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THE EVALUATION OF NUTRITIONAL HABITS, NUTRITIONAL STATUS TRIATHLON'S WITH AND WITHOUT MENSTRUAL DISORDERS

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Abstract

Introduction: Meaning of regular physical exercise is generally estimated. However, currently to positive aspects of activities, professional sport can lead to serious healing disorders in women, especially in reproductive function. It has been provided that even 50% of female athletes suffer from hypothalamic menstrual disorders.

The aim of this study was to estimate differences in the nutritional status and daily diets of triathlon female athletes with and without menstrual disorders.

Material and methods: Twenty triathletes participated in the study. A questionnaire specially designed by the authors was used to assign athletes to two groups (regular cycle RC = 8, menstrual disorders MD = 12). The nutritional status was evaluated based on anthropometrical indices and analysis of body composition (percentage of adipose tissue [FM] and lean body mass [FFM]). Nutritional value was estimated by the 24-h dietary recall (record) method on 7 successive days. Total energy expenditure (TEE) was also estimated on the same days.

Results: Body fat mass were significantly lower in MD athletes in compared to the RC athletes. The MD athletes diets were not properly balanced for energy and several nutrients: calcium, iron, vitamin A, niacine, folate, vitamin C), while the RC group diets supplied enough energy, but it was unbalanced with regard to contents of iron, vitamin A, folate and vitamin C.

Conclusion: Unbalanced diets – negative energy balance, as well as low percentages of the adipose tissue in the body might contribute to menstrual disorders in female triathlon athletes.

Key words: *menstrual disorders, nutritional status, energy balance, female athletes*

Introduction

It has been very well documented that recreation physical activity is very important for obtaining a good psychophysical condition, but professional sport can led to many unfavourable health effects, especially in women [1-3]. In literature the so-called "*female athlete triad*" was described, defined as disordered eating, amenorrhoea and osteoporosis [1-4].

An abnormal menstrual cycle is generally attributed to an inhibition or dysfunction of the hypothalamic–pituitary–ovarian axis [1, 3, 5]. Disorders in pulse secretion of gonadoliberin (GnRH), lower luteinizing hormone (LH) and estrogen levels, stimulation of the hypothalamic–pituitary–adrenal axis, hypercortisolemia and hyperandrogenemia have been observed in professional athletes [1, 3, 5]. These studies showed that a combination of intensive exercise, especially started before puberty, a negative energy balance, undernutrition and stress as a inseparable factor of sport competitions might lead to menstrual disorders [4]. What is more, it is known that female athletes do not have sufficient knowledge on sport nutrition and they use inadequate dietary practice [4]. Disproportions between energy availability and energy expenditure, nutrient deficiencies, administration of laxative and dehydrating medicines or starvation can lead to an inadequate nutritional status, which can inhibit the reproductive function in women [4]. This problem assumes a special meaning in specific disciplines, which demand low body and fat mass. The frequency of menstrual disorders in different studies ranged from 3.7% to 80% and depended on the type of sports disciplines and the level of competition [1, 2, 6].

The aim of this study was to estimate differences in the nutritional habits and nutritional status of female triathlon athletes with and without menstrual disorders.

Material and Methods

Twenty female triathlon athletes from the Poznań Sports Club participated in this study. The inclusion criteria for the study were no use of any hormonal medications, including oral contraceptives, a minimum 3-year training period and a written consent form.

This study was approved by the Bioethics Committee at the Karol Marcinkowski University of Medicine in Poznan (no. 334/09).

A questionnaire was used to estimate the type of disorders in the menstrual cycle and to include ath-

letes to an adequate group. Questions asked for data on the characteristics of the menstrual cycle: age at menarche, duration of the menstrual cycle, duration of menstrual bleeding, non-appearance of menstruation, and painful menstruation. Athletes were also asked about their age at which they started training and daily exercise period. Athletes were included to two groups. The first included athletes with a regular menstrual cycle (RC: 10–12 menstrual bleeding in last years - *eumenorrhoea*), while the other comprised athletes with menstrual disorders (MD: *polymenorrhoea* – the appearance of menstrual bleeding more frequently than 21 days, *oligomenorrhoea* – the appearance of menstrual bleeding in a period of 35 days to 6 months, *amenorrhoea* - no regular menstrual cycles in a 3-month period if previous menstruation had been regular, or in a 6-month period if previous menstruation had been irregular) [2].

