WFL Publisher
Science and Technology
Meri-Rastilantie 3 B, FI-00980
Helsinki, Finland
e-mail: info@world-food.net

Journal of Food, Agriculture & Environment Vol.11 (1): 278-280. 2013

www.world-food.net

Increase of fitness level assessed through heart rate, body mass index and muscular mass as component of a healthy life style

Cristian Negrea

Faculty of Physical Education and Sports, West University of Timisoara, Bld. Vasile Parvan Street, No. 4, 300223 Timisoara, Romania. e-mail: cristian_negrea_ro@yahoo.com

Received 24 September 2012, accepted 18 January 2013.

Abstract

The study was conducted on a sample of 42 adult volunteers from Romania, aged 30 years, with sedentary lifestyle, grouped into the following categories: normal weight and obese (World Health Organisation-WHO). The study lasted six months and investigated the evolution of several fitness parameters, which represent the expression of health state of a human adult organism: heart rate in rest, body mass index (BMI) and muscular mass. The subjects consisting of adult persons, women and men, followed a specific program of physical training aiming the two components of the fitness: aerobe and muscular. The training frequency was three times a week and respectively one hour daily for each subject. Nutritive supplements were not administrated. Also, the proportion of proteins, carbohydrates and lipids administrated to each person by food during the study were identical, being respected in the same time the differences arising from the body weight. Results showed that following physical training and controlled nutrition, all the analyzed parameters were improved. For both studied categories of subjects, significantly lower values ($p < 0.05$) of the heart rate at rest were recorded at the end of the programme as compared to the values obtained upon the initial testing. Also, following the training programme, the subjects were differently distributed according to the body mass index values as compared to the values obtained upon the initial testing. Thus, subjects initially classified in the 1st and 2nd degrees of obesity were later distributed as normal weight and overweight, respectively (according to WHO). As for the muscle mass index, a significant increase occurred ($p < 0.05$) in both categories of subjects, which represents an argument for using this type of training in cases where muscular hypertrophy is also targeted.

Key words: Fitness, health state, height, body weight, muscular mass, heart rate, body mass index, physical training.

Introduction

Modern statistics underline the importance of physical activity for the decrease of chronic pathology and mortality [1-3]. Sedentarism and diet are decisive factors for the health status [4].

Improper diet has a primordial role in the etiology of numerous chronic diseases. High fat and sugar diets, with a dense energy content and increased intake of animal products have all been demonstrated as determinant factors for numerous chronic diseases [5].

Following regular, high intensity physical activity, certain metabolic adjustments occur in the entire organism [6]. In the skeletal muscles, in particular, there is a significant increase in the size and number of mitochondria, as well as in the oxidative activity of enzymes. The myoglobin content may increase, thus increasing the amount of oxygen stored in each of the individual muscular fibres, but the effect is variable. These adjustments, together with the increase in the number of capillary vessels and of the blood flow in trained muscles, increase the oxydative capacity and the muscular endurance. Endurance trainings also increase the ability of trained muscles to store glycogen [7]. At the same time, the capacity of trained muscles to utilise fat as a source of energy is improved, thus sparing the glycogen deposits. The increased capacity to use fat as a consequence of endurance training is a consequence of the property to mobilise free fatty acids from the fat deposits and of the improvement of the fat oxydising capacity due to the increase in the level of enzymes responsible for fat oxidation [8].

Endurance trainings lead to significant changes in the cardio-respiratory responses, both during rest and when the organism is in movement, at maximal as well as submaximal activity levels. The extent of adjustments depends on the initial fitness level, the mode, frequency, intensity and duration of exercises, and on the period of time from the beginning of exercising (weeks, months, years) [8-9].

Study of the adaptive responses of the cardiovascular system to regular physical activity showed a reduction in sympathetic activity and an increase in parasympathetic activity during rest and at different absolute intensities of exercise in a cross-sectional design, trained individuals who exercised at least 5 days/week for 45. There was a relative bradycardia in the trained groups at rest and at the same absolute intensity of exercise in both young and middle-aged subjects. Spectral analysis was capable of showing changes in autonomic control of heart rate at rest and across intensities of exercise [10].

Materials and Methods

The study was conducted on a sample of 42 adult volunteers, aged 30 years, with sedentary lifestyle, grouped into the following categories: normal weight and obese. These categories were established according to the World Health Organisation classification (WHO 2004): normal range BMI of 18.5-24.99 and class I obesity BMI of 30-34.99. Each category included 14 persons, 7 men and 7 women.

Heart rate was measured using a Polar watch RS 400 with a Polar chest strap.

Anthropometric measurements consisting of determining the Quetelet index for BMI by the formula: Weight (kg) /Height ^{2} (m^2). The subjects were measured using an electronic scale with height rod (measurement error ±0.1 kg). Height measurement was performed in orthostatic position, shoes off, with the back against the measuring rod. Body weight measurement was done with the subjects wearing light clothing, after urination and taking into account the restrictions required by the assessment of body composition and nutritional analysis (restricted food and liquid intake at least 3 hours prior to the evaluation).

