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ESTIMATION OF ENERGY AND NUTRITIONAL INTAKE OF YOUNG MEN PRACTICING AEROBIC SPORTS

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ABSTRACT

Background. Keeping to a balanced diet plays a key role in maximizing the body's efficiency so that sports training becomes more effective. Previous studies have shown that an athletes' diet is often not properly balanced, and can thus negatively affect sporting performance.

Objectives. To assess the energy and nutrient intake in young men practicing aerobic sport and compare them with those recommended.

Material and methods. Subjects were 25 male athletes, aged 19-25 years, practicing aerobic sports who were students at two Warsaw Universities; The Military University of Technology and University of Physical Education. The average body mass was 80.6 ± 9.6 kg and average height was 187.0 ± 7.6 cm, (BMI thus being 23.01 ± 1.70 kg/m2). Dietary assessment was based on three-day dietary recalls consisting of two weekdays and one day of the weekend. The energy and macro/micro-nutrient intake were evaluated using the Polish Software 'Energia' package and compared to recommendations and standards. Supplements were absent from the athletes' diets.

Results. The energy value of diets were too low in most instances; average %-age deficiency was 30.22 ± 13.76%. Total protein intake, (mean 1.41 ± 0.36 g per kg body weight) was inadequate in 40% of cases, whilst all showed appropriate intakes of animal protein. Most subjects' carbohydrate intake (84%) was deficient; median 3.28 g/kg body weight. Fibre intake, (median 17.17 g) was also insufficient in 76% cases. Total fat intake, (33,9% ± 5,7 energy) was too high in 32% of cases. The %-age dietary energy obtained from saturated fatty acids was 12,18% ± 2,53 and 5,72% ± 1,43 from polyunsaturated fatty acids, where most subjects' diet (64%) was, as well, high in cholesterol. Furthermore, significant deficiencies were observed in the following: Vitamin A (44% of group below EAR), vitamin C (80% below EAR), vitamin D (92% below EAR), foliate (84% below EAR), calcium (52% below EAR) and magnesium (60% below EAR). Vitamin E intake was however higher than the AI level. Almost all subjects had adequate intakes of vitamins B_1, B_2, B_6, B_{12}, niacin and zinc.

Conclusions. The energy value of diet and carbohydrate intake were inadequate to the athletes' requirements. Dietary deficiencies of folate, vitamins C and D, magnesium, calcium and potassium were also observed. There is therefore a need for sports nutrition counselling and education which would help athletes improve their eating habits and health, as well as for optimising their sports training performance.

Key words: *athletes, aerobic sports, diet*

STRESZCZENIE

Wprowadzenie. Zbilansowana dieta odgrywa kluczową rolę w maksymalizacji wydolności organizmu i zwiększeniu efektywności treningu fizycznego. Wcześniej przeprowadzone badania pokazały, iż bardzo często dieta sportowców jest źle zbilansowana, co może wpływać negatywnie na ich wyniki podczas zawodów sportowych.

Cel badania. Celem przeprowadzonego badania była ocena realizacji potrzeb żywieniowych młodych mężczyzn uprawiających sporty aerobowe

Materiał i metody. Badanie zostało przeprowadzone z udziałem 25 mężczyzn w wieku 19-25 lat, trenujących sporty aerobowe. Mężczyźni byli studentami warszawskich uczelni: Wojskowej Akademii Technicznej lub Akademii Wychowania Fizycznego. Średnia masa ciała w badanej grupie wynosiła 80.6 ± 9.6 kg, zaś wzrost 187.0 ± 7.6 cm (BMI 23.01 ± 1.70 kg/m^2). Ocena ich racji pokarmowych została oparta o trzydniowe bieżące notowania spożycia (trzy dni: dwa powszednie i jeden świąteczny). Zawartość makro- i mikroskładników diety została obliczona przy pomocy programu komputerowego „Energia", a następnie porównana z zaleceniami i normami żywieniowymi. Badani nie stosowali suplementacji.

