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DIFFERENCES IN PHYSIOLOGICAL LOAD OF STUDENTS DURING NORDIC WALKING AND JOGGING

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Abstract
Physical activity is important for the physical and mental health of almost everyone. Nordic walking is a physical activity in which participants use specially designed poles while walking, while the term jogging implies light running at speeds less than 10 km/h. **PURPOSE:** The aim of this research is to monitor the load intensity in real conditions, using a heart rate monitor Team Polar System, during nordic walking and jogging and comparing possible differences in heart rate responses after the fifth minute of activity, at an average speed of 7.5km/h. **METHODS:** The assessment of heart rate responses for this research was conducted on the 30 male students, at 2 separate days. **RESULTS:** The results of the variables used in this study show statistically significant differences at the level of significance p=.000. From the mean value results (M) it is obvious that the respondents achieved higher results of heart rate responses during nordic walking compared to the identical tests applied during jogging. **CONCLUSION:** The results of this study indicate that both Nordic walking and jogging are beneficial but Nordic walking contributes more in achieving higher body loads resulting in increased oxygen consumption and thus calories
Key words: load intensity, heart rate, nordic walking, jogging

INTRODUCTION

Physical activity is important for the physical and mental health of almost everyone, because over a long period of practicing can cause long-term health benefits, regulate body weight, reduce body fat, increase bone density, positively affect on: systolic pressure, fats in the blood and cardiorespiratory capacity (Mišigoj-Duraković, 2008). Physical activity may include structured activities such as walking, jogging, strength training or sports. It can also include daily activities such as housework, field work or a dog walk. Haskell et al. (2007) in their study state that healthy people aged 18–65, in order to promote and maintain health, should participate in moderate-intensity physical activity for at least 30 minutes a day five days a week or in higher-intensity physical activity for at least 20 minutes a day three days a week. The authors also state that the most common joint activity in related to the above recommendations is brisk walking for moderate activities and jogging-running for activities of higher intensity.
Nordic walking is a physical activity in which participants use specially designed poles while walking. It is an effective and inexpensive physical aerobic activity optimal for raising cardiorespiratory capacity and at the same time with a low risk of side effects. Porcari, Hendrickson, Walter, Terry, and Walsko (1997) investigated and found that the use of walking poles significantly increases oxygen consumption (23%), heart rate (16%) and energy consumption (22%) compared to walking without walking poles in physically fit subjects. In a study Hagen, Hennig, Stieldorf (2011) found that compared to running at the same speeds (8 km/h and 8.5 km/h) Nordic walking can be recommended as a sport with low loads on the joints, with 36% lower load rates and 59% lower foot pronations. Since the mentioned research shows an increase in energy consumption and heart rate and a simultaneous decrease in the load on the joints, these effects are reflected in the greater involvement of the muscles of the upper body.
The term jogging implies light running at speeds less than 10 km/h. Jogging is an ideal cardiovascular activity and it gained popularity primarily due to its simplicity, the ability to fit into any schedule. You can run all year round and it has a lot of positive effects on your health. Increases endurance, strengthens the heart and blood circulation, reduces the risk of heart disease, lowers the percentage of fat deposits, strengthens the bones and muscles of the legs and back.
The transformation of anthropological characteristics is directly related to the level of intensity of a person's load during physical activity. Functional changes in the body of a person caused by physical activity are manifested in increased work of the cardiac and respiratory system and in more intensive metabolism. Therefore, the physiological load can be indirectly controlled by measuring the heart rate, using a heart rate monitor, which is a real indicator of the load of the person exercising. You will find the heart rate monitor under different names: heart rate monitor,

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heart rate watch, cardiotachometer, pulsmeter. The primary application of the device is heart rate measurement. The required work intensity can be determined with high precision via the heart rate. According to Hottenrott (2006) the load can be determined with great accuracy because physiological manifestations can be recorded. The basic statistical indicators, using the Polar Team System used in this study, are based on heart rate.
This research is an attempt to determine the differences in heart rate and work intensity at students during Nordic walking and jogging.

METHODS
Participants

The sample of respondents consisted of 30 students enrolled in the second year of study at the Faculty of Physical Education and Sports. All respondents who underwent this test regularly attended classes at the faculty and therefore classes in the subject of Activities in Nature. Respondents had average measures for the age 21.053 ± .6, for the body height 181.567 ± 6.7cm, for the body mass 74.96 ± 7.4kg and for the body mass index 22.7 ± 1.23. The study was carried out according to the principles of the Helsinki Declaration on experimentation on living subjects (WMA, 2017).

Variables

To estimate the heart rate, by transmitting data from the transceiver via the base station to the computer, and with the help of the Polar Precision Performance 4SW software package, the following parameters were taken:

- HRMJ –maximum measured heart rate value during jogging,
- HRAJ –average measured heart rate during jogging,
- HR5J - measured heart rate value immediately after the fifth minute during jogging,
- HR10J - measured heart rate value immediately after the tenth minute during jogging,
- HR15J - measured heart rate value immediately after the fifteenth minute during jogging,
- HRMN -maximum measured heart rate value during Nordic walking,
- HRAN - average measured heart rate during Nordic walking,
- HR5N - measured heart rate value immediately after the fifth minute during Nordic walking,
- HR10N - measured heart rate value immediately after the tenth minute during Nordic walking,
- HR15N - measured heart rate value immediately after the fifteenth minute during Nordic walking.

Procedure

Heart rate was monitored and registered via the Polar Team System heart rate monitor (Polar Electro Oy, Finland). The transceiver integrated on the elastic electrode belt, which is placed around the chest below the chest muscles of the respondents, detected heart rate and other parameters every 5 seconds during the activity, and stored the data in the internal memory. After the measurement, the transceivers were connected to the base station, which is in charge of receiving and transmitting the stored information to a computer through a sophisticated program, and the data was analyzed.
All tests and measurements were performed and arranged so that all measurements could be performed without interruption.
Measurement of heart rate for jogging was realized in the in the morning after waking up. The total sample of respondents was divided into three groups of 10 respondents. Measurement of heart rate for Nordic walking was realized 24 hours after measuring heart rate for jogging.
Heart rate measurement was started after the general warm-up protocol, which consists of a five-minute warm-up from five exercises (high knee raise - skip, butt kicks, sideways movement, lunges, squats).
The first five minutes of test activity (jogging or Nordic walking) were used to gradually increase the pace of work to a maximum speed of 10 km/h, so as not to exceed the limit that implies light running (jogging) at speeds less than 10 km/h, with the aim that the organism reaches a stable state, in order to gradually return to the desired average speed of 7.5 km/h, which was then maintained until the end of the activity.
Heart rate parameters were measured from the beginning of the test, and relevant data for this test were taken after the fifth minute until the end of the test, that is in the fifth, tenth and fifteenth minute.
The test was field-based and was performed on a 2 km route which was recorded using the app, for smartphone, Sports Tracker and GPS (global positioning sensor) sensor, lasting an average of 16:30 min.

Data analysis

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To test the significance of differences between the arithmetic means of the applied variables in the respondents, T-Test for dependent samples is used. Testing the normality of the distribution of results and distributions for all applied variables we used Kolmogorov-Smirnov (KS) test.

RESULTS

The significance of the deviation of the observed distribution of each variable from the theoretical normal distribution for the corresponding sample of subjects was tested by the Kolmogorov-Smirnov test (KS). Table 1. shows that there are no statistically significant differences between the obtained distribution of results from the normal distribution of results for all applied variables.

Table 1. T-test values, arithmetic means and Kolmogorov-Smirnov (KS) test results of applied variables during jogging and Nordic walking

		Mean	N	Std. Deviation	KS	Sig. (2-tailed)
Pair 1	HRMJ	147.80	30	14.566	.200c,d	.000
	HRMN	159.57	30	13.253	.168c	
Pair 2	HRAJ	128.67	30	13.207	.200c,d	.000
	HRAN	136.70	30	12.860	.200c,d	
Pair 3	HR5J	131.40	30	14.354	.200c,d	.000
	HR5N	143.23	30	13.876	.200c,d	
Pair 4	HR10J	133.83	30	14.914	.200c,d	.000
	HR10N	143.97	30	13.892	.134c	
Pair 5	HR15J	138.87	30	14.289	.099c	.000
	HR15N	151.90	30	15.832	.100c	

Based on the results of arithmetic means of applied variables during jogging and Nordic walking and on the significance of changes tested by T-test for dependent samples (Table 1), it is clear that heart rate differs at a statistically significant level p<. 01, in all applied variables.

With the variables HRMJ - HRMN the difference in heart rate is 11.77beats/min, with the variable HRAJ - HRAN the difference in heart rate is 8.03beats/min, then with the variables HR5J - HR5N the difference in heart rate is 11.83beats/min, for the variables HR10J - HR10N the difference in heart rate is 10.14beats/min and for the variables HR15J - HR15N the difference in heart rate is 13.03beats/min.

As already mentioned in the introduction, the physiological load can be indirectly controlled by measuring the heart rate, using a heart rate monitor, which is a real indicator of the load of the person exercising. Exercise intensity can be determined using a relative measure such as the percentage of maximum heart rate -% HRmax (Norton, Norton and Sadgrove, 2010), if we know the maximum heart rate (HR max) of the subjects, or the highest heart rate a subject can achieve in his effort to bring himself to the point of exhaustion. Camarda et al (2008), in their study, state that the Carvonen and Tanaka equations, for calculating maximum heart rate, are similar and show a good correlation with the measured maximum heart rate. In order to define the maximum heart rate (HR max) in this study we used the formula 208 - (0.7 x years of age) defined by Tanaka, Monahan and Seals (2001). Based on the average age of the subjects we obtained a value of HR max = 193.26beats/min for maximum frequency hearts for the respondents in this study.

Values of exercise intensity categories are defined according to Norton, Norton and Sadgrove, (2010), and we distinguish seating category <40% HR max, light category 40<55% HR max, moderate category 55<70% HR max, energetic category 70<90% HR max and high category ≥90% HR max.

Based on the stated values of measured heart rates, the categories of exercise intensity were defined for the subjects in this study (Table 2).

If we compare the obtained mean values for the variables HRMJ - HRMN which represent the maximum measured value of heart rate during the activities we see that both activities have recorded values in the energy category of exercise intensity, which tells us that respondents during both tests at one time had 70-90% of maximum heart rate load. Although they belong to the same category of

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exercise intensity, the difference between these two activities in the measurement variables HRMJ - HRMN is 11.77beats/min or 7.96% HR max, which is based on t-test results at a statistically significant level and is in favor of Nordic walking.

Table 2. Values of exercise intensity categories

Training Intensity Categories	Objective measure	Categories of heart rate values of subjects in relation to HRmax
sedentary category	<40 %HRmax	<77,31
lightweight category	40<55 %HRmax	77,31<106,29
moderate category	55<70 %HRmax	106,29<135,28
energetic category	70<90 %HRmax	135,28<173,94
high category	≥90 %HRmax	≥173,94

The mean values obtained for the variables HR5J - HR5N, which represent the measured value of heart rate in the fifth minute during the performed activities, are 131.40beats/min for jogging and belongs to the intensity of exercise in the moderate category, and 143.23beats/min for Nordic walking and belongs to the intensity of exercise in energetic category. The difference in the mean values for the variables HR5J - HR5N is 11.83beats/min or 9% HRmax, which is based on the results of the t-test at a statistically significant level and is in favor of Nordic walking.

Then, the obtained mean values for the variables HR10J - HR10N, which represent the measured value of heart rate in the tenth minute during the performed activities, differ by 10.14beats/min or 7.6% HRmax, which is based on t-test results at a statistically significant level and goes to the benefit of Nordic walking. It is also the case here that the intensity of jogging belongs to the moderate category, while the intensity of Nordic walking belongs to the intensive category.

The obtained mean values for the variables HR15J - HR15N, which represent the measured value of heart rate in the fifteenth minute during the performed activities, differ by 13.03beats/min or 9.4% HRmax, which is based on t-test results at a statistically significant level and is in favor Nordic walking. In this part of the activity, which according to the average duration of the activity of 16:30min is the end of the test, the subjects during the Nordic walking are still in the intensive category of exercise intensity, while during jogging only in this phase of testing exercise

DISCUSSION and CONCLUSION

All the aforementioned differences in the applied variables are in favor of Nordic walking, compared to jogging, and based on that it can be said that when performing Nordic walking, exercise is more intense. Further analysis of the obtained results shows approximately the same values of heart rate in the fifth and tenth minutes for Nordic walking, while the recorded value of heart rate in the fifteenth minute for Nordic walking increased by 7.93beats/min. This means that after the fifth minute the body of the subject comes to a stable state, ie there is an adjustment to the intensity of exercise, which lasts an average of the next five minutes after which the body is forced to re-adapt and increase heart rate.

The stated values recorded for jogging differ in that in jogging there was a constant increase in the obtained mean values of heart rate, ie there is a difference between the fifth and tenth minutes of 2.43beats/min, and that there is a difference between tenth and fifteenth minutes which is 5.04beats/min.

Taking into account that the values of heart rate for Nordic walking in this study are higher in all measured time intervals, it can be concluded that Nordic walking from the beginning of exercise causes a higher heart rate during exercise compared to jogging.

Church, Earnest and Morss, (2002); Porcari et al (1997); Hendrickson, (1993) found in their research that there is a significant increase in oxygen consumption, heart rate and energy consumption compared to walking without poles in physically fit subjects, so based on the results of these studies, we expect that energy consumption in our respondents is proportional enlarged.

The results obtained can be explained by the fact that Nordic walking involves a larger number of muscles in the performance of the activity itself, such as the muscles of the shoulder girdle and upper back, as opposed to normal walking or jogging. We can also say that the speed of the activities was appropriate for testing, because according to

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Laukannen (2006) if the speed was higher, then there would be less time for effective push-ups with poles and that will reduce the effective activation of shoulder girdle muscles.

The average speed of both activities for all tested groups in this study was 7.5km/h. Motschall and Mechling, (2006) in their study state that jogging at speeds of 6.8km/h and 7.5km/h led to a significant increase in oxygen intake and heart rate compared to walking and vigorous walking, while Nordic walking at 7.5km/h exceeded jogging values.

Downer, (2014) states that in a study conducted by Dr. Schwameder from the University of Salzburg found that Nordic walking increases metabolism by 12-25% compared to walking without poles when the technique is correct, then that muscle activity is significantly increased and oxygen consumption is increased by 23-33%. He also says that Nordic walking at 7.7km/h produces the same benefits to the body as jogging at 9.8km/h, with 30% less strain on the knees. This study also states that when using shorter poles than recommended, the muscular effort is higher, but also the load on the knees.

In a study conducted by Porcari (1999) on 32 healthy men and women walking with poles compared to walking without poles on a treadmill, resulted in an average of 23% higher oxygen consumption, 22% higher caloric consumption and 16% higher heart rate.

The results of this study indicate that both Nordic walking and jogging, at an average speed of 7.5km/h, are beneficial but Nordic walking contributes more in achieving higher body loads, taking into account that they exercised in a higher intensity zone for most of their duration. Activities resulting in increased oxygen consumption and thus calories. (Motschall and Mechling, 2006).

Generalization of the results obtained by this research is possible primarily on the population that has the same characteristics as the respondents in this study and on those segments of the anthropological space that are included in the sample of applied variables.

Future research of a similar type should include a larger group of respondents and a larger number of measuring instruments to obtain data on the amount of calories consumed and oxygen used.

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