Trakia Journal of Sciences, Vol. 8, Suppl. 3, pp 381-388, 2010

Available online at:
http://www.uni-sz.bg

ISSN 1313-7069 (print)
ISSN 1313-3551 (online)

COMPARATIVE ANALYSIS OF THE ENERGY CONSUMPTION AT "RUNNING AND WALKING ON THE SPOT" AND "RUNNING AND WALKING ON TREADBAN" WITH MUSICAL ACCOMPANIMENT

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ABSTRACT
A comparative analysis of the energy consumption at "running and walking on the spot" and "running and walking on tread ban" with musical accompaniment (according to model programs for female students "having a normal BMI" and with a BMI "before obesity") has been made. The investigation results have shown that the model programs can substitute in an efficient way such an expensive device as the tread ban. The motive activities "running and walking on the spot" with musical accompaniment are recommended as particularly suitable to be practiced at home during the winter months and the examination periods.

Key words: an energy consumption, BMI, "running and walking on the spot"

INTRODUCTION

Sedentary lifestyle results in many health problems and is closely related to the problem of overweight and obesity [1]. The assessment of body weight is made mostly by the Body Mass Index (BMI). Overweight is a socially significant health problem [2, 3, 4, 5, 6, 7, 8, 9, 10]. Over 1 billiard people in Europe are overweight. Bulgarians are ranked in fifth place in obesity in Europe. In Europe, 300 million suffer from this disorder. According to Merdzhanov [11] physical activity is on the decrease in nearly all segments of the population.

Body mass index in students of Trakia University was studied in the period 2004 – 2010 [12, 13, 14, 15, 16]. Recent data indicate that the percentage of overweight female students in Bulgaria is nearly three times greater and for male students more than five times greater than the percentage of their peers [17, 18]. There is also a high risk of cardiovascular disease in both women and men.

Physical activity is an essential component of a healthy lifestyle and a requirement for achieving and keeping of body mass within a normal range [19, 20, 21, 22]. Various modern appliances and other equipment are being used in fitness rooms in recent years. "Running on the spot" combined with "walking on the spot" are physical activities readily available and suitable for individual workouts, easily applicable and not requiring funds to buy expensive fitness equipment. In the literature known to us only three authors have ever developed programmes for the running on the spot technique. The programme of Kalaykov [23] is the simplest. It is scheduled for 12 weeks starting with one minute during the first week and reaching 20 minutes in the last week. Kenneth Cooper [24] has developed a program conditionally divided into an introductory and basic part, of a total duration 3-4 months. The author believes that after completion of this programme full readiness is obtained to practice the sport discipline chosen. In the programs of Davidov [25] each activity represents a structurally complete workout with a preparatory, main and final part.

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Until now no comparative analysis of energy expenditure in running and walking on the spot and treadmill running and walking with musical accompaniment for female university students of different body mass index was conducted in Bulgaria.

The purpose of this research is to determine the presence or difference in the energy expenditure in running and walking on the spot and treadmill running and walking with musical accompaniment under model programmes for female university students with Normal BMI and Pre-Obesity 1 BMI.
Completion of this purpose involves solution of the following *tasks:*
1. Determination of individual values of BMI.
2. Preparation of model programmes for female university students with Normal BMI and Pre-Obesity 1 BMI and selection of music suitable for the purpose of the research.
3. Measurement of energy expenditure in running and walking on the spot and treadmill running and walking with musical accompaniment under model programmes for female university students with Normal BMI and Pre-Obesity 1 BMI.
4. Making a comparative analysis between energy expenditure during both model programmes.

METHODS

Subject of the research is the *energy expenditure* in running and walking on the spot and treadmill running and walking with musical accompaniment under model programmes for female university students with Normal BMI and Pre-Obesity 1 BMI.
Object of the research are *385 female university students* in their first and second years of studies in Trakia University of Stara Zagora. Of these, *18 students of Normal BMI* and *18 students of Pre-Obesity 1 BMI* participated in the measurement the energy expenditure in running and walking on the spot and treadmill running and walking.
Working hypothesis. Running on the spot in combination with walking on the spot with musical accompaniment are readily available and easily applicable physical activities that can be widely used in an independent workout as elements of programmes for maintenance or reduction of body mass instead of expensive fitness equipment such as treadmill.

