CHARACTERISTICS AND DIFFERENCES IN THE HEART RATE AND BLOOD LACTATE CONCENTRATION VALUES MEASURED DURING HI-LO AND STEP AEROBICS CLASSES

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Abstract:

The investigation was carried out to determine the characteristic portion of energy demands measured during HI-LO and STEP aerobics classes, and also to establish any possible differences between these two aerobic dance programmes by monitoring the same parameters.

Twenty-three female students, aged 18-20 years, experienced aerobic dancers, participated in both the HI-LO and STEP aerobics sessions. The heart rate (average HR per session) and lactic acid concentration values were measured during both classes. The obtained average values of the heart rate and blood lactate offered no evidence of differences between the HI-LO and STEP aerobics programmes in the observed parameters. Nevertheless, the results revealed a relative disproportion in the values of these two parameters, characterised by the relatively higher heart rate values than expected in relation to the blood lactate concentration values. This can be explained, as has been done in some previous research studies, by the exerted influence of the disturbed body hemodynamic balance (caused by the extensive overhead arm motions) and by emotional excitement. The results of the present research suggest the conclusion that both the HI-LO and STEP aerobics programmes were energetically equally demanding. Therefore, it could be recommended that participants should choose individually the programme they wish to be engaged in just according to their preferences. Further investigations are needed to determine any possible (anthropological) predictive values of load intensity of the respective aerobic programmes.

Key words: STEP aerobics, HI-LO aerobics, female participants, heart rate, blood lactate

EIGENSCHAFTEN UND UNTERSCHIEDE IN DER HERZFREQUENZ UND BLUTLAKTATKONZENTRATIONEN, WÄHREND HI-LO UND STEP-AEROBICSTUNDEN GEMESSEN

Zusammenfassung:

Diese Untersuchung wurde unternommen, um den charakteristischen Umfang der in den HI-LO und STEP Aerobicstunden gemessenen Intensität des Energieaufwands zu bestimmen sowie die möglichen Unterschiede zwischen diesen zwei Aerobic-Tanzprogrammen durch die Beobachtung derselben Parameter festzustellen.

23 Studentinnen, 18-20 Jahre alt, erfahrene Aerobics-Tänzerinnen, haben an HI-LO sowie STEP Aerobicstunden teilgenommen. In beiden Aerobicstunden wurden die Herzfrequenz (durchschnittliche Herzfrequenz pro Aerobicstunde) und die Blutkonzentration der Milchsäure Säure gemessen. Die erworbenen durchschnittlichen Herzfrequenz- und Blutlaktatwerte bewiesen bezüglich der beobachteten Parameter keinen Unterschied zwischen HI-LO und STEP-Aerobic. Doch, die Ergebnisse deckten eine relative Disproportion in der Werten zweier Parameter auf, denn die Herzfrequenzwerte im Vergleich zur Blutlaktatkonzentration relativ höher als erwartet waren.

Wie in einigen Untersuchungen bereits versucht worden ist, kann das durch den Einfluß des gestörten körperlichen hämodynamischen Gleichgewichts (verursacht durch die extensive Bewegung der Arme oberhalb des Kopfes) sowie durch die emotionale Aufregung erklärt werden. Die Ergebnisse unserer Untersuchung weisen daran auf, dass sowie HI-LO als auch STEP-Aerobic gleichmässig anspruchsvoll bezüglich Energieaufwands sind. Deshalb kann es empfolen werden, dass die Teilnehmer nach ihrer individuellen Bevorzugung zwischen den Programmen wählen. Weitere Untersuchungen sind nötig, um den möglichen (antropologisch) voraussehbaren Wert der Belastungsintensität zweier Aerobic programme festzustellen.

Schlüsselwörter: STEP-Aerobic, HI-LO-Aerobic, Teilnehmerinnen, Herzfrequenz, Blutlaktat

Introduction and purpose of the study

Contemporary aerobics or aerobic dance programmes are nowadays the most wide-spread and frequently participated in forms of organised recreational exercise activities in the world. One of the possible causes that has significantly contributed to the boom in popularity of this sports-recreational activity is undoubtedly the immense variety of forms or working modalities (M. Zagorc et al., 1996; D. Metikoš et al., 1997). All forms of aerobics or aerobic dance, no matter how different the programmes may be (step, hi-lo, slide, funky, and others), are primarily characterised by the possibility of prescribing and monitoring the workload or exercise intensity fairly accurately. The intensity is basically of an aerobic or moderate anaerobic nature (Williford et al., 1989; Sekulić, 1995 and 1997) with a series of confirmed transformational effects (Vaccaro and Clinton, 1981; Williams and Morton, 1986; Berry et al., 1992; Garber et al., 1992; Kravitz et al., 1993; Shimamoto et al., 1998).