The nutritional status was evaluated based on anthropometrical indices (height, weight), using an anthropometer, coupled with a WPT 200 OC verified medical scale (Rad Wag) and BMI (kg/m^2) calculation. Participants were dressed in minimal clothing during the measurements, which were recorded accurate to 0.5 kg and 0.5 cm, 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 BODYSTAT 1500 with the subjects lying in a supine position, after an overnight fast [7]. The measurements were conducted in the morning hours.

Dietary records for 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 nutritional value of daily diets (DRP), including these data, were analyzed for energy and nutrient levels, established by computer software package *Dietetyk* (Food and Nutrition Institute & A. Mięgoć), based on Polish food composition tables [9]. Moreover, "The album of photographs of foodstuffs and dishes" was also used [8]. Data of nutrient intake were shown as a percentage of nutrition allowances at the level of recommended dietary intakes for women a high level of physical activity [10, 11], with a deviation of ± 10%. Moreover, the recommended intake of dietary fiber was assumed at 27–40 g [10].

Physical activity questionnaire was used to estimate total energy expenditure (TEE) of athletes, focusing on energy expenditure for training, which was evaluated using a physical activity questionnaire, following procedures reported by Mulvihill et al. [12].

Comparisons between groups were carried out using a one–way ANOVA (post hoc, Tukey test for different N). Statistical analyses were performed using the STATISTICA^{TM} program, version 8.0 by StatSoft, Inc. (2008).

Results

Menstrual disorders were observed in 12 athletes, which constituted 60% of the subjects. Two of the subjects (17%) suffer from *amenorrhoea secundaria*, while in four of them (33%) *oligomenorrhoe*a was diagnosed. In turn, in five of athletes (25%) the cycle was shorter than 21 days (*polymenorrhoea*). The same percentage of athletes suffer from a typical menstrual irregularity (*oligomenorrhoe*a with *polymenorrhoea*) (Table 1).

Significant differences in body composition were found. The MD athletes had a significantly lower fat mass and a higher fat free mass, compared to the RC group (RC: FM 23.0 ± 2.1%, FFM 42.0 ± 6.1 kg, DM: FM 19.2 ± 1.5%, FFM 45.8 ± 4.9 kg, $P<0.05$) (Table 2).

The main components of total energy expenditure of athletes were five hours of training (RC: 57% TEE, MD: 58% TEE). A single energy expenditure of training (WET) was 7.5 ± 1.2 kcal·kg·m.c.$^{-1}$·h^{-1}, proving its very high intensity. The next component of total energy expenditure was daily activity (classes and lectures included), to which female athletes devoted on average 11 h daily (RC: 30% TEE, MD: 29% TEE). Moreover, triathletes athletes spent on average seven hours sleeping, which in both groups accounted for a mean 13 % TEE (Table 3).

During the evaluation of dietary habits it was observed that daily diets (DRP) of the MD athletes provided 13.3 ± 1.4 MJ/d (3202 ± 320 kcal/d), which was only 89% of total energy expenditure (energy balance MD: - 1.5 ± 0.7 MJ/d (-363 ± 178 kcal/d) (Table 4).

Furthermore, the percentages of nutrients were non-significantly different when compared to recommended values for athletes training endurance disciplines (11) and in group RC they were: protein 14%,

Table 1. *Characteristic of menstrual cycle of athletes with menstrual disorders*

Type of menstrual disorders	Frequency 60% (n = 12)
Amenorrhoea	17 (2)
Oligomenorrhoea	33 (4)
Polimenorrhoea	25 (3)
Polimenorrhoea/ Oligomenorrhoea	25 (3)

Table 2. *Subject characteristics (Different of letter description indicate of significantly differences)*

	Regular menstrual cycle (RC) n = 8 40%	Menstrual disorders (MD) n = 12 60%
	Mean ± standard deviation	
Age (y)	19.2 ± 1.0	19.6 ± 1.0
Height (cm)	163.3 ± 5.8	167.7 ± 5.8
Body mass (kg)	54.7 ± 9.1	56.7 ± 5.8
BMI (kg/m^2)	20.4 ± 2.1	20.1 ± 1.6
FM (%)	23.0 ± 2.1	19.2 ± 1.5*
FFM (kg)	42.0 ± 6.1	45.8 ± 4.9*
Training period (y)	3.5 ± 0.5	5.2 ± 1.2*
Daily exercise period (h per day)	29.2 ± 5.3	31.1 ± 3.7
Age of menarche (y)	13.3 ± 0.5	13.6 ± 0.9