One of the methods applied was anthropometry. Height was measured by standard methods and a professional medical apparatus of the Japanese company TANITA was used for measuring body mass and determining the individual BMI. Attached is the International Classification of BMI (according to the World Health Organization) [26].

Classification	**BMI(kg/m2)**	
Underweight	**<18,50**	**<18,50**
Severe thinness	<16,00	<16,00
Moderate thinness	16,00 – 16,99	16,00 – 16,99
Mild thinness	17,00 – 18,49	17,00 – 18,49
Normal range	**18,50 – 24,99**	**18,50 – 22,99**
		23,00 – 24,99
Overweight	**≥25,00**	**≥25,00**
Pre-obese	25,00 – 29,99	Pre-obese 1 25,00 – 27,49
		Pre-obese 2 27,50 – 29,99
Obese	**≥30,00**	**≥30.00**
Obese class I	30,00 – 34,99	30,00 – 32,49
		32,50 – 34,99
Obese class II	35,00 – 39,99	35,00 – 37,49
		37,50 – 39,99
Obese class III	≥40,00	≥40,00

Two programmes were designed for walking and running on the spot and treadmill walking and running for female university students with Normal BMI and Pre-Obesity 1 BMI,

including proposed stages of preparation, but in this paper the model programs are presented and tested in their basic version. Appropriate music was selected and played as a background to the two programmes during their completion. A DIGITAL MP3 PLAYER was used.

BASIC VERSION OF MODEL PROGRAMME for female university students with Normal BMI (BMI in the range 18.5 – 24.99)

4 min. running (First element)	**4 min. running (Second element)**	**4 min. running (Third element)**	**4 min. running (Fourth element)**	**4 min. running (Fifth element)**

Programme duration – 20 min., of which 8 min. running on the spot and 12 min. walking on the spot. Music tempo – 130 – 140 beats per minute.

BASIC VERSION OF MODEL PROGRAMME for female university students with Pre-Obesity 1 BMI (BMI in the range 25 – 27.49)

4 min. walking (First element)	**2 min. running +2 min. fast walking (Second element)**	**4 min. walking (Third element)**	**2 min. running +2 min. fast walking (Fourth element)**	**4 min. walking (Fifth element)**

Programme duration – 20 min., of which 4 min. running on the spot and 16 min. walking on the spot. Music tempo – 130 – 140 beats per minute.

Both programmes were performed using a treadmill adjusted at a speed suitable to match music tempo - SPEED 6 for walking and SPEED 6,4 for fast walking and running.

Energy expenditure was continuously measured with a Sense Wear Pro 2 Body Monitoring System multi sensor monitor.

According to the International System of Units (SI), the unit used to measure the quantity of energy is joule (**J**), while a calorie is mainly used to indicate the energy value (calorific value) of food. The relation between calorie and standardized J is:

1 **cal** = 4.184 **J** 1 **J** = 0.239 **cal**

The unit of measurement used in this paper is J.

Attached are mathematical and statistical methods for quantitative assessment of research indicators and comparative method of analysis of data obtained by statistical processing. The t - criterion of Student was used. Differences at $p < 0.05$ were assumed as reliable.

Data in **Figure 1** show the percentage of female university students with different BMI. Accordingly, 66.2% were with Normal BMI, 8.3 % with Pre-Obesity 1 BMI. The persons studied for energy expenditure were selected on random basis from this sample.

The group of students with Pre-Obesity 1 BMI is of particular importance as it is closest to the group of students with Standard BMI. Differences in body mass between the two groups are not high. We believe that reduction leading to achievement of normal body mass can be obtained through some small effort, good motivation and change in lifestyle. The above is of strategic importance in order to avoid further accumulation of body mass and a shift to the obesity group. It is worrying that in total 22.1 % of those studied were overweight.