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Wyniki. Racja pokarmowa większości badanych miała zbyt małą wartość energetyczną (średnie niedobory 30.22 ± 13,76%). Całkowita podaż białka (średnia 1,41 ± 0,36g/kg m.c.) była niewystarczająca u 40% sportowców, zaś spożycie białka pochodzenia zwierzęcego było prawidłowe u wszystkich badanych. Większość grupy (84%) dostarczała z dietą zbyt małą ilość węglowodanów (mediana 3,28 g/kg m.c.). Spożycie błonnika (mediana 17,17g) była niewystarczająca u 76% sportowców. Udział energii z tłuszczu w diecie (33,92 ± 5,70 % energii) był zbyt duży u 32% badanych. Udział energii pochodzącej z nasyconych kwasów tłuszczowych wynosił średnio 12,18 ± 2,53%, podczas gdy średnie spożycie wielonienasyconych kwasów tłuszczowych stanowiło 5,72 ± 1,43% wartości energetycznej diety. Większość racji pokarmowych cechowała się zbyt dużą zawartością cholesterolu (378,62 ± 144,36 mg). Zaobserwowano niewystarczające spożycie w przypadku: witaminy A (44% grupy spożywało mniej niż EAR), witaminy C (80% badanych poniżej EAR), witaminy D (92% poniżej EAR), kwasu foliowego (84% poniżej EAR), wapnia (52% poniżej EAR) oraz magnezu (60% poniżej EAR). Średnie spożycie witaminy E w grupie było większe niż zalecane na poziomie AI. Prawie wszyscy badani mieli prawidłową podaż witamin B_1, B_2, B_6, B_{12}, niacyny oraz cynku.

Wnioski. Wartość energetyczna racji pokarmowych, a także ilość spożywanych węglowodanów była niewystarczająca w porównaniu do potrzeb sportowców. Spożycie kwasu foliowego, witamy C, D, magnezu, wapnia oraz potasu było zbyt małe. Istnieje konieczność prowadzenia poradnictwa i edukacji żywieniowej sportowców w celu poprawy ich zwyczajów żywieniowych, a tym samym poprawy stanu zdrowia i wydolności fizycznej.

Słowa kluczowe*: sportowcy, sporty aerobowe, dieta*

INTRODUCTION

The role of a balanced diet is well recognised for helping to maximise the physical efficiency of bodily function and hence improve the effectiveness of training. This has now lead to an ever growing interest in nutritional sciences, which has become apparent within the last decade amongst athletes and coaches [26]. During intensive physical activity, it is vital that an adequate energy intake is supplied for the body's needs together with sufficient fluids, electrolytes, protein, carbohydrates as this crucially affects athletic performance and appropriate body composition [1]. Furthermore, because of the heightened requirement for micro- and macro- nutrients, during training, athletes are often much more vulnerable to any deficiencies so arising, compared to the general population [25]. Previous studies demonstrate that an athlete's diet is frequently unbalanced; being deficient in protein, carbohydrates [21], vitamins and minerals [26] whilst also providing insufficient energy [7, 17].

To date, there have been few studies conducted in Poland tailored to the individual athlete's needs regarding energy and nutritional requirements as most have been focused on just evaluating nutrition amongst young athletes [6, 11, 33]. Further investigations are thus necessary.

The aims of the presented study were to therefore determine whether the diets of young athletes fulfil the body's energy and the micro/macro-nutrient requirements.

MATERIAL AND METHODS

Subjects were 25 male students attending two universities in Warsaw, aged 19-25 years, practicing aerobic sports/exercises who agreed to participate in the study. The universities were the Military University of Technology and University of Physical Education. The average body mass was 80.6 ± 9.6 kg and average height was 187.0 ± 7.6 cm, (BMI thus being 23.01 ± 1.70 kg/m2). The dietary assessment was based on three-day dietary recalls consisting of two weekdays and any one day from the weekend.

The sizes of served portions and meals consumed by athletes were converted into gram amounts based on a photograph album of Polish dish sizes and meals [34]. The 'Energia' Software package was used to assess diets and the nutritional value of foodstuffs based on Polish standards [15]. These were then compared to the recommendations of the American Dietetic Association (ADA), Dieticians of Canada (DC) in association with the American College of Sports Medicine (ACSM) for athletes [1] as well as to the relevant Polish dietary recommendations [14].