The question, however, arises: are all the contemporary aerobic dance programmes equally appropriate to accomplish the particular transformational effects? Some answers could be obtained from the comparative exploratory studies in which two (or more) aerobic dance programmes and their features are parallelly examined.

Due to the fact that the effectiveness and orientation of the transformational process of a particular training activity depends on the workload parameters (Darby et al., 1995), the idea of the research design was to investigate the independent indicators of the actual energy demands or exercise intensity of two modern aerobic dance programme classes. The results of the comparison between these indicators might allow for the possible manifested distinctions to be defined, which could eventually indicate any potential differences in the transformational effectiveness of a particular programme.

The goal of the present research was to determine the actual values, and also to establish the level of differences in the energy demands or workload parameters of the STEP and HI-LO aerobics classes.

The two employed programmes were included in the investigation due to their current extreme popularity both in Croatia and worldwide. The additional reason was a relatively small number of studies about the differential effects of these two programmes. Therefore, the authors dedicated themselves to defining the characteristics of each training programme. The inferences should contribute to a significant improvement in the training prescription adjusted to the individual needs and capabilities of the participants, as well as to a more sensible and effective exercise programming of these popular exercise modalities.

Materials and methods

Subjects

The sample encompassed 23 female participants, students who attended the obligatory PE course at the Faculty of Mathematics, Sciences and Education, University of Split, Croatia. All the participants were in a good health condition, with an average body height of 172.5 cm (± 5.16 SD) and body weight of 60.91 kg (± 5.43 SD). Their average age was 19 years. The subjects were all fairly well-trained and well-acquainted with the programmes since they were regular, experienced aerobic dancers.

Variables

The heart rate monitors "POLAR" were utilised to measure the heart frequency during the STEP and HI-LO aerobics classes. The result was an average heart rate value of a single dancer in each class (HRhi-lo - average heart rate in the HI-LO aerobics session; HRstep - average heart rate in the STEP aerobics session). Due to its simplicity, its broad applicability and high level of reliability and accuracy (enhanced by the portable versions of the appliances for monitoring the heart rate), this procedure is today probably the most frequently used method for the actual workload level assessment in the world (Bell and Bassey, 1994; Potteiger and Evans,

1995; Selley et al., 1995; Gilman, 1996; O'Toole et al., 1998).

The measure of the lactic acid concentration in the blood of the participants, achieved at a particular aerobics class (LACTstep and LACThi-lo), was added to the average heart rate measure to complete the insight in the energy component of the load intensity that the examinees were subjected to at a training session. Blood lactate concentration measurement is nowadays a procedure very often used. The occurrence of a particular level of concentration of lactic acid in the blood of athletes is regarded as a direct indicator of the intensity of work and of their energy engagement (Golnick et al., 1986; Casaburi et al., 1995; Stoudemire et al., 1996; Held et al., 1999). The measurement was accomplished by means of the portable blood lactate analyser "ACCUSPORT", produced by the "Boehringer Manheim" (Neumann et al., 1994). The values of the measured blood lactate concentration were expressed as a ratio of millimols in a litre of blood (mmol/l).

Such a combination of measurement methods (the heart rate and the blood lactate concentration) is nowadays a very popular procedure for the determination of energy demand or the workload level (Gilman et al., 1993; Neumann et al., 1994). It proved to have been applicable and very useful in our research as well.

Data processing methods

The descriptive statistic parameters (Table 1) were computed. The results are graphically represented as a frequency histogram with double ordinate axis (Figures 1 and 2).