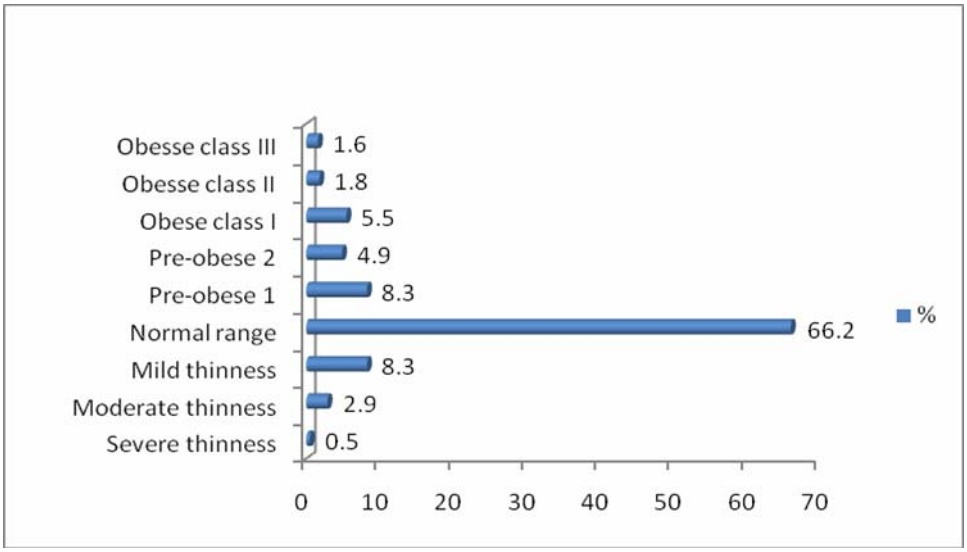

Figure 1. Percentage of persons studied on BMI basis

From **Table 1** is seen that the results obtained from the comparative analysis of energy expenditure by types of physical activities (by elements) of the model programme for female university students with Normal BMI are statistically significant, with the exception of the fourth element. The second element has the highest statistical significance - running ($p < 0.01$). On examination of energy expenditure differences in the on the spot workout and treadmill workout it should be noted that in the beginning a difference of 8.3 J is found, in the second and third element it changes almost by half and values become almost similar – 4.18 J and 4.19 J, then in the fourth element the difference is three times greater – 12.55 J, and in the fifth element the figure is the same but with a negative sign.

Table 1. *Data for comparative analysis of energy expenditure by types of physical activities (elements) of the model program for female university students with Normal BMI*

Duration (min.) and type of physical activity (elements)	Energy expenditure with Normal BMI					
	Energy expenditure – on the spot workout $\bar{X}$	S_1	***Energy expenditure – treadmill workout*** $\bar{X}$	S_2	d	Statistical significance
4 min. walking (First element)	92.05 J	0.11	83.68 J	0.1	8.37	p<0.05*
4 min. running (Second element)	133.88 J	1.1	129.70 J	0.21	4.18	p<0.01**
4 min. walking (Third element)	117.15 J	0.2	112.96 J	0.1	4.19	p<0.05*
4 min. running (Fourth element)	138.07 J	0.1	125.52 J	0.13	12.55	p<0.05*
4 min. walking (Fifth element)	117.15 J	0.2	129.70 J	0.15	-12.55	n.s.
Total 20 min. running and walking	119.66 J	0.1	116.31 J	0.11	3.35	p<0.05*

The study shows that energy expenditure in the model programme for running and walking on the spot for female university students with Normal BMI is 3.35 J greater as compared to treadmill running and walking.

Figure 2 gives a graphical presentation of the differences between energy expenditure in the running and walking on the spot workout and the treadmill running and walking workout in female university students with Normal BMI. It is noteworthy that in the first four elements the energy expenditure is higher in the running and walking on the spot as compared to the treadmill running and walking. In the fifth element the difference has reversed relation.