The carbohydrate intake was compared with levels suggested by published guidelines for athletes [4]. In the case of micronutrients, observed levels were compared to the Estimated Average Requirement (EAR) in order determine whether these were sufficient using the 'cut--off point method' [13]. However Vitamin E, sodium or potassium do not have such established levels, therefore average values were compared to Adequate Intake (AI) levels [14].

The amount of physical activity performed was as declared by the subjects themselves, who undertook aerobic sports most days of the week; with each session lasting more than 1.5 hours. In addition, physical activity was directly assessed in fifteen of the subjects who wore a special multisensory armband throughout a 48 hour period; Armband SenseWear Pro3, (Body Media Inc USA). Activity levels were found to be similar in all cases and did not exceed more than 14 hours per week which was thus classified as being moderate [20]. The body energy requirement was estimated individually by the BMR (basal metabolic rate) calculated using the modified *Harris-Benedict* formula [12] and then multiplied by an index of physical activity which was taken as being 1.75, for individuals performing moderate physical activity [14].

The *Shapiro-Wilk* test was used to test the data for normality. Distributions so conforming, were summarised statistically by the mean and the standard deviation whilst medians were used for non-parametric data. A critical value of $p \leq 0.05$ was adopted as being statistically significant. Analyses were performed using the Statistica 9.1 software.

All experimental protocols were approved by the Bioethical Commission of the Regional Medical Chamber in Warsaw; registered as medical experiment KB/611/07, date: 07.02.2008.

RESULTS AND DISCUSSION

The athletes' average dietary intake of energy and macronutrients are presented in Table 1. Using the individual calculated energy requirements, it was found that the energy value of the diet was too low in most subjects; average deficiency being 30.22 ± 13.76%. This deficiency level is widely observed amongst athletes [7, 17]. Polish recommendations emphasise that the distribution of the BMI should be used for evaluating the energy values of any diet. The proportion of persons with a higher or lower BMI than recommended, should be used for validating energy intake [13]. It is therefore assumed that intake of energy from a diet is adequate for people with a proper body weight. All study participants in fact had a correct body weight, thus it may be concluded that the dietary energy intake may have been adequate in this group. All dietary assessment methods however have limitations. In this study the three-day dietary recalls were prepared by the athletes. Factors like under- or overreporting, incorrect estimation of portion size, changing the dietary habits during recall and improper recording need to accounted for when interpreting the data. In addition, it is observed that underestimations of consumed food increases with increasing intake [30, 31]. Nutrients intake results so obtained thus require careful interpretation [35], where for example the underestimation of energy intake could lead to underestimation of nutrient intake. A prudent approach therefore becomes necessary for making any practical assessment of dietary nutrient deficiency because intakes can be actually higher than those of dietary recall.

Protein intake, per kg of body weight, (b.w.) was found to be inadequate in 10 athletes (40%), nevertheless all had consumed at least 0.8 g of protein/kg b.w, which is sufficient to maintain proper body function, but may cause sports performance to decline[1]. Only in one subject, did protein intake range from 1.2 - 1.4 g/kg b.w., whilst in 56%, it ranged 1.4-2.0 g/kg b.w. This means that intake of protein was in most cases too high compared with recommendations, although this amount is still safe. Indeed, previous studies indicate that a protein intake of 1.4-2.0 g/kg body weight can even improve body adaptability to intensive physical activity [5]. It is also observed that well-trained athletes with a high protein intake, (up to 2.8 g/kg b.w.), does not have an adverse effect on renal function [28]. Furthermore, other research has reported a higher than average protein

Table 1. Energy and macronutrients intake in comparison with recommendations [n=25]

