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Energy expenditure and fat metabolism in trained and untrained women

Wydatek energetyczny i metabolizm tłuszczów w grupie trenujących i nie trenujących kobiet

The one of major components, which determine energy expenditure at rest and during exercise is physical activity (Ravussin et. al, 1993). In our previous study we showed that the aerobically trained woman had higher energy expenditure at rest than the untrained woman (Ziemann , 2003). Equally the fitness level expressed in the maximal oxygen consumption, fat mass, fat-free mass can affect energy expenditure at rest and during exercise. (Poehlman et. al, 1994, Tremblay 1986).

It is known that low levels of fat free mass are related to impaired functional capacity and decreased physical activity/energy expenditure, and increase the risk gaining of obesity The prevention of obesity is the balance between fat intake and fat oxidation. Regular physical activity is crucial in maintaining this balance. An increase in fat mass is very often the first indication that people have stopped training

In our study we wanted to compare the body composition of two groups of women: students-volunteers of physical education: untrained and trained commencing studies. The second aim of this study was to determine energy expenditure and fat intake/oxidation at rest and during exercise. We were looking for a correlation between fitness levels and fat mass, fat free mass and fat oxidation.

MATERIALS AND METHODS

Subjects. Fourteen women – students of University School of Physical Education volunteered for this study. The subjects were divided in two groups. The first group was untrained women (UN) and the second group was women, who in the period of their age 14-19 were long-distance runners but actually they take part only in students occupations. All women ate in students canteen but we didn`t control their diet.

Preexperimental protocol. In both groups were determined main aerobic components: values of VO_2 max in ml O_2 / min/ kg b.m. and values of anaerobic threshold (AT) expressed in % VO_2 max using gas analyser EOS SPRINT Jaeger. Peak oxygen uptake (VO_2 max) and anaerobic threshold (AT) was measured for each subject during incremental cycling exercise to volitional fatigue on cycloergometer Monark.

Experimental protocol I: Resting energy expenditure and percentage of energy delivered from fat were estimated in the morning, using Jaeger Nutrition program and indirect calorimetry based on basic primary variables: VO_2 , VCO_2 , rate of nitrogen excretion (two weeks after VO_2 max test). All women were tested in follicular phase of the menstrual cycle.

Experimental protocol II : The second exercise was 2h long lasting work in individual intensity 35%of VO_2max. We determined the energy expenditure and fat oxidation during work using Jaeger Nutrition program and indirect calorimetry too.

Statistic. All reported values are means ± SD. The data were statistically analyzed according to the t-Student's test using the variance analysis. The level of $p< 0.05$ was considered as statistical significant.

RESULTS

The anthropological and physiological parameters of subjects participated in experiments are shown in table 1, 2. We observed the significant differences in body composition between groups: lower fat mass and the higher fat free mass in aerobically trained woman than untrained group. The higher fitness level expressed in VO_2max and the level of the anaerobic threshold was observed in aerobically trained women. Energy expenditure and fat metabolism are presented in tab 3 and 4. The contribution of lipids in energy yielding at rest was lower in untrained group but during exercise fat turnover increased in this group more in accordance with trained group. We observed the correlation between fitness level expressed in maximal oxygen consumption and fat oxidation during work only in trained group.

Table 1. Anthropometric characteristics of subjects

Subjects	Age [yr]	Weight [kg]	Height [cm]	% Fat	Fat mass [kg]	Fat free mass [kg]]
Untrained N=7	22,4± 0,8	57,0± 4,5	166± 3,2	21,3± 2,3	12,2± 2,1	44,8± 2,7
Trained N=7	22,1± 0,4	57,1± 5,2	169± 2,8	15,6± 2,7	9,0± 2,2	48,2± 3,3
				P<0,001		P<0,01
Values are mean ± SD, n no of subject, * differences from height activity (as determined by paired *t*-test)						

Table 2. Aerobic capacity measurements during two test

Subjects	VO_2 max [ml/min/kg]	AT [ml/min/kg]	AT [%VOmax]	Energetic cost of 2h exercise	
				%VO_2 max 1h	%VO_2 max 2h
Untrained N=7	38,9 ± 2,9	27,3 ± 6,2	62,1±10,6	35±7,8	47±8,2
Trained N=7	45,3 ± 4,0	44,5 ± 6,7	55,2 ±5,4	35±6,4	39±3,2
	P< 0,001				P< 0,05
* differences from height activity (as determined by paired *t*-test)					

Table 2. Energy expenditure at rest and during exercise

Subjects	Rest		2 h Work	
	REE [kJ/2h]	REE [kJ/kg/2h]	REE [kJ/2h]	REE [kJ/kg/2h]
Untrained N=7	679,7± 130	12± 2,4	2741,2± 197	48,3± 5
Trained N=7	760,6± 111	13,3± 1,8	2708,6± 309	47,7± 7
* differences from height activity (as determined by paired *t*-test)				

Table 3. Contribution of fat in energy yielding at rest and during exercise

Subjects	Rest			Work		
	FAT [g/2h]	FAT [g/kg/2h]	FAT [%]	FAT [g/2h]	FAT [g/kg/2h]	FAT [%]
Untrained N=7	4,4* ±1,4	0,08* ±0,01	24,3 * ±8,0	27,7* ±6,2	0,49* ±0,9	38,0* ±8,16
Trained N=7	7,2* ±2,4	0,13* ±0,04	37,9 * ±10,9	21,0* ±5,4	0,37* ±0,1	30,8* ±7,2
	P<0,01	P<0,05	P<0,01	P<0,05	P<0,05	P<0,05
* differences from height activity (as determined by paired *t*-test)						

