Rocz Panstw Zakl Hig 2014;65(4):353-357

ASSESSMENT OF PHYSICAL ACTIVITY, ENERGY EXPENDITURE AND ENERGY INTAKES OF YOUNG MEN PRACTICING AEROBIC SPORTS

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ABSTRACT

Background. Adequate nutrition and energy intake play key rule during the training period and recovery time. The assessment of athlete's energetic needs should be calculated individually, based on personal energy expenditure and Sense Wear PRO3 Armband (SWA) mobile monitor is a useful tool to achieve this goal. However, there is still few studies conducted with use of this monitor.

Objectives. To assess individual energy needs of athletes by use of SWA and to determine whether their energy intake fulfils the body's energy expenditure.

Material and Methods. Subjects were 15 male students attending Military University of Technology in Warsaw, aged 19-24 years, practicing aerobic. The average body mass was 80.7 ± 7.7 kg and average height was 186.9 ± 5.2 cm, (BMI 23.09 ± 1.85 kg/m2). Assessment of physical activity and energy expenditure (TEE) was established using SWA, which was placed on the back side of dominant hand and worn continuously for 48 hours (during the training and non-training day). The presented results are the average values of these 2 days. Assessment of athletes' physical activity level was established by use of metabolic equivalent of task (MET) and number of steps (NS). Estimation of energy intake was based on three-day dietary recalls (two weekdays and one day of the weekend), evaluated using the Polish Software 'Energia' package.

Results. The average TEE of examined athletes was 3877 ± 508 kcal/day and almost half of this energy was spend on physical activity (1898 ± 634 kcal/day). The number of steps was on average 19498 ± 5407 and average MET was 2.05 ± 2.09. The average daily energy intake was 2727 ± 576 kcal.

Conclusions. Athletes consumed inadequate amount of energy in comparison to their energy expenditure. Examined group did not have an adequate knowledge about their energy requirement, which shows the need of nutritional consulting and education among these athletes.

Key words*: athletes, aerobic sports, energy expenditure, energy intake*

STRESZCZENIE

Wprowadzenie. Prawidłowe żywienie oraz odpowiednia podaż energii z dietą odgrywają kluczową rolę zarówno w czasie treningu jak i w okresie regeneracji. Ocena potrzeb energetycznych powinna być dokonywana indywidualnie dla każdego sportowca, w oparciu o jego wydatki energetyczne. Pomocnym urządzeniem do pomiaru jest aparat pomiarowy Armband SenseWear PRO3 (SWA). Jednak w dalszym ciągu jest niewiele badań przeprowadzonych z udziałem tego urządzenia.

Cel. Celem badań było oszacowanie indywidualnych potrzeb energetycznych sportowców, przy użyciu urządzenia pomiarowego SWA oraz ocena, czy podaż energii z dietą kompensuje wydatki energetyczne organizmu.

Materiał i metody. Badanie zostało przeprowadzone z udziałem 15 studentów Wojskowej Akademii Technicznej w Warszawie, w wieku 19-24 lata, trenujących sporty aerobowe. Średnia masa ciała wynosiła 80.7 ± 7.7 kg, zaś wzrost 186.9 ± 5.2 cm, (BMI 23.09 ± 1.85 kg/m^2). Ocena aktywności fizycznej oraz wydatków energetycznych (TEE - *total energy expenditure*) została dokonana przy pomocy SWA, który został umieszczony na tylniej stronie ręki dominującej i noszony nieustannie przez 48 godzin (w dzień treningu oraz w dzień wolny od treningu). Zaprezentowane wyniki stanowią średnią z pomiarów. Oszacowanie stopnia aktywności fizycznej zostało dokowane przy użyciu równoważnika metabolicznego (metabolic equivalent of task - MET) oraz liczby kroków (NS). Ocena spożycia energii została oparta o trzydniowe bieżące notowania spożycia (dwa dni poprzednie i jeden świąteczny) i obliczona przy pomocy programu komputerowego „Energia".