Body composition analysis was performed in order to find the percent of body muscular mass. For this, a multifrequency bio-impedance meter has been used (InBody 720, South Korea). Data analysis and interpretation were done using software analysis programmes (Metasoft, Cardiosoft, Spirowin).

The physical training programme was done using the equipments of the Faculty of Physical Education and Sport of the West University in Timisoara, Romania. Exercises were performed three times a week (on Mondays, Thursdays and Fridays) for one hour daily of which 30 min were allocated to aerobic fitness and 30 min to muscle fitness.

The following cardio equipments were used: treadmill Technogym Run Excite 900E, synchro Technogym 700E, step Technogym 700E, bike Technogym 700E/recline Technogym 700E, crosstrainer Technogym cardio wave 700E, upper body Technogym Top 700E.

The cardio exercises were structured on the following groups of cardio equipments corresponding to three week days: treadmill + cardio wave: 15 min treadmill running, 2 min pause, 15 min cardio wave; synchro + top: 15 min synchro, 2 min pause, 15 min top; step + bike/recline: 15 min step, 2 min pause, 15 min bike/recline.

Throughout the entire study period, the subjects were monitored during training using a chest strap. This allowed the monitoring of effort intensity to reach training programme recommendations.

- During the 1st – 2nd months the increase of aerobic capacity and muscle tonus were targeted; training consisted of performing a circuit composed of 10 series of exercises of 20 repeats each, with 1 min 30 s. pause between exercises.
- During the 3rd – 4th months the increase of aerobic capacity, of body fat consumption and the maintenance of muscle mass were targeted; training consisted of twice performing circuit composed of 10 series of exercises of 15 repeats each, with 1 min pause between series and 3 min pause between circuits.
- During the 5th – 6th months the increase of fitness parameters, improvement of muscle fitness and increasing the percent of muscle mass were targeted; training consisted of three times performing a circuit composed of 10 series of 20 repeats each, with 1 min and 30 s pause between series and 2 min pause between circuits.

The equipments used for muscle fitness exercises were: Strength Technogym Chest Press, Strength Technogym Lat Machine, Strength Technogym Crunch Bench (crunch and reverse crunch), Strength Technogym Leg Press, Strength Technogym Leg Curl, Strength Technogym Multipower (pushing up the barbell from the chest), Strength Technogym Pulley, Strength Technogym Leg Extension, Bobath ball.

With each of the previously mentioned equipments one series of exercises was performed, except the Strength Technogym Crunch Bench which was used for 2 series, with a different exercise each, i.e. crunch and reverse crunch. The crunch was performed horizontally on the crunch bench. The reverse crunch was performed on the same bench with 10° decline. The Bobath ball was used for the following exercise: starting from dorsal decubitus, calf on the ball, arms spread laterally, palms on the floor, concomitant calf flexion on the thigh and pelvis pushed forward until the shoulder, pelvis and knee are on the same level and the heel is close to the gluteal muscle, then back to the starting position.

The evolution in time of the muscle fitness training programme was done according to the body's effort adaptation capacity, and load dosage was done according to the previously decided number of repeats.

After each month of training, muscular strength was tested on each equipment, adjusting the load in order for the subject to be able to perform the decided number of repeats.

The subjects adhered to a diet previously decided according to the basal metabolic rate (as determined by the nutritional analysis test) plus the daily calories requirement resulting from daily activities. Thus, proteins covered 15%, lipids 25% and carbohydrates 60% of the daily caloric needs, with the objectives of increasing muscular mass and decreasing body fat.

The recorded data were statistically processed by SPSS version 8.0. For the results, significant and highly significant values of statistical significance threshold were found ($p < 0.05$).

Results and Discussion

As a result of the proposed training programme, the adjustment response of the organism was observed by the improvement in the studied fitness parameters (Table 1).

Thus, for both studied categories of subjects, significantly lower values ($p < 0.05$) of the heart rate at rest were recorded at the end of the programme as compared to the values obtained upon the initial testing. Also, following the training programme, the subjects were differently distributed according to the body mass index values as compared to the values obtained upon the initial testing. Thus, subjects initially classified in the 1st and 2nd degrees of obesity were later distributed as normal weight and overweight, respectively (BMI between 25 and 29.99 according to WHO). As

Table 1. Mean values of the analyzed parameters recorded in the studied categories (normal weight and obese).

Analyzed parameter	Category of subjects			
	Women		Men	
	initial	final	initial	final
	Normal weight			
Heart rate in rest (beats per minute)	78.71±5.31	66.57±5.09	70.71±2.69	59.85±1.86
BMI (kg·m^2)	22.04±1.76	21.6±1.61	22.61±1.15	23.47±1.19
Muscular mass (kg, %)	27.22±2.73	29.72±2.72	33.15±4.95	35.51±6.01
	Obese			
Heart rate in rest (beats per minute)	81.85±5.33	68.00±4.12	77.00±6.11	61.85±2.91
BMI (kg·m^2)	32.6±1.21	25.06±0.94	36.12±1.98	25.29±1.51
Muscular mass (kg, %)	23.92±2.56	26.54±1.89	34.88±0.53	40.34±1.52

Table 2. Values of fitness parameters (final versus initial) in the studied groups (Wilcoxon test,p<0.05).