* $P < 0.05$

Table 3. *24–h energy expenditure of subjects*

	Regular menstrual cycle (RC) n = 8	Menstrual disorders (MD) n = 12
	Mean ± standard deviation	
Total energy expenditure MJ/dz kcal/dz	14.6 ± 2.2 3501 ± 528	14.9 ± 1.13 566 ± 254
Training session MJ/dz kcal/dz (h, % TEE)	8.3 ± 1.8 1990 ± 422 (5, 57)	8.7 ± 1.0 2073 ± 228 (5, 58)
Daily activity (lectures included) MJ/dz kcal/dz (h, % TEE)	4.4 ± 0.9 1056 ± 224 (11, 30)	4.3 ± 0.4 1019 ± 105 (11, 29)
Sleep MJ/dz kcal/dz (h, % TEE)	1.9 ± 0.4 455 ± 97 (8, 13)	1.9 ± 0.2 474 ± 53 (8, 13)

Table 4. *Energy balance of subject (Different of letter description indicate of significantly differences)*

	Regular menstrual cycle (RC) n = 8	Menstrual disorders (MD) n = 12
	Mean ± standard deviation	
TEE MJ/dz kcal/dz	14.6 ± 2.2 3501 ± 528	14.9 ± 1.1 3566 ± 254
Daily diets provided (DRP) MJ/dz kcal/dz	14.7 ± 1.8 3520 ± 431	13.3 ± 1.4* 3202 ± 329*
Energy balance MJ/dz kcal/dz	0.1 ± 1.1 19 ± 282	-1.5 ± 0.7* -363 ± 178*

* $P < 0.05$

Table 5. *Percentage of energy intake from nutrients*

	Regular menstrual cycle (RC) n = 8	Menstrual disorders (MD) n = 12
% energy intake from protein	14	15
% energy intake from fat	29	30
% energy intake from carbohydrate	57	55

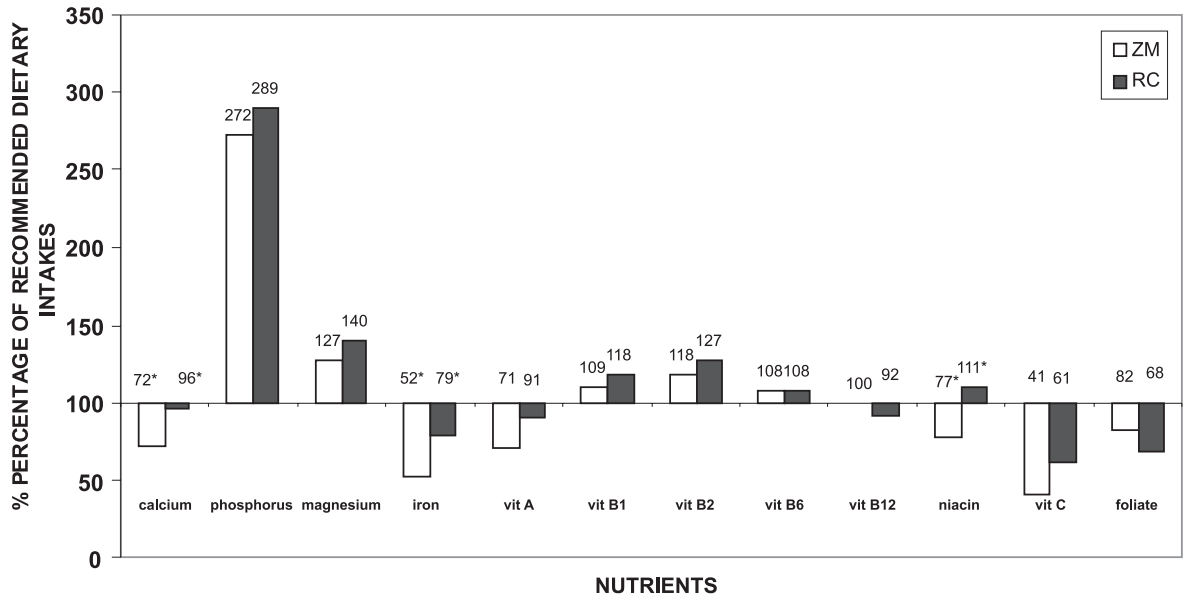

Fig. 1. *Percentage of recommended dietary intakes*

fat 29%, carbohydrates 57%, and in the MD group: protein 15%, fat 30%, carbohydrate 55%, respectively (Table 5).