Table 1: The differences of the average heart rate at different intervals during the main part of the HI-LO and STEP aerobics sessions (F test - F, and level of significance of the variance analysis - p)

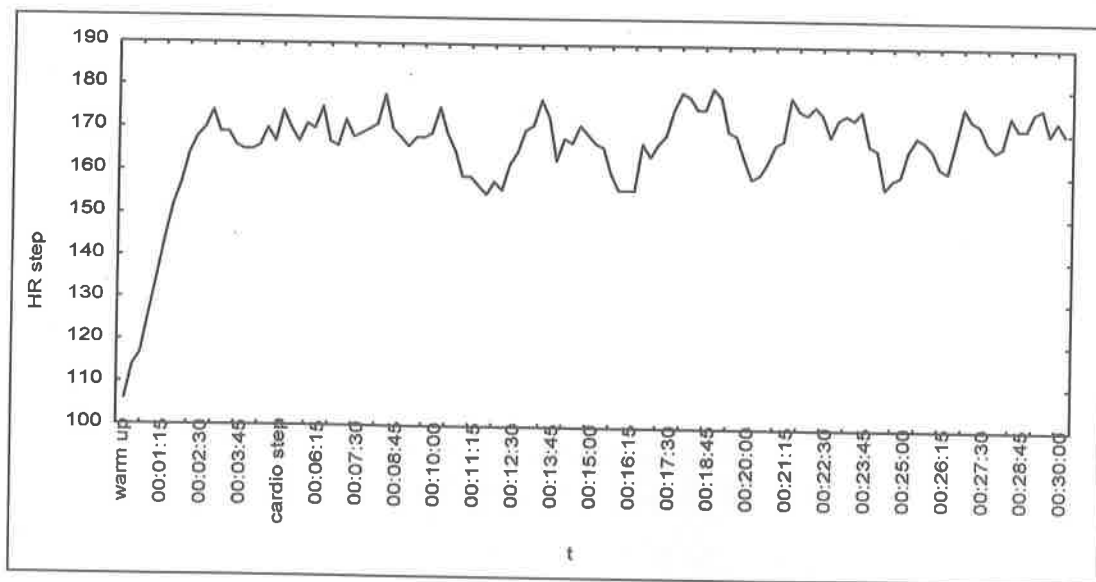|	HI-LO AEROBICS			Analysis of variance for the repeated measurements	STEP AEROBICS			Analysis of variance for the repeated measurements
	MAIN PART OF THE SESSION				MAIN PART OF THE SESSION			
	$1^{st}-8^{th}$ minute	$8^{th}-16^{th}$ minute	$16^{th}-24^{th}$ minute		$1^{st}-8^{th}$ minute	$8^{th}-16^{th}$ minute	$16^{th}-24^{th}$ minute	
AVERAGE HR (AM± SD)	158±17.6	163±22.4	162±21.9	F = 1.39 p = 0.26	162±13.0	166±14.2	157±11.9	F = 0.46 p = 0.63

Figure 1: Graphic presentation of the heart rate values measured in one participant during the STEP aerobics class

Table 2: *Basic statistical parameters (arithmetic mean - Mean, minimal result - Min, maximal result - Max, standard deviation - SD); results of the t - test for dependent samples (value of the test - t, level of significance - p); results of the multivariate analysis of variance - MANOVA (Rao's R, Wilks' Lambda and level of significance - p)*