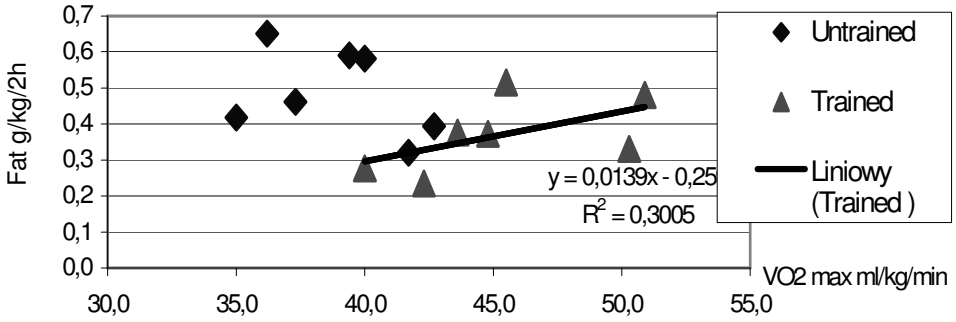

Fig 1. The correlation between fitness level expressed in maximal oxygen consumption and fat oxidation during work

DISCUSSION

Fat can be the primary energy sources beside carbohydrate during exercise. The relative amount used of fat depends on factors :exercise intensity and duration, level of physical fitness and dietary practice. In our experiments we observed higher fat intake at rest in trained group, but during exercise we indicated some opposite results. Fat oxidation was higher in untrained group. Similar results we found in Astrup`s study), who observed a higher rate of fat oxidation in obese women as compared to nonobese women (Astrup, 1994) The larger adipose tissue mass promotes increased fat oxidation. In our study untrained woman had the largest fat mass as trained. However untrained group represented mid body fat mass in standards recommended by Lohman (Lohman 1997). Energetic cost of exercise was lower in trained woman and this fact could be a reason for smaller fat oxidation in trained group. We indicated as fat intake increases, fat oxidation does not increase proportionately. Fat oxidation in active group was depended on fitness level expressed in maximal oxygen consumption. We didin`t observe this correlation in untrained group.

REFERENCES

1. Astrup A., Buemann B., Western P., Toubro S., Raben A., Christensen NJ., Obesity as an adaptation to hogh-fat diet: evidence from a cross-sectional study. Am J. Clin Nutr. 1994:59: 350-5
2. Poehlman E., Gardner A., Arciero P., Goran M., Calles-Escandon. J., Effects of endurance training on total fat oxidation in elderly persons. J. Appl. Physiol. 76:2281-2287, 1994
3. Ravussin E., Swinburn BA., Energy metabolism.In:Stunkard JA, Wadden TA, eds.Obesity:Theory and Therapy. New York: Raven Press Ltd, 1993:97-123
4. Tremblay A., Fontaine E., Poelman E., Mitchell D., Perron L., Bouchard C., The effect of exercise training on resting metabolic rate in lean and moderately obese individuals. Int. J. Obesity 10: 511-517, 1986
5. Ziemann E., Grzywacz T., Laskowski R., Jastrzębski Z., Szczęsna-Kaczmarek A., 2003, Physical activity and energetic profile in women. Annales Universitatis mariae Curie-Skłodowska Sect.D.Medicina , vol.58 suppl 13, s. 521-525

SUMMARY

The one of major components, which determine energy expenditure at rest and during exercise is physical activity. Regular physical activity can decrease the risk gaining of develop obesity . Equally, the balance between fat intake and fat oxidation is one of kind of the prevention of obesity. In our study we compare fat metabolism and energy expenditure in trained and untrained women. Resting energy expenditure and fat oxidation were measured using the expiratory gas analyzer EOS sprint and computer program Nutrition of Jaeger. It was the indirect calorimetric method. Aerobic capacity we

determined in VO_2 max and the level of anaerobic threshold. We concluded that the larger adipose tissue mass promotes increased fat oxidation during exercise in untrained group but in trained woman fat oxidation was depended on fitness level and not on fat mass. Training changed metabolism for the long time. This work was supported by KBN statutory grant.

STRESZCZENIE

Jednym z istotnych czynników, który wpływa na wydatek energetyczny oraz reguluje metabolizm tłuszczów jest aktywność fizyczna. Trening fizyczny zmienia metabolizm oraz pomaga w utrzymaniu równowagi między spożyciem tłuszczów, a ich utlenianiem. Celem pracy było porównanie metabolizmu tłuszczów w grupie kobiet trenujących konkurencje wytrzymałościowe przed rozpoczęciem studiów oraz w grupie nie trenujących W pracy szukano również zależności między wydolnością fizyczną mierzoną wartością VO_2 max , a metabolizmem tłuszczów w spoczynku i podczas wysiłku długotrwałego. Oceny spoczynkowego wydatku energetycznego oraz udziału tłuszczów w uwalnianiu energii dokonano metodą kalorymetrii pośredniej. Do oceny wykorzystano program kalorymetrii pośredniej - Nutrition firmy Jaeger. Uzyskane wyniki wskazują, iż wyższy poziom tkanki tłuszczowej w organizmie powoduje większe utlenianie tłuszczów podczas wysiłku w grupie nie trenującej. Ilość utlenianych tłuszczów zależy od wzrostu kosztu energetycznego wysiłku. Trening zmienia metabolizm tłuszczów w grupie trenującej. Czynnikiem regulującym utlenianie tłuszczów jest poziom maksymalnego poboru tlenu.