Component	Min - max	Mean/ median	Recommendations	Percentage of participants lower than recommended level	Percentage of participants higher than recommended level
Energy [kcal]	1482 - 3759	2466 ± 591	3331± 252*	88	0
Total protein [g/kg b.w.]	0.83 - 1.95	1.41 ± 0.36	1.2-1.4**	40	56
Total fat [% energy]	24.16 - 46.53	33.92 ± 5.70	20-35***	0	32
Saturated fatty acids [% energy]	8.30 - 19.80	12.18 ±2.53	DRV not established***	-	-
Polyunsaturated fatty acid [% energy]	3.53 - 9.55	5.72 ± 1.43	DRV not established***		-
Cholesterol [mg]	142.25-636.67	378.62± 144.36	<300***	-	64
Total carbohydrate [g/kg b.w.]	2.19 - 7.28	3.28	5-7****	84	0
Fibre [g]	10.62 - 55.44	17. 17	>25***	76	-

* individually calculated according to methodology

** ADA. DC. ACSM recommendations [1]

*** Polish recommendations for healthy individuals [14]

**** *Burke* at al. [4]

DRV- Dietary Reference Values

intake in a group of baseball players [21] and soccer players [8]. In contrast, lower protein consumption has been observed in basketball and volleyball players [26]. It should be also noted that all subjects consumed adequate amount of animal protein, (constituting more than half of total protein intake), which is essential in athletes' diets.

The majority of subjects (84%) consumed too little carbohydrate, consistent with findings from other studies [10, 21]; an adequate intake of carbohydrates being very important for athletic performance [39]. Carbohydrates are essential not only as a source of energy for active muscles, but also in protecting protein from being exploited as an energy source[12]. Moreover, an inadequate intake of carbohydrates increases the risk of injury in athletes [24], an inadequate energy value of the diet and a deterioration of sporting performance [9]. Fibre intake was insufficient in 76% of athletes, in keeping with a low fibre intake observed by other research [8, 16].

The fat intake was found to be too high in 32% of athletes; the rest having recommended intake levels of fat. Excessive fat intake has also been reported in other studies on athletes [8, 21]. Besides, it was found that the majority of subjects had a saturated fatty acid consumption twice higher than the intake of polyunsaturated fatty acids. The %-age dietary energy obtained from saturated fatty acids was 12.18% ± 2.53 and 5.72% ± 1.43 from polyunsaturated fatty acids, where most subjects' diet (64%) was, as well, high in cholesterol. High intakes of saturated fatty acids and cholesterol coupled with low consumption of polyunsaturated fatty acids has been observed in other studies on young persons [32]. It may be caused by the athletes' desire to increase muscle mass through consuming high quantities of animal foodstuffs which also contain considerable quantities of cholesterol and saturated fatty acids [16]. An excessive fat intake and inappropriate proportions of fatty acids may constitute risk factors for many diseases, such as obesity, some cancers or cardiovascular disease [27].

The average intake of vitamins and minerals are presented in Table 2. A significant deficiency in vitamin A intake was observed, though there is no evidence that deficiency of this vitamin affects sports performance [19], although it may lead to reduced immunity, fertility problems and vision disorders [12]. Although insufficient vitamin A intake was also observed by other research [22], generally speaking most athletes follow diets that are adequate in vitamin A [19]. Intakes of vitamin E were mostly higher than the AI level however 40% did not reach this level. An insufficient intake of this vitamin, has been seen in other studies on athletes [8, 26], leading to increased body oxidative stress, neurodegenerative changes, haemolysis and muscle degradation. Further studies indicate that nutritional deficiencies of vitamin E are higher in physically inactive individuals than in athletes [19] and that vitamin E reduces tissue damage [36]. In addition, a substantial deficiency of folate and vitamin C was seen in the diets. Inadequate intake of folate has also been observed in football players [8], on the other hand, appropriate vitamin C intakes were observed in other studies on athletes [8, 26]. Due to the important role of vitamin C, its deficiency may adversely affect efficiency and performance of sport leading to fatigue and muscle weakness [19]. Folic acid deficiency, can lead to anaemia developing together with central

Table 2. Vitamins and minerals intake in athletes [n=25] compared with Polish dietary recommendations [14]