Wyniki. Średnia wartość TEE u badanych sportowców wynosiła 3877 ± 508 kcal/dzień, z czego prawie połowa wydatkowana była na aktywność fizyczną (1898 ± 634 kcal/dzień). Liczba kroków wynosiła średnio 19498 ± 5407 zaś średni MET 2,05 ± 2,09. Średnia podaż energii z dietą wynosiła 2727 ± 576 kcal/dobę.

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Wnioski. Wykazano, że sportowcy dostarczają wraz z dietą niewystarczającej ilości energii w porównaniu do swoich wydatków energetycznych. Badana grupa posiadała niewystarczającą wiedzę na temat potrzeb energetycznych, co wskazuje na konieczność prowadzenia ich edukacji w tym zakresie.

Słowa kluczowe*: sportowcy, sporty aerobowe, wydatki energetyczne, wartość energetyczna diety*

INTRODUCTION

Adequate nutrition plays key rule during the training period and recovery time. Well balanced diet should provide sufficient amount of energy to cover its expenditure during the day, increase performance, and accelerate body recovery and to maintain correct body composition [4, 14]. Low energy diet may result in muscle mass lose, lower bone density and lead to increase the risk of injury, fatigues or other health problem [1]. However, the assessment of energetic needs should be calculated individually, as each athlete has unique energy requirements [2]. To achieve this goal, it is essential to assess correctly total energy expenditure [12].

Recent studies conducted on healthy adults showed that Sense Wear PRO3 Armband (SWA) mobile monitor gives reliable estimation of energy expenditure [17, 22]. There are few studies both: abroad and in Poland, in which SWA was used to estimate TEE of athletes. Some researchers suggest that the device tends to underestimate TEE with growing physical intensively [4, 8]. However, further studies should be provided.

The aims of this study were to assess individual energy needs of athletes by use of SWA and to determine whether their energy intake fulfils the body's energy expenditure.

MATERIAL AND METHODS

Subjects were 15 male students attending Military University of Technology in Warsaw, aged 19-24 years, practicing aerobic sports who agreed to participate in the study. The average body mass was 80.7 ± 7.7 kg and average height was 186.9 ± 5.2 cm. The valid values of body mass index (BMI) were assumed to 23.09 ± 1.85 kg/m2 and all athletes had correct body mass [20].

Assessment of physical activity and energy expenditure was made using SenseWear PRO3 Armband mobile monitor (SWA), produced by Body Madia, Pittsburg (USA). The armband recorded the fallowing parameters: total energy expenditure [TEE, kcal], active energy expenditure [AEE, kcal], and average metabolic equivalent of task [MET, -], number of steps [NS, -], lying down duration [LD, min] and physical activity duration [PAD, min] which include moderate activity duration [MPA, kcal], vigorous activity duration [VPA, min] and very vigorous activity duration [VVPA, min]. The monitor was placed on the back side of dominant hand and worn continuously for 48 hours (during the training and non-training day). The presented results are the average values of these 2 days. According to the fact that the reading did not contain information on sedentary energy expenditure [SEE, kcal], the value was calculated from the formula SEE = TEE-AEE.

Assessment of athletes' physical activity level was established by use of metabolic equivalent of task (MET), which is a physiological measure derived from the resting oxygen consumption, equals to 3.5 ml O_2/ kg /min or 1 kcal/kg/h [3]. The recommendations of the monitor's producer were used to classify the physical activity levels.

The fallowing division was set up:

- sedentary lifestyle, MET < 3
- moderate physical activity, MET 3 – 5.9,
- vigorous physical activity, MET 6 – 8.9,
- very vigorous physical activity, MET ≥ 9.

The classification of physical activity was also made based on the number of steps [19]:

- < 5000 steps/ day- sedentary lifestyle,
- 5000-7499 steps/ day – low daily activity,
- 7500- 9999 steps/ day – moderate activity,
- 10000-12499 steps/ day – active lifestyle,
- > 12500 steps/ day – highly active lifestyle.