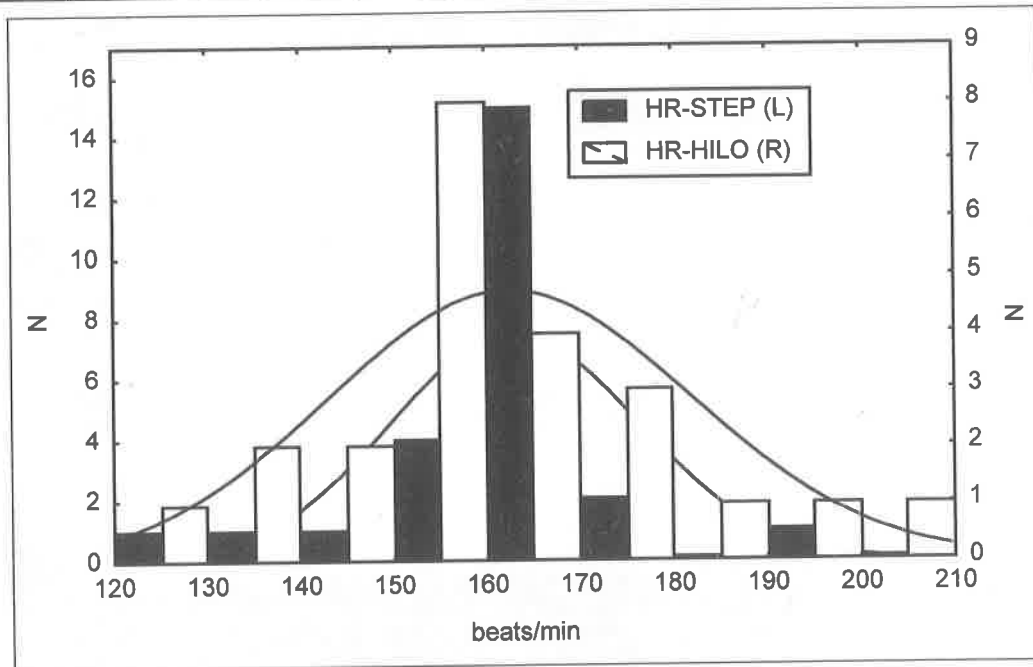| Var	Step aerobics				HI-LO aerobics				Analyses	
	Mean	Min	Max	SD	Mean	Min	Max	SD	t - test	MANOVA
HR	162.90	130.00	198.00	13.91	162.43	124.00	208.00	19.38	t = 0.16 p = 0.88	Rao R = 0.57 Wilks' λ = 0.94 p = 0.58
LACT	2.43	1.20	3.90	0.79	2.64	1.20	5.30	0.91	t = - 0.73 p = 0.48	

Figure 2: *Histogram of variables HRstep and HRhi-lo*

The results of the assessment of the energy load intensity of the aerobic classes were processed by means of MANOVA in order to determine any possible general load distinctions between the two aerobic programmes (HI-LO and STEP). Additionally, the values of the *t*-test for dependent samples were computed to determine any possible partial differences in the levels of the workload of the set aerobic programmes (Table 1).

The experiment description

The experimental part of the research encompassed the following procedures:

➤ The group of female subjects performed a classical STEP aerobics routine or training choreography (the construction of

which is described in the next paragraph). During one training session the data about the heart rate in each examinee were collected.

➤ Each participant was individually summoned to the blood lactate concentration measurement after 25 minutes of working. The examinees interrupted their work 45-75 seconds before the blood sampling.

➤ The same measurement procedure was applied to the same subjects during the HI-LO aerobics class. The differences between these two aerobic dance programmes were limited to their classical comparative variety. The speed of the music utilised in the HI-LO aerobics class had 145-152 BPM (beats per minute).

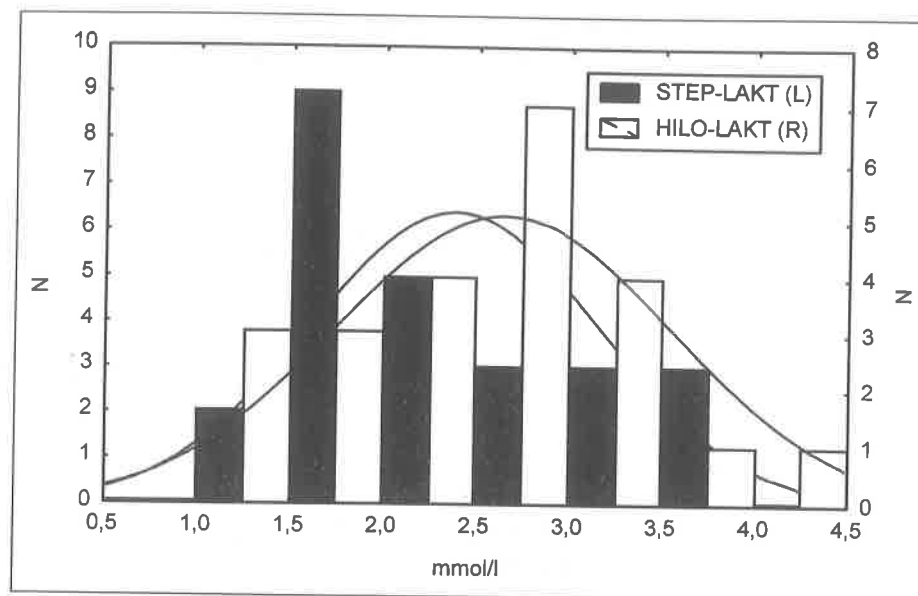➤ Ten days elapsed between the two measurement sessions. Both classes were

Figure 3: Histogram of variables LACTstep and LACThi-lo

held in the morning and the participants stated that they had not been engaged in any intensive physical activity within the 24-hour period before the testing. Therefore, it can be stated that the examinees were fresh to perform the prescribed routine.