Vitamin/ mineral	Min - max	Mean/ median	EAR	AI	Percentage (%) of individuals with intakes lower than recommendations n= 25
Vitamin A [ug]	201.03- 5283.53	740.03	630	-	44*
Vitamin D [ug]	1.26 - 16.58	2.92	10	-	92*
Vitamin E [mg]	5.86 - 24.52	12.27± 4.99	-	10	40**
Vitamin B_1 [mg]	0.92 - 2.80	1.52	1.1	-	8*
Vitamin B_2 [mg]	1.02 - 3.32	2.05± 0.55	1.1	-	4*
Niacin [mg]	10.49 - 36.87	25.05± 6. 58	12	-	4*
Vitamin B_6 [mg]	1.35 - 5.04	2.45	1.1	-	0*
Folate [µg]	118.61- 484.52	222.63	320	-	84*
Vitamin B_{12} [µg]	1.72 - 13.80	4.63	2.0	-	4*
Vitamin C [mg]	2.81 - 336.04	44.22	75		80*
Sodium [mg]	1518.42 - 4345.20	2757.53± 782.32	-	1500	0**
Potassium [mg]	2305.22 - 9066.53	3027.55	-	4700	84**
Calcium [mg]	372.37 - 1762.80	918.09± 401.21	800		52*
Phosphorus [mg]	1092.94 - 2450.06	1714.64± 388. 55	580	-	0*
Magnesium [mg]	235.89 - 617.34	317.46	330	-	60*
Zinc [mg]	7.36 - 18.90	13.28± 2.90	9.4	-	8*

* Percent of individuals with intakes lower than the EAR level

** Percent of individuals with intakes lower than the AI level nervous system function dysfunction through abnormal production of protein and tissue regeneration [19, 38].

One of the factors that cause exercise-induced muscle fatigue is the generation of free radicals in active skeletal muscles. A key role is played by dietary antioxidants in cooperation with endogenous antioxidant defence mechanisms to protect muscles against such exercise-induced oxidative damage [29]. Thus the observed vitamin C and E deficiencies, may result in deteriorating training effectiveness. Antioxidant supplementation in athletes however remains controversial [29] as dietary sources of antioxidants are still of paramount value.

Almost all of the subjects showed adequate intakes of vitamins B_1, B_2, B_6, B_{12}, niacin and zinc, consistent with other studies of athletes [26]. Despite this, vitamin D intakes were found insufficient and at the same time, 52% of subjects consumed less than 800 mg of calcium per day. It is well recognised that low calcium intake connected with vitamin D deficiency can lead to a deterioration of bone mineralization and thus increase its susceptibility to fracture. Moreover, recent studies have indicated a link between vitamin D and muscle function [2]. Indeed, dietary vitamin D deficiency is a commonly seen problem in athletes [8, 29], although a study by *Papandreou* et al. [26] did not demonstrate any vitamin D deficiencies in the diets of professional athletes.

Average sodium intakes were found to be higher than the AI level. In most subjects, it in fact also exceeded WHO recommendations for the maximum daily intake [37]. It should however be noted, that significant amounts of sodium are excreted in sweat during exercise. Athletes must therefore consume more sodium to compensate for such losses incurred during physical activity [36]. A study on football players showed no deficiencies in sodium intake[8]. Conversely average potassium intakes were seen to be significantly lower than the AI level and additionally 84% of subjects did not even attain the AI level. Intake of magnesium in the majority of athletes (60%) was also inadequate, in keeping with other studies [8] which have shown that this is a common problem in athletes [3, 18], which may affect physical performance [23].

Athletes wishing to optimise their exercise performance need to follow a properly balanced diet [1]. The diet of the examined subjects was inadequate. Athletes should therefore pay more attention to consuming an energetically adequate diet that is rich in micronutrient-containing foodstuffs [29]. In this respect there is a growing need for sports nutrition counselling and education which would help athletes to improve their eating habits. Better health and optimisation of training performance could thus be achieved.

CONCLUSIONS

1. The energy value of diet and carbohydrate intake were inadequate compared with the needs of athletes.
2. Athletes consumed insufficient amounts of dietary folate, vitamins C and D, magnesium, calcium and potassium.
3. There is a need for sports nutrition counselling and education which would help athletes to improve their eating habits and achieve better health as well as optimising their training performance.

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