What is more, daily diets of triathletes were inadequately properly balanced for several nutrients. A significantly lower intake of calcium (MD: 72% recommended value 96%, $P<0.05$), iron (MD: 52%, RC: 79%, $P<0.05$) as well as niacin (MD: 77%, RC: 111%, $P<0.05$) intake were found in athletes with menstrual disorders (Fig. 1).

The next negative aspect of dietary habits of athletes was associated with a lower dietary fiber intake (RC: 25.8 ± 5.2, MD: 26.3 ± 4.4), below the lower limit of the recommended value and an inadequate ratio of calcium to phosphorus Ca : P (RC: 1.8 ± 0.4, MD: 2.3 ± 0.4).

Disscusion

Available literature contains information on the effect of training intensity on the frequency of menstrual disorders in female athletes [2, 13, 14]. Skierska [1] suggested that these dysfunctions might depend on the type of sports disciplines. The highest prevalence of menstrual dysfunctions is observed in esthetic – acrobatic activities (gymnastics: 38.2%) and endurance sports (marathon: 19.3%, runners: 52.9%). More recent studies have suggested that menstrual disorders are associated not only with intensive exercise, but also with low body mass and low body fat [1, 2, 15]. It has been recognized that 22% of body fat is the lower limit for obtaining regular changes in androgens to estrogens and estradiol. Lower fat mass, relatively frequently found in female athletes, may prove to be inadequate to maintain this process and lead to the inhibition of the functioning the hypothalamic–pituitary–ovarian axis [16]. In this study athletes suffering from menstrual disorders had a significantly lower fat mass compared to athletes with regular menstrual cycles. Also Farah et al. [5] observed a lower than recommended (22%) fat mass in athletes with menstrual dysfunction. Stokic et al. [14], examining body composition of ballet dancers, maintained that an inadequate body composition is the main cause of amenorrhoea in this group of women. However, in many studies no differences were observed in body and fat mass in female athletes suffering from menstrual disorders, in compared with eumenorrheic athletes [13]. Also Sanborn et al. [17] did not confirm a relationship between menstrual disorders and bone density in their study on female runners.

We also need to stress the fact that in this study energy balance was negative in female triathlon athletes with menstrual disorders. What is more, athletes' daily diets were not properly balanced in respect of nutrients: calcium, iron, niacin, vitamin A, foliate and vitamin C. Manore [15] reported on general female athletes' undernutrition and emphasized the fact that deficiency of vitamin B, iron and zinc intake can unfavourably affect reproductive functions in women and cause their dysfunction. What is more, the authors also pointed to the necessary increased supply of calcium, exceeding 1500 mg in diets of female athletes suffering from menstrual cycle disorders, due to the increasing risk of osteoporosis [15]. Kaiserrauer et al. [18] also linked the prevalence of menstrual cycle disorders in female runners with an insufficient energy value of the food ration in relation to the requirement. Also Christo et al. [19] reported a significantly lower energy intake in amenorrhoeic athletes as compared with eumenorrheic athletes. At the same time it was found that amenorrhoea or oligomenorrhoea are typical responses of the organism, manifested in a reduction of energy consumption, required for the maintenance of a complete menstrual cycle [5].

There are many controversies hypothesizes about effect of consumption dietary fibre intake on the maintenance of reproductive functions. Lloyd [20] suggested that higher intake of dietary fibre might lead to irregularity in menstrual cycle irregularities due to an increased excretion of estrogens with faeces. In this research, as well as in studies presented by Christo et al. [19] these statement wasn't been confirmed.

Long-term energy imbalance, inadequate nutrient intake and disorders in the hypothalamic–pituitary axis are especially dangerous due to the future consequences connected with osteoporosis [20, 21]. In this respect the results presented by Cobb et al. [22] and Nicolas et al. [23] need to be mentioned, as these researchers observed a significantly lower bone density in female athletes with amenorrhoea in comparison to athletes with regular physiological menstrual cycles.

Conclusions

In female athletes with menstrual disorders:

a) daily diets were inadequately balanced for energy in relation with total energy expenditure (negative energy balance).
b) the percentage of fat mass was lower when compared to female athletes with regular menstrual cycles.