Construction of the training sessions

The STEP aerobics class was designed as follows:

Warm-up. Duration - 10 minutes. The following routines or movement structures were implemented in the warm-up: step touch, march in place and in motion, squat, squat with the weight transfer to the right and to the left, and grapevine. Leg motions were accompanied by the appropriate upper body movements in a sequence: overhead press, double-arm biceps curl, double-arm front raise, and front raise alternately. The same movement arrangement and duration of the warm-up was applied in the HI-LO aerobics class.

The main part of the class or training bout - total time: 25 minutes. The training programme consisted of five routines (motion structures), usually implemented in the STEP aerobic dance, as follows: basic step, V-step, knee lift, repeater, over the top. Leg motions

were accompanied by the appropriate upper body movements in a sequence: double-arm overhead press, alternate lateral deltoid raise, double-arm pull back high, alternate front raise, double-arm front big circles.

Routines were performed in identical sets (cycles or series): right leg (RL) four times, left leg (LL) four times, 2xRL, 2xLL, 2xRL, 2xLL, 8xRL+LL. The duration of each set of movement structure (cycle) was 40 to 50 seconds, which depended on the actual rhythm of music. When one motion structure set had been completed, the other one followed. So, the participants repeated the same sequence of motion structures or routines until the determined period of 25 minutes was over.

The speed of the music utilised ranged from 120 to 128 BPM, this being the usual tempo for the STEP aerobic dance. The height of the step-stool used in the aerobics class was 15cm.

The HI-LO aerobics class construction was identical to the STEP aerobics class regarding the duration or time parameters (warm-up 10 minutes + the main part of the class 25 minutes). The motion structures employed in the warm-up of the HI-LO class were identical, as far as their selection and arrangement were concerned, to those used in the STEP aerobics class.

The motion structures (or routines) used in the main part of the HI-LO aerobics class were as follows: squat - step touch, grapevine

"hoop", jogging in place and in motion, knee lift "hi", and V-step + jumping jack. Arm motions were identical to the ones used in the STEP aerobics class.

Generally speaking, all the routines used in both aerobics classes were selected according to the existing evidences on their comparable energy demands when applied to music of the herein defined tempo (Sekulić, 1995 and 1996; Željković, 1995).

Therefore, it could be assumed that the selection and cyclic repetition of the movement structures (routines) define the training work in both programmes as a continuous or mildly discontinuous one. This hypothesis was additionally analysed so that the differences between these two programmes (HI-LO and STEP) in the heart rate values were determined at three eight-minute intervals during the main part of the session (after the first, the second and the third 8-minute interval; the entire main part of the session lasted 25 minutes).

Results and discussion

In Table 1 the average heart rate values at particular time intervals of the main part of the classes are presented (1-8 minutes, 8-16 minutes, 16-24 minutes). The results of MANOVA revealed there were no significant differences in the heart rate values between the observed intervals within a particular exercise programme. Therefore, it could be stated that both programmes, in the implementation mode used herein, had all the characteristics of a continuous work, with no substantial oscillation in the work intensity.

The aforementioned was attainable due to the invariable speed of the music used (which is generally the crucial parameter for the work intensity changes in aerobic dance) and to the selected routines or movement structures that set almost equal energy demands on the dancers.

The histogram of the heart rate value curve, measured in one subject, corroborates the aforementioned results.

Table 2 and Figures 2 and 3 show a somewhat larger range of the heart rate values

measured at the HI-LO aerobics class (HRhi-lo) than those measured at the STEP aerobics class (HRstep). The same is obvious from the analysis of the maximum and minimum values obtained (Min, Max), as well as from the standard deviation (SD). However, no noticeable numerical difference has been observed in the arithmetic means.