Total energy intake was assessed based on self-reported three-day dietary recalls of food consumption (two weekdays and one day of the weekend). The portion sizes consumed by subjects were converted into gram amounts according to a photograph album of the Polish dish sizes and meals [18]. The Polish dietetic software 'Energia' was used to establish energy value of the diet due to Polish standards [10]. More results about nutrition value of the diet may be found in previous publication [21].

The fallowing statistic methods were used: (1) *Shapiro-Wilk* test to test the data for normality, (2) t--*Student* test to compare two parameters of the normal distribution and (3) *Pearson* correlation coefficient, to study the relationship between the quantitative features of a continuous distribution.

A critical value of $p \leq 0.05$ was stated as being statistically significant. The statistical analysis were made using IBM SPSS Statistics 20.

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 characteristic of physical activity and energy expenditure levels were presented in Table 1.

Tab.1 Physical activity characteristics and energy expenditure levels among examined athletes [n=15]

Parameter	Mean/ median	Minimum	Maximum
TEE [kcal/day]	3877± 508	2881	4787
TEE [kcal/kg b.m./day]	47.1± 5.6	36.9	56.9
AEE [kcal/day]	1898± 634	1058	2839
SEE [kcal/day]	1979± 425	1242	2776
MET	2.05±2.09	1.55	2.50
LD [minutes]	474± 92	318	714
PAD [minutes]	317± 111	187	502
MPA [minutes]	285±105	155	445
VPA [minutes]	31± 18	2	65
VVPA [minutes]	0	0.00	4
NS [number]	19498± 5407	11266	27156

TEE- total energy expenditure, AEE- active energy expenditure, SEE- sedentary energy expenditure MET- metabolic equivalent of task, LD- lying down duration (including sleeping time), PAD- physical activity duration (in general), MPA- moderate activity duration, VPA- vigorous activity duration, VVPA- very vigorous activity duration, NS- number of steps

The analysis of TEE results show that examined athletes were characterized by high daily energy expenditure. Almost half of TEE was consumed on physical activity, which means that the subjects lead an active lifestyle. Other study, in which TEE was measured by the doubly labelled water method, showed that total energy expenditure of soccer players was slightly lower than the one presented in this research [6]. In the review of previous studies Nogueira and Da Costa [12] noted that the average energy expenditure of athletes, depending on the sport discipline, ranges from 2690 up to 3550 calories per day, which was also lower than the value obtained in our study. On the other hand, similar results were presented by *Ekelund* et al. [7], who observed that TEE values were around 3800 kcal during both: training and non-training days. However, in none of this studies SensWear device was used as there is still few studies conducted on athletes using this method. There is need for further research using this device.

The assessment of physical activity level, based on the number of steps also leads to the conclusion that subjects had an active (6.7%) or very active lifestyle (93.3%).

Examined athletes spent an average of 5 hours and 17 minutes per day (± 1 h 50 min) for physical activity, most of which occurred to be a moderate activity (4 h 45 min ± 1 h 45 min). Intense exercise lasted an average of 31.4 ± 18.2 minutes per day.

The average daily energy intake was 2726.9 ± 575.7 kcal (ranged from 1871.45 up to 3758.84), which means that TEE was higher than energy intake (p=0.0000).

Energy value of the diet covered TEE in at least 95% only in 2 (13.3%) athletes. Therefore, it can be assumed that they met their energy needs. The rest of the examined sportsmen consumed insufficient amounts of energy (deficiency on average by 33.1% ± 11.4%), as it is shown in Figure 1. No correlation between dietary energy intake and total energy expenditure was observed, which confirms that the diet did not provide athletes with sufficient amount of energy (p = 0.271, R = 3040). Moreover, previous studies had shown that SWA often underestimate energy expenditure while high- intense activity is concern [4, 5, 9], which may suggest that the difference between energy intake and expenditure can be even bigger. Insufficient energy intake in comparison to energy expenditure is very unfavorable for athletes. Maintaining the adequate balance between TEE and the energy consumption ensures both: the maintenance of correct body weight and of the right proportions between fat mass and fat free mass. In ad-