Acknowledments

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References

1. Skierska E. Wysiłek fizyczny jako czynnik dysfunkcji układu rozrodczego kobiet [Physical exercises as a factor in dysfunctions of the reproductive system of females]. Warszawa: Studia i Monografie AWF, 1998.
2. Skrzypulec V, Lindert O, Morawiec M, et al. Menstruation disorders among female athletes. *Gin Prakt* 2005; 86, 5: 28-31.
3. Loucks AB, Nattiv A. Essay: The Female Athlete Triad; *Medicine and Sport* 2005; 366: 49–50.
4. Loucks AB. The female athlete triad: position stand. *Med Sci Sports Exerc* 2007; 39: 1867–81.
5. Farrah S, McLean C, Graham TE**.** Plasma leptin in female athletes: relationship with body fat, nutritional, and endocrine factors. *J Appl Physiol* 2000; 88: 2037–44.
6. Dusek T. Influence of High Training on Menstrual Cycle Disorders in Athletes. *Croat Med J* 2001; 42, 1: 79-82.
7. Heyward VH, Wagner DL. Applied Body Composition Assessment. Second edition, Champaign, IL: Human Kinetics, 2003.
8. Album fotografii produktów i potraw [An album of photographs of foodstuffs and dishes]. Warszawa: Instytut Żywności i Żywienia, 2001.
9. Kunachowicz H, Nadolna I, Przygoda B et al. Tabele składu i wartości odżywczej żywności [Tables of composition and nutritive value of food]. IŻŻ Warszawa: PZWL 2005.
10. Jarosz M, Jachymczyk–Bułhak B. Normy Żywienia Człowieka. Podstawy prewencji otyłości i chorób niezakaźnych. [Standards of Human Nutrition. Foundation of prevention of obesity and non-contagious diseases]. Warszawa: PZWL, 2008.
11. Dunford M. Cardiovascular and Wellness Nutritionists Dietetic Practices Group. Sports Nutritions - A Practice Manual for Professionals. 4th edition. Chicago Illinois: American Dietetic Association, 2006.
12. Mulvihill CB, Davies GJ, Rogers PJ. Dietary restraint in relation to nutrient intake, physical activity and iron status in adolescent females. *J Hum Nutr Diet* 2002; 15(1): 19-31.
13. Warren MP. Clinical review 40. Amenorrhoea in endurance runners. *J Clin Endo & Meta* 1992; 75: 1393-7.
14. Stokić E, Srdić B, Barak O. Body mass index, body fat mass and the occurrence of amenorrhea in ballet dancers. *Gynecol Endocrinol* 2005; 20(4): 195-9.
15. Manore MM. Dietary recommendation and athletic menstrual dysfunction. *Sports Med* 2002; 32(14): 887-901.
16. Frish RE, Mc Arthur JW. Menstrual cycles: fatness as a determinacy of minimum weight and height necessary for their maintenance or onset. *Science* 1974; 185: 849-60.
17. Sanborn CF, Albrecht BH, Wagner J. Athletic amenorrhoea: lack of association with body fat. *Med Sci Sports Exerc* 1987; 19: 207-12.
18. Kaiserrauer S, Snyder AC, Sleeper M et al. Nutritional, physiological, and menstrual status of distance runners. *Med Sci Sports Exerc* 1989; 21: 120-5.
19. Christo K, Prabhakaran R, Lamparello B et al. Bone metabolism in adolescent athletes with amenorrhea, athletes with eumenorrhea, and control subjects. *Pediatrics* 2008; 121, 6: 1127-36.
20. Lloyd T. Interrelationships of diet, athletic activity, menstrual status, and bone density in collegiate women. *Am J Clin Nutr* 1987; 46: 681-4.
21. Lanay M., Mudd MS, Fornetti W. Bone Mineral Density in Collegiate Female Athletes Comparisons among Sports. *J Athl Training* 2007; 42(3): 403-8.
22. Cobb KL, Bachrach LK, Greendale G, Marcus R et al. Disordered eating, menstrual irregularity and bone mineral density in female runner. *Med Sci Sports Exerc* 2003; 35: 711-9.
23. Nicholas JN, Rauch MJ, Barrack MT et al. Disordered Eating and Menstrual Irregularity in High School Athletes in Lean-Build and Nonlean-Build Sports. *IJSNM* 2007; 17, 364-77.

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