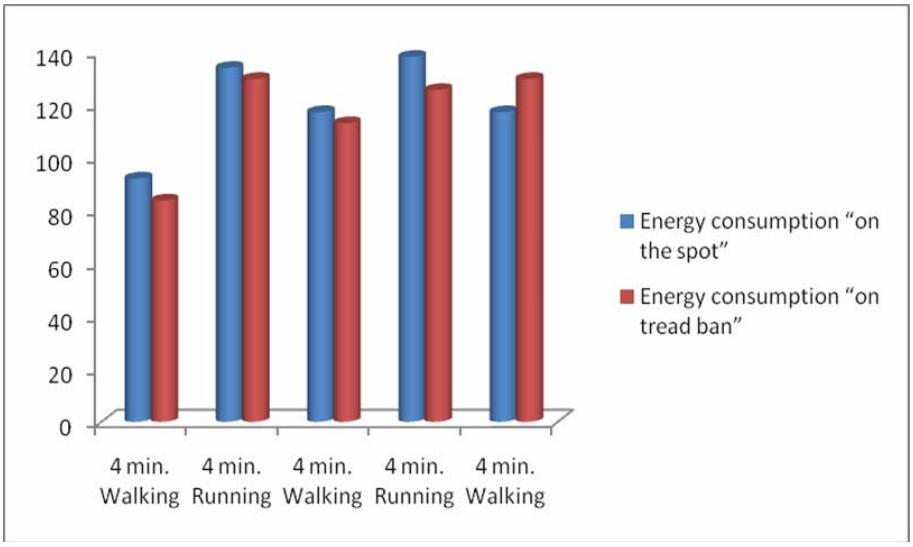

Figure 2. Differences in energy expenditure between running and walking on the spot workout and treadmill running and walking workout in female university students with Standard BMI

Data in **Table 2** from the comparative analysis of average values by elements of the model programme for female university students with Pre-Obesity 1 BMI show that all differences are supported by the necessary statistical reliability ($p < 0.05$) The highest differences are in the first element – 8.36 J, the lowest in the fourth – 1.56 J.

Results indicate that energy expenditure in the model programme for running and walking on the spot for female university students with Pre-Obesity 1 BMI is by 6.51 J higher s compared to treadmill running and walking. The result is supported by high statistical reliability.

Table 2. *Data for comparative analysis of energy expenditure by types of physical activities (elements) of the model program for female university students with Pre-Obesity 1 BMI*

Duration (min.) and type of physical activity (elements)	Students with Pre-Obesity 1 BMI					
	Energy expenditure – on the spot workout $\bar{X}$	S_1	***Energy expenditure – treadmill workout*** $\bar{X}$	S_2	d	Statistical significance
4 min. walking (First element)	108.78 J	0.12	100.42 J	0.2	8.36	p<0.05*
4 min. running (Second element)	150.62 J	0.01	146.66 J	0.15	3.96	p<0.01**
4 min. walking (Third element)	138.07 J	0.12	133.89 J	0.12	4.18	p<0.05*
4 min. running (Fourth element)	146.44 J	0.14	133.89 J	0.12	1.56	p<0.05*
4 min. walking (Fifth element)	138.07 J	0.2	133.89 J	0.02	4.18	p<0.01**
Total 20 min. running and walking	136.40 J	0.11	129.89 J	0.1	6.51	p<0.01**

Figure 3 gives a graphical presentation of the differences between energy expenditure in the running and walking on the spot workout and the treadmill running and walking workout in female university students with Pre-Obesity 1 BMI. The energy expenditure in all five elements of the model programme is higher in the running and walking on the spot compared to the treadmill running and walking.

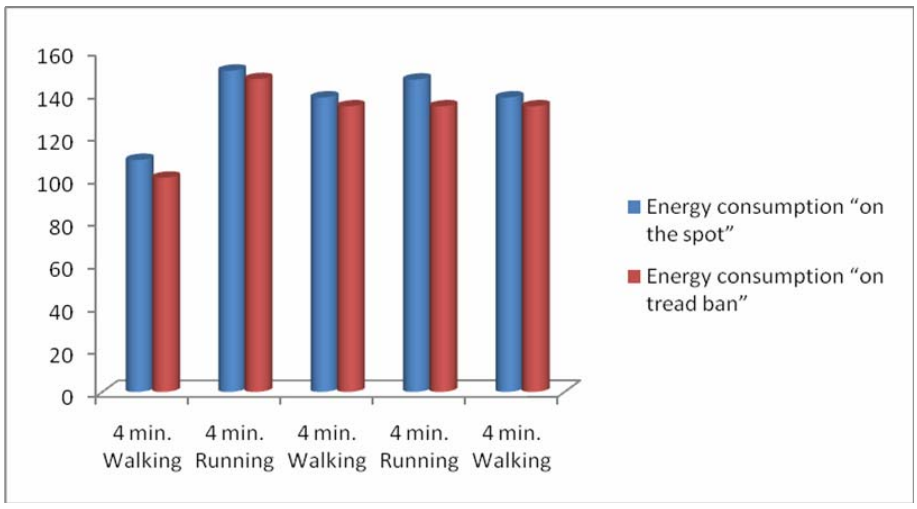

Figure 3. Differences in energy expenditure between running and walking on the spot workout and treadmill running and walking workout in female university students with Pre-Obesity 1 BMI

Graphical presentation of the results of this study show differences analyzed at two levels *(***Figure 4**).