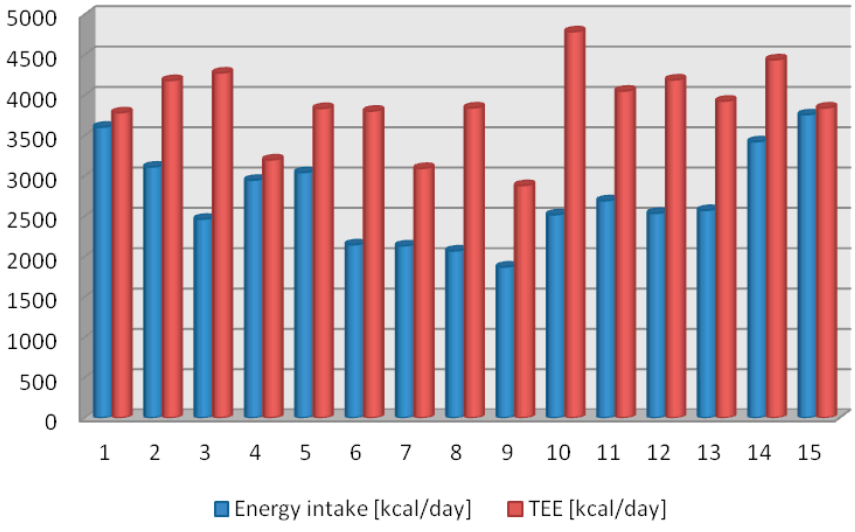

Figure 1. Energy intake and total energy expenditure (TEE) of athletes [n=15]

dition, keeping this balance affects positively glycogen reserves, the vitamins and minerals status and physical fitness [12]. Moreover, in a case of energy deficit, the proteins may be used as an energy ingredient for a body. Proteins are not only delivered from food but also from amino acids produced during the degradation of body proteins, which cause the decrease of muscle mass [24].

In a study conducted on Kenyan runners, *Onywera* et al. [13] also observed that the total energy expenditure, assessed using physical activity ratios, was higher than the supply of energy in the athletes' diet (3605 ± 119 kcal vs. 2987 ± 293 kcal). Same conclusions were drown from the study on long- distance runners conducted with use of SenseWear mobile monitor, where the average energy intake of 3030±520 kcal did not cover energy expenditure of 3470 ± 250 kcal [23]. In contrast, *Papandreou* et al. [14] noted that energy intake was higher than TEE in volleyball players (2639 ± 293kcal vs. 2011 ± 123 kcal) and long-distance runners (2511 ± 301 kcal vs. 1974 ± 130 kcal), and too low in basketball players (1901 ± 323 vs. 2453 ± 104 kcal). In quoted study, the energy expenditure was calculated by multiply resting metabolic rate by PAL value. Insufficient energy balanced was also observed in soccer players (TEE established using doubly labeled water method) [6] and judo athletes (TEE based on SWA) [4].

A positive correlation between total energy expenditure (TEE), and BMI (p=0.001, R= 0.7553) was observed. However, this result was not correlated with an increase of the energy intake, which may lead to a higher energy deficit in athletes with higher body weight, and in a consequence to a weight reduction.

On the other hand, the incorrect body mass was not observed in any of athletes which suggests that the energy intake was adequate. The underreporting of dietary energy consumption is often observed in athletes [2, 4, 6, 11, 21], as many factors can interfere with the self--report. Improper recording, inadequate estimation of portion size or changing the dietary habits during recall have to be taken under consideration while analyzing the data. Additionally, higher the food consumption is, bigger the underestimation becomes [15, 16].

CONCLUSIONS

1. Athletes consumed inadequate amount of energy in comparison to their energy expenditure.
2. Athletes did not have an adequate knowledge about their energy requirement, which shows the need of nutritional consulting and education among this group.

Acknowledgements

This study was funded by the Faculty of Human Nutrition and Consumer Sciences (WULS-SGGW) Warsaw, Poland.

Conflict of interest

The authors declare no conflict of interest.

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Received: 12.03.2014
Accepted: 28.08.2014