WHO Category	Gender Category	Statistic indicator	Heart rate in rest final-initial	BMI final-initial	Muscular mass final-initial
Normal weight	Women	Wilcoxon coefficient	-2.384	-2.366	-2.371
		Signification (2-tailed)	0.017	0.018	0.018
	Men	Wilcoxon coefficient	-2.414	-2.379	-1.183
		Signification (2-tailed)	0.016	0.017	0.237
Obese	Women	Wilcoxon coefficient	-2.375	-2.366	-2.366
		Signification (2-tailed)	0.018	0.018	0.018
	Men	Wilcoxon coefficient	-2.371	-2.366	-2.366
		Signification (2-tailed)	0.018	0.018	0.018

Table 3. Evolution of the analyzed fitness parameters at the end of study.

Gender category	Normal weight		Obese	
	Women	Men	Women	Men
Heart rate in reset mean decrease (%)	15.44	15.31	16.85	19.42
Muscular mass mean increase (%)	9.37	11.75	11.30	15.63

Table 4. Comparative evolution rate of fitness parameters in the three categories of the studied group (normal weight and obese) at the end of the physical training (Wilcoxon test, p<0.05).

Gender category	Compared categories	Statistic indicator	Fitness indicator	
			Heart rate in rest decrease	Muscular mass increase
Women	Obese - Normal weight	Wilcoxon coefficient	-2.366	-2.028
		Signification (2-tailed)	0.018	0.043
Men	Obese - Normal weight	Wilcoxon coefficient	-2.197	-2.366
		Signification (2-tailed)	0.028	0.018

for the muscle mass index, a significant increase occured (p < 0.05) in both categories of subjects, which represents an argument for using this type of training in cases where muscular hypertrophy is also targeted (Table 2).

Depending on the heart rate at rest, a better adaptation to effort and a higher muscle mass gain were recorded in men as compared to women (Table 3).

The results obtained within the same gender group but among different body weight categories showed that for the heart rate at rest indicator, in both obese women and men, better evolution rates were recorded reported to their normal weight counterparts. The same situation was also noted for the muscle mass indicator (Table 4).

Conclusions

The results showed that following physical training and controlled nutrition, all the analyzed parameters have been improved.

Following the training programme, subjects were redistributed according to their body mass index by being classified in a lower WHO category, with an improvement in their heart rate at rest and with muscle mass hypertrophy, respectively.

Acknowledgements

The author acknowledges the men and women who participated in the study.

References

[1]Francis, K. 1996. Physical activity in the prevention of cardiovascular disease. Phys. Ther. **76**(5):456-468.

[2]Minami, M., Demura, S. and Nagasawa, Y. 2002. Cross sectional study of the relationship between physical fitness and life style, health-status in healthy aged males. Jpn. J. Publ. Health **49**(10):1040-1052.

[3]Sato, T., Demura, S., Murase, T. and Kobayashi, Y. 2006. Contribution of physical fitness component to health status in middle-aged and ederly males. J. Physiol. Anthropol. **25**(5):311-319.

[4]Lamb, K. L., Brodie, D. A. and Roberts, K. 1988. Physical fitness and health-related fitness as indicators of a positive health state. Health Promot. Int. **3**(2):171-182.

[5]Swartz, A. M., Tarima, S., Miller, N. E., Hart, T. L., Grimm, E. K., Rote, A. E. and Strath, S. J. 2012. Prediction of body fat in older adults by time spent in sedentary behavior. J. Aging Phys. Act. **20**(3):332-344.

[6]Negrea, C. and Iordache, M. 2012. Evolution of several fitness parameters in an adult human population as expression of health state. J. Food Agric. Environ. **10**(2):137-141.

[7]Kiens, B., Essen-Gustavsson, B., Christensen, N. J. and Saltin, B. 1993. Skeletal muscle substrate utilization during submaximal exercise in man: Effect of endurance training. J. Physiol. Cardiol. **469**:459-478.

[8]Poehlman, E. T., Denino, W. F., Beckett, T., Kinaman, K. A., Dionne I. J., Dvorak, R. and Ades, P. A. 2002. Effects of endurance and resistance training on total daily energy expenditure in young women: A controlled randomized trial. J. Clin. Endocrinol. Metab. **87**(3):1004-1009.

[9]Brown, D. W., Balluz, L. S., Heath, G. W., Moriarty, D. G., Ford, E. S., Giles, W. H. and Mokdad, A. H. 2003. Associations between recommended levels of physical activity and health-related quality of life; Findings from the 2001 Behavioral Risk Factor Surveillance System (BRFSS) survey. Prev. Med. **37**(5):520-528.

[10]Gregoire, J., Tuck, S., Yamamoto, Y. and Hughson, R. L. 1996. Heart rate variability at rest and exercise: influence of age, gender, and physical training. Can. J. Appl. Physiol. **21**(6):455-470.