subjects caloric restriction in active women may be hazardous for their health possibly resulting in the deficiency of essential micronutrients.

The frequency of too low caloric intake (less than recommended 3350 kcal/day) in male subjects of the present study was less than in females (67.5%) and in consequence they were characterized by lower risk of micronutrients deficit. However, both sex were at high risk of copper deficiency.

## Acknowledgment

This study was supported by the grant DS-77 and DS - 108 from the University of Physical Education in Warsaw

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Received: November 08, 2007
Accepted: December 24 , 2007
Published: December 31, 2007

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**Author's contribution**
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection