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Monitoring the Effects of Work on Physical Education Classes Expressed through the Heart Rate Value*

Marija Lorger[1], Mateja Kunješic[2] and Srna Jenko Miholic[3]

Department for Kinesiology Education, Faculty of Teacher Education, University of Zagreb, 10000 Zagreb, Croatia
E-mail: [1]<marija.lorger@ufzg.hr>, [2]<mateja.kunjesic@ufzg.hr>, [3]<srna.jenko@ufzg.hr>

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ABSTRACT The aim of this study is to monitor the effects of performance during obstacle course work form by measuring heart rate in all parts of the physical education (PE) classes and rest phases too. The sample consisted of 103 female students of the Faculty of teacher education during their regular PE classes for three weeks. Data analysis was processed in 7.0 Statistics on the descriptive level, while statistically significant difference between means was tested by t – test for dependent samples. The results showed that the heart rate values in all parts of the PE classes differed significantly at the beginning and at the end of the work. Throughout the second week, there was only exception during the final part of the class when pulse values at the workout beginning was 102 beats/min and at the end of it was 100 beats/min.

INTRODUCTION

Health benefits of regular physical activity, such as reducing the risk of some cancers (Batty and Thune 2000), and preventing coronary heart diseases and obesity (Warburton et al. 2006) are well known to everyone. Because of present lifestyle, physical education class may be the only place where students can participate in regular physical activity. According to American Heart Association (2015: 1), "Physical education program should provide physical activity to enhance current health while teaching knowledge and skills that foster a long-term commitment to physical activity as part of a healthy lifestyle that will help children prevent numerous conditions." Subsequently, one of the major efficiency factors and wish to make education process closer to the needs, interests, and desires of the immediate subjects during physical education classes, is also making education process to be more contemporary in the active involvement of the participants in the teaching process. This entails offering students a wide choice of attractive training activities which are adapted to their age, abilities, and characteristics as well as to the level of their motor skills and accomplishments (Findak 2007). Accordingly, each student (or an entity in the learning process) should allow the education process to take place in accordance with the present state of its anthropological status (Beiner 2002, according to Findak 2007).

Subsequently, physical education class with its characteristics is a complex process whose versatility is evident in the impact on the transformation of student's anthropological characteristics and in the contribution to their education (Findak 2003). Also, physical education class contains in its structure various number of factors which may contribute to its effectiveness. Giving to each teacher autonomy in their work, these factors could be achieved in different ways. Thus, this can be done by selecting and using various work methods and methodical organizational forms of work. One of the possible factors which could play an important role in refreshing the teaching process is obstacle course like a methodical organizational form of work, which, among other things, offers the possibility for students' high physical loads (Zdanski 1986; Lorger 2009). However, it also offers introduction of those motor activities in which students show more interest during the classes. An obstacle course is a form of movement characterized with the overcoming of various natural or artificial barriers (Findak et al. 1987) and performing successively one after another variety of motor movements (exercises) on a natural trail or on the standards designed track indoors or outdoors (Zdanski 1986). Obstacle course along with circuit training, fitness/strength, and fitness/endurance belongs to the group of activities called "looks-like-physical training" (Larrson and Karlefors 2015). Thus, these kinds of activities are aimed toward developing endurance, strength,

and other physical properties (Engström 2008) such as coordination, balance and strategy (Gdonteli 2015). The application of this type of work is to raise ones overall coordination level and motor abilities development (Findak et al. 1987). Furthermore, this form of work allows almost unlimited application in terms of gender, age, work condition and location, level of skills, knowledge, and achievements (Findak 1999). However, it also encourages the participant's boldness in mastering different tasks (Findak et al. 1987). It has a positive effect on student motivation during exercise as well as on their personality (Zdanski 1986).

An obstacle course was used in this research as a methodical organizational form of work in order to refresh the teaching process and to make positive impact on the functional abilities of the Faculty of teacher education students. Thus, this is same as to monitor the effects of their work, that is, organism adaptation to the three weeks effort during physical education classes.

Objectives

The aim of this study is to monitor the effects of performance during obstacle course work form by measuring heart rate in all parts of the physical education classes and rest phases too. Apart from this, the study also aimed at identifying possible adaptation changes caused by the implementation of this kind of work form.

METHODOLOGY

Assessment was carried out on 103 female students of the Faculty of teacher education from the University of Zagreb (targeted sampling of respondents) for the three week effects of their training and development of methodical - organizational form of work - an obstacles course during regular physical education classes. Final analysis only show the results of participants who exercised regularly without a break for all three weeks (six lessons). This is with the view of maintaining continuity in their work, while incomplete results were not considered. Effects of work were monitored by measuring heart rate with palpation method during all parts of the lesson, respectively at the beginning and at the end of a particular part of the lesson. Consequently, obstacle course was standardly created (as for the sequences, number of tasks, the manner of performance were set in advance and are always performed in the same way). It consists of nine well-known and previously overcome tasks which were focused on improving students' movement coordination and aerobic-anaerobic abilities. In addition, obstacle course time was two minutes. During the first lesson, students performed one round, since it took more time to set up the obstacle course, introducing, and in explaining the task methodology. For the rest of the classes, three rounds were performed in the main "B" part of the lesson. Subsequently, this considers the fact that the process of learning, training and performing, demanded a lot less time than at the beginning of the first week. Work effects and mastering the obstacle course through different parts of lesson, were presented in terms of heart rates. Measuring heart rate was executed by palpation method. Data analysis was performed in 7.0 Statistics on the descriptive level (Means, median, minimum results, maximum, standard deviation, and FSmax%), while statistically significant difference between means was tested by t – test for dependent samples.

RESULTS

The analysis of the results from Table 1 reveals that the overall load of the lesson grows according to the physiological load curve (Findak 1999). The highest exercise intensity was reached in the main "B" part of the lesson (163.33 HR/min, 81.66 %FSmax), and the lowest HR was measured at the beginning of the introductory part of the lesson (87.86 HR/min, 43.86%FSmax).

Heart rate average values ranged from 87.86 bpm which accounted for 43.86 percent of HR max at the beginning of the lesson to an average of 163 bpm, respectively. In addition, 81.66 percent of HR max reached the end of the main "B" part of the lesson (at the first week). It is interesting to note how the number of heart rate in the main "B" part of the lesson at the stage of the highest overall loads has reduced in the next coming lessons for the same working time (below 160 beats). Nevertheless, this might have been previously mentioned as an indication of adaptation to training impulses.

Displayed values of loads through measured period during physical education classes could be viewed within four levels (Fig. 1).

First Level - Heart rate values which enter *the low loads zone (below 60% HR max)* were observed at the start of the introductory part of

Table 1: Descriptive parameters HR measurement - results at the start and at the end of certain parts of a lesson for N=103

Lesson parts:	*Mean*	*Median*	*Min*	*Max*	*Standard deviation*	*% FS max*
Introductory part start	87.86	87.33	48.66	132.00	13.65	43.8
Introductory part end	150.76	153.33	86.00	209.00	23.10	75.2
Preparatory part start	122.00	121.03	72.00	197.03	23.60	60.7
Preparatory part end	136.90	134.66	66.66	193.33	22.32	68.3
A part start learning	104.74	108.00	56.00	144.00	19.31	52.3
A part end learning	140.33	144.00	66.00	216.00	32.43	70.1
A part start repetition	110.30	107.00	64.00	183.00	21.73	55.1
A part end repetition	143.60	146.00	78.00	192.00	23.55	71.8
B part lesson - start 1. round	122.92	120.00	69.33	180.00	23.87	61.4
B part lesson - start 2.round	104.09	104.00	60.00	146.00	18.20	52.0
B part lesson – start 3.round	103.91	102.00	64.00	150.00	17.71	51.9
B part lesson - end 1.round	**163.33**	164.00	83.33	210.00	21.95	**81.6**
B part lesson - end 2.round	158.71	158.00	87.00	205.00	21.83	78.5
B part lesson – end 3.round	157.73	160.00	96.00	207.00	21.69	78.9
Rest - start 1	162.70	164.00	83.33	210.00	22.66	81.3
Rest – end 1	103.49	102.66	60.00	149.33	19.70	51.7
Rest – start 2	158.52	158.00	87.00	205.00	22.12	79.2
Rest – end 2	102.54	101.00	64.00	150.00	18.07	51.2
Rest – start 3	157.41	160.00	82.00	207.00	22.81	78.7
Rest – end 3	102.53	101.00	66.00	151.00	17.85	51.2
Ending part – start	103.12	102.00	62.60	152.66	18.37	51.7
Ending part – end	98.85	97.03	60.00	142.66	18.41	49.4

Legend: Minimum (Min), Maximum (Max), percent of maximum heart rate (%FS max).

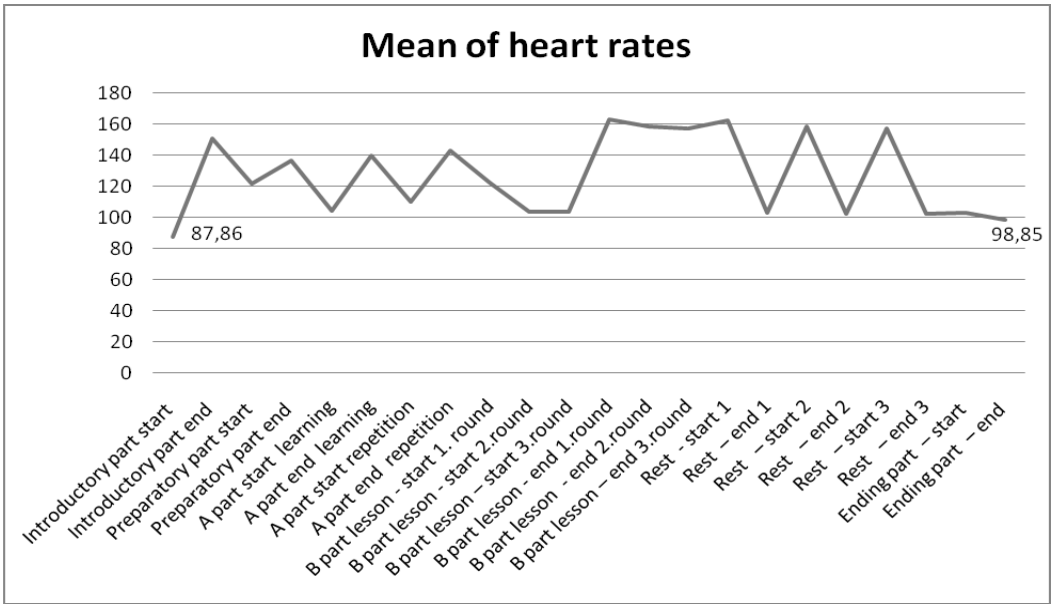

Fig. 1. Total trend of overall load during the lesson

the lesson (43.86% HR max), at the start of the main "A" part of the lesson (from 52.36% to 55.15% HR max), at the end of the break (51.74% and 51.26% HR max), and at the start (51.72% HR max) and the end of the final parts of the lessons (49.41% HR max). Low values of heart rate, which ranges from 61.46 percent to 51.93 percent HR max were observed at the start of the main "B" part of the lesson. Although this value is not particularly high, it may indicate very likely that the level of adoption for motoric tasks which make up the structure of obstacle course has increased during the third week of the work. Congruently, larger number of repetitions was performed and the higher intensity of work was reflected based on the number of the heart beats.

Second Level - Heart rate values in the *medium loads zone (from 60 to 70% HR max),* that is, values in the aerobic endurance zone (Vucetic et al. 2002). This zone included the start and the end of the preparation part of the lesson throughout all three weeks of the workout. In the first and second week, loads of limited mean values were also achieved in the main "A" part of the lesson at the end of learning. Thus, during the third week, the load at the end of main "A" part of the lesson reached all the way to the zone of submaximal values, but not too far from the threshold (71.80 % HR max). Through all the three weeks, the start of the first rounds in the main "B" part of the lesson was in the medium loads zone. Unlike the first round, the start of the second and third round during main "B" part of the lesson was in the low load zone. So, it may be assumed that this is the result of a light adaptation to the loads. However, it also results to better techniques and more economically movement performance.

Third Level – Heart rate values in *submaximal load zone (70 to 80 % HR max).* Values of heart rate from 75.20 percent HR max was reached at the end of the introductory part of the lessons throughout all three weeks, which indicates a high intensity of work in the introductory part of the lesson. These values are logical and expected since the aim of the introductory part of the lesson in the physiological sense is to raise pulse levels and prepare the transport body system to receive a larger amount of oxygen. Values of heart rate in the previously mentioned ending of the main "A" part of a lesson (rerun) during the third week of workout crossed into the zone of submaximal values (71.80% HR max). This step out most likely occurred because of the enhanced level of student motoric skills, and also because of better cardiovascular adaptations to the required effort within 90 seconds which has allowed greater number of repetitions in contrast to the first two weeks of workout. Values of heart rate also varied in submaximal zone values at the end of the second and third rounds of the main "B" part of the lesson (during the second and third week). Although the heart rate values were close to the limit of maximum load zone values (from 78.51% to 78.94% HR max), this heart rate trend may be able to point to the positive effects of exercise and the adaptation of the organism to the work effort during exercise in this relatively short period of workout. In accordance with the above mentioned, starting values of heart rate in resting phase after these rounds were in the zone of submaximal value.

Fourth Level – Values of heart rate in the *maximum load zone (above 80% HR max).* Logically, in considering the tendency of the work was the impact on the functional abilities (anaerobic, especially aerobic). Hence, participants have spent short time in the maximum load zone. During the all three training weeks, the maximum work load range was reached at the moment when the first round during the main "B" part of the classes ends and afterwards at the beginning of the rest phase. Hence, there may be two reasons for this.

The first relates to maximum energy intake and motivation of the beginning interest for the workout. The second reason indicates the start of adaptive processes of the organism to the work effort which resulted in lowering the heart rate and keeping the heart rate plateau in submaximal value zone during the second and third round of the work.

Analysis of Heart Rate Values Difference by Certain Part of the Lesson

During the introductory part of the lesson, functional preparation was successful for the next coming work during the lessons. However, this was reflected in the transition from a zone of low (43.86% HR max) to a zone of submaximal loads (75.20% HR max). T-test results showed that the changes of work intensity were significant.

Throughout all the three weeks, the introductory part beginning and the end of the preparatory part of the lesson showed a significant

difference in the work load. However, this indicates a gradual increase in the intensity of work and the retention of impact to participants' aerobic fitness, specifically the zone of aerobic endurance. More importantly, there is no significant difference at the end of the preparatory part of the lesson throughout all the three weeks. Loads at the end of the preparatory part of the lesson were almost identical to the heart rate values (136 - 137 beats per minute) respectively at the upper level of the medium loading zone (68.37% HR max). Subsequently, those values indicate high impact to aerobic component of organism. If we know this part of the lessons last less or up to 10 minutes, then it could be said how specific exercises in the preparation part of the lesson were dynamic and well targeted in the sense of preserving medium load levels which are the characteristics for aerobic endurance zone (Vucetic at al. 2002) where most of the energy during this intensity work is made by the combustion of body fat (Swain and Edvards 2002, according to Bronikowski 2004). Due to the sedentary lifestyle of the students, this is an important information in terms of the impact to aerobic capacity, respectively, to health, and also to aesthetic component.

Results in Table 2 showed the overall load - the exercise effects were significantly different at the beginning and at the end of the main "A" part of the lesson throughout all three weeks. This indicates how the exercise contents mainly focused on information adoption was sufficiently intense. This is next to cognitive impact which encourages changes in the participant's motor - functional area.

Rest after Work in the Main "B" Part of the Lesson

Through the recovery phase (rest) which lasted for two minutes, noticeable drop of cardiac frequency values is visible after working on the 0.00 significance level (Fig. 2). Quantitatively speaking, it was between 62 beats per minute at the end of the first round during the first week of workout, to 54 beats per minute at the end of the third round of the third week. The decrease range in cardiac frequency stretched from a zone of maximum and submaximal load to a low load zone at the end of rest (about 52% FS max). Hence, this indicates the importance of rest phase in the organism recovery, as was previously stated.

DISCUSSION

Heart rate does not measure physical activity directly but is based in the linear relationship between oxygen uptake and hart rate. The wide spread use of heart rate monitoring is due to ease of measurement, its ability to record values over time and its reflection of the relative stress placed on the cardiopulmonary system due to physical activity (Welsman and Armstrong 1992). Since

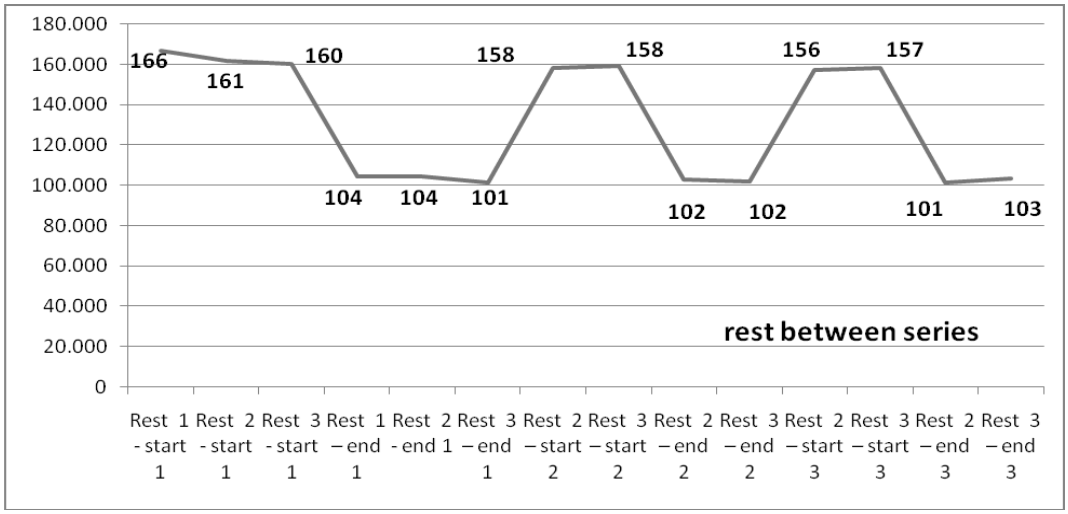

Fig. 2. Trend of the work load during the rest phases

Table 2: T-test for dependent samples: values of heart rate – start and end of certain parts of the lesson

Lesson parts	*Introductory part N=103, df=102*				*Preparatory part N=103, df=102*			
	mean	*standard deviation*	*t-value*	*p-level*	*mean*	*standard deviation*	*t-value*	*p-level*
start 1	85.49	13.00	-22.79	**0.00**	116.67	20.83	-8.79	**0.00**
end 1	146.35	29.39			136.46	23.26		
start 2	90.50	14.78	-40.31	**0.00**	124.63	25.60	-4.67	**0.00**
end 2	157.55	19.18			137.59	23.39		
start 3	87.69	13.19	-26.62	**0.00**	124.70	24.36	-5.62	**0.00**
end 3	147.49	23.62			136.66	20.28		

	Lesson parts Main Part "A"N=103, df=102				*Ending part N=103, df=102*			
	mean	*Standard deviation*	*t-value*	*p-level*	*mean*	*Standard deviation*	*t-value*	*p-level*
start 1	104.73	19.30	-11.91	**0.00**	104.46	18.34	4.38	**0.00**
end 1	140.33	32.43			97.37	17.98		
start 2	112.63	24.24	-9.227	**0.00**	102.56	18.33	1.09	0.27
end 2	141.92	25.93			100.47	17.62		
start 3	107.98	19.20	-21.10	**0.00**	103.32	18.45	2.47	**0.01**
end 3	145.28	21.17			98.69	18.60		

"B" lesson part N=103,		*Main Part "B" First round*			*Main Part "B"Second round*				*Main Part "B" Third round*			
df=102	*mean*	*standard deviation*	*t-value*	*p-level*	*mean*	*standard deviation*	*t-value*	*p-level*	*mean*	*standard deviation*	*t-value*	*p-level*
lesson 1	start	120.09	24.22	-19.24	**0.00**							
	end	166.58	23.52									
lesson 2	start	121.98	22.96	-16.35	**0.00**	104.56	17.54	-26.35	**0.00**	103.84	17.24	-25.05	**0.00**
	end	162.78	22.44			158.97	22.60			157.37	21.85		
lesson 3	start	126.69	24.41	-16.28	**0.00**	103.70	18.85	-31.56	**0.00**	103.98	18.18	-25.48	**0.00**
	end	160.63	19.87			158.44	21.10			158.07	21.51		

the heart rate is quite an individual characteristics, the intensity of physical loads level derived from the values of heart rate (HR) should not be placed in study frameworks (Karpljuk et al. 2000). Consequently, this can be observed especially in work conditions and with palpation method that was used for this research which has a great possibility of error. Exercise professionals rely on heart rate (HR) to monitor exercise intensity because HR and intensity are directly related (Karvonen et al. 1957). Because of this relationship, exercise professionals use exercise HR to establish effective and safe exercise intensities for their clients (Dinesh et all. 2007.) The actual values of the heart rate can vary for each individual for many reasons (such as emotional moods, biological indicators, etc.), (Mišigoj - Durakovic et al. 1999), or some other different factors (like environmental factors (Skinner et al. 1973, according to Koltyn and Morgan 1992), or psychological states (Morgan 1973, according to Koltyn and Morgan 1992). However, formula HR max = 220 - years of age may serve as a guide to express physical load levels during physical exercise. It is well known how aerobic endurance and anaerobic ability are characteristics exposed to the impact of training in both genders (Mišigoj - Durakovic 2008). In improvement of these skills under the influence of training, there can be noticeable individual differences. Therefore, people differ with significant and insignificant improvement of abilities. Along some important factors such as gender, age and sport experience, it is very likely that genetically defined capacity of the body to adapt to the training influence is most responsible for the variability of adaptation to training (Mišigoj - Durakovic 2008). Measuring of heart rate may be multiple beneficial. In the process of kinesiology education it is usually used as an indicator of the work intensity (Sabolic et al. 2015), but in some extensive studies the heart rate is used as an indicator of cardiovascular fitness (Cooper et al. 2015). In this group of subjects who are under the influence of kinesiology operators, it is possible to spot such an adaptation component on two levels; firstly by watching the group as a whole, and secondly by observing changes in individual subjects.

Considering the change during the learning and improvement of certain motoric programs in its structure from rough structure through the process of stabilization and to high levels of sophistication (Metikoš et al. 2003), it is very likely that a systematic process of training which is an already well known motoric movement led to positive reactions of the organism and higher levels of their adoption. Thus, all that resulted in a reduction of workload range at the same or even higher level of work.

Cognitive function and motor factors of higher order are improved by all of the mentioned before, in particular by the general factor of coordination under whose operation depends on efficiency in performing a given motor program (Metikoš et al. 2003). There was progress during the perfecting phase of the motor program training structure (Metikoš et al. 2003). Thus, it is evident that there is a significant difference of the work load at the beginning of the second and third lesson (second and third week) of the work. Intensity of work in the main "A" part of the lesson throughout the first and second week was in the zone of medium loads (104.73 – 141.92 HR/minute). During the third week, however, at the end of the main "A" part of the lesson, medium load zone was abandoned and submaximal load zone entered (145.28 HR/minute). This indicates a higher level of technical correctness when performing the exercises, thereby increasing the volume load. It is well known that the level of technical correctness when performing the exercises is the most important criterion for determining the volume load (Metikoš et al. 2003) of which in this case was dictated by the participants themselves.

Subsequently, results also indicate high work efficiency for the main "B" part of the lesson. The increase in cardiac frequency in all three weeks ranged from 33 to 46 beats per minute, that is, 60 percent FS max at the beginning of the first rounds up to 83 percent FS max at the end of the first rounds. However, this indicates that the load after the first rounds through all three weeks were maximal, with a tendency of pulse decrease (166–160 FS/min) to the third week of this research. This shift may indicate the process of organism adjustment and harmonization of information and motor components. Considering the fact second and third rounds starts after an interval of 2 minutes, heart rate trend was very similar in second and third week. Workout intensity, as an indicator of exercise effects, was shown as an increase of heart rate frequency of about 54 beats per minute. However, the pulse values

did not overstep maximum value limit, but remained in the submaximal load zone (79% FS max). Although these are limits of submaximal values, this kind of organism reaction to workout may indicate very likely a completed process of adaptation over three weeks of targeted workout. Thus, it was assumed that this transformation would be even more visible if the frequency of stimulation was increased the more, and not only once a week for 90 minutes.

The final part of the lesson follows the pause (rest phase) after the first workout round in "B" part during the first week. Thus, same follows the pauses after the third rounds in the second and third week of operation. Cardiac frequency values show extreme importance for the rest component in restoring organic functions from the zone of maximum and submaximal values to the initial level. During work intervals, an oxygen debt in recovery was also a stimulus for increasing aerobic capabilities of the organism (Prskalo 2004). However, this confirms what was previously stated.

CONCLUSION

In order to monitor the intensity of the physical education classes of students of Faculty of Teachers Education for three weeks, measuring of cardiac frequency values was performed in all parts of the lessons including the rest phases. The results showed that cardiac frequency values in all parts of the lesson differed significantly at the beginning and at the end of the work. During all three workout weeks, the highest exercise intensity was reached in the main "B" part of the lesson. Thus, this proves that the work was done in accordance with the curve of the physiological and emotional work load range.

During three week period of exercise program implementation, authors likely consider organism adaption to effort process completed. This signifies that positive transformation of functional abilities in observed group of subjects would have been even more pronounced if the frequency of stimulation was increased.

RECOMMENDATIONS

Since the measurement was performed by hand (palpation), it is recommended to measure the results using the cardiac monitor and execute the comparison of two measurements.

NOTE

[*]This article was presented at The International Conference on Lifelong Learning and Leadership for All (ICLEL-15), in Olomouc on October 29-31, 2015.

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