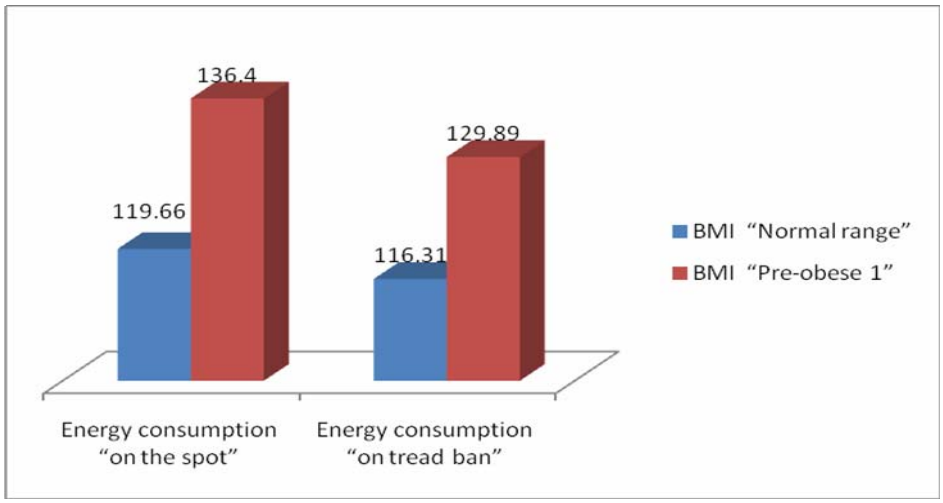

Figure 4. Differences in energy expenditure between on the spot workout and treadmill workout in female university students with Normal BMI and Pre-Obesity 1 BMI

The first level *involves different BMI of students*. Despite the fact that the duration of running in the model program for students with Pre-Obesity 1 BMI is ½ that of students with Normal BMI, energy expenditure in the former is higher than the latter, both for the on the spot workout (136.4 J to 119.66 J) and the treadmill workout (129.89 J to 116.31 J).

These results are entirely consistent given the difference in body mass which accounts for the higher energy expenditure.

The second level *involves the workout mode – "on the spot" and "treadmill"*. The energy expenditure in the on the spot workout (119.66 J) is higher compared to the treadmill workout (116.31 J) in female university students with Standard BMI. The energy expenditure in the

on the spot workout (136.4 J) is higher compared to the treadmill workout (129.89 J) also in female university students with Pre-Obesity 1 BMI. Although the difference is not high, this is a fact. In this case, however, the number of individuals studied is small and it more reasonable to talk of close values with a slight preponderance of energy expenditure in the "on the spot" programmes over the "treadmill" programmes.

CONCLUSIONS AND RECOMMENDATIONS

The results of this study show that:

1. Energy expenditure in model programs, including running and walking on the spot for female university students with Standard BMI and Pre-Obesity 1 BMI is greater than the energy expenditure in treadmill running and walking.

2. The working hypothesis that running on the spot combined with the walking on the spot with musical accompaniment are readily available and easily applicable physical activities that could be widely used in independent workouts as elements of programs for maintenance or reduction of body mass in place of expensive fitness equipment such as the treadmill was confirmed.

3. Development of model programs for other categories of overweight (according to the classification of the World Health Organization) and their application in practice would help overcome the problems of sedentary lifestyle, overweight and obesity.

These conclusions allow us to recommend the physical activities of running and walking on the spot with music accompaniment as exceptionally suitable home conditions during winter months and during student examination sessions.

Acknowledgements: This work was supported by a grant from the Ministry of Education, Youth and Science of Bulgaria, 2009 and a grant of Y9/09.

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