A larger dispersion of results is also discernible in the indicators of variability (standard deviation) of the blood lactate concentration values obtained at the HI-LO aerobic class (LACThi-lo). It is probably due to the conspicuously higher measurement maximum (as seen in Table 2 and Figure 2). Similarly, no noticeable numerical difference has been observed in the arithmetic mean of the variable in relation to the same parameter measured at the STEP aerobics class (LACTstep).

Such a dispersion of results indicates the existence of certain special features of the analysed training programmes. So, it is feasible to assume that the smaller variance of the energy load variables measured at the STEP aerobics class (HRstep and LACTstep) suggests that the STEP aerobic dance probably offers a larger potential to determine the work intensity more accurately during the implementation than it is the case with the HI-LO aerobics.

Values of the central and dispersive parameters of the results' distribution, however, indicate certain disproportions between the heart rate and blood lactate concentration indicators in the particular aerobic dance classes. For example, in the STEP aerobics class the maximum value of the average heart rate was 198 b/min (from Figure 1 it is obvious the value was registered in one subject only). The results obtained suggested it would have been feasible to expect the occurrence of the anaerobic level of workload in certain participants. Theoretically, such a phenomenon could have been expected in participants whose heart rate values exceeded 165-170 b/min (Scharf - Olson et al., 1992). However, the blood lactate values, measured at the same aerobic class, did not indicate any occurrence of an anaerobic exercise intensity. The blood lactate value should have exceeded the 4 mmol/l concentration level (Golnick et al.,

1986) in the case of switching to the anaerobic work regimen. During the STEP aerobics class such values were not obtained in any participant (Table 2 and Figure 3).

Even more conspicuous disproportions in the heart rate values and the blood lactate concentration status are observed with regard to the HI-LO aerobics session. The maximum values of the average heart rate, registered in three examinees, range from 180 to over 200 b/min. Such results again indicated the possibility that certain subjects could have entered the anaerobic work regimen in the HI-LO aerobics class. This assumption was confirmed in one participant only (the blood lactate concentration level exceeded 4 mmol/l).

From all the aforementioned, it is feasible to conclude that the heart rate values, measured during the aerobics sessions, are not quite reliable indicators of the energy demands or exercise intensity (workload), because the heart frequency values are slightly more elevated than expected according to the direct connection with the size of the oxidative energy system engagement.

The phenomenon is not unknown and it has been already investigated (Berry et al., 1992; Parker et al., 1989). The first research investigators related the energetically disproportionate higher heart rate in aerobic dance training with the disturbed haemodynamic balance (excessive overhead arm motions), as well as with the sympathetic nervous system activity responses or emotional excitement, which regularly occurred during the aerobics classes. The same explanation is acceptable for the issue in the present research.

The significance of the differences among indicators of the energy demands or exercise intensity of the HI-LO and STEP aerobic classes can be tested by means of multivariate analysis of variance (MANOVA). Implemented procedure compared two variables for the energy load assessment in the HI-LO aerobics programme (HRhi-lo and LACThi-lo) to the same variables obtained in the STEP aerobic dance class (HRstep and LACTstep). However, numerical values of the parameters of general differences, obtained by means of the mentioned methodological procedure, showed no significance at the satisfactory statistical level (Wilks' lambda = 0.94, Rao R = 0.57, p = 0,57).

It is feasible therefore to state that in the global space no statistically significant differences could have been determined between the indicators of the energy workload of the HI-LO and STEP aerobic classes as performed in the experiment.

The partial differences between respective variables for the energy workload assessment were analysed by means of t-test for the dependent samples. No statistical significance was determined by means of the employed procedure between numerical values of the heart rate indicators registered in the HI-LO (HRhi-lo) and STEP (HRstep) aerobics classes. The value of the t-test was 0.16, which corresponded to the significance level p of 0.88 (12%).

The same inference was derived from the analysis of the blood lactate concentration (LACThi-lo and LACTstep). The value of the t-test was -0.73, which corresponded to the statistical level p of 0.48 (52%).

The measures of both the multivariate and univariate differences indicated that no significant differences existed between indicators of energy workload of the STEP and HI-LO aerobics classes. So, on the basis of the obtained results it can be concluded that, with the participants involved, exercise intensity or energy demands (energy workload) of the HI-LO aerobic dance programme was comparable to the one measured in the STEP aerobics class, under the herein defined conditions.

Conclusion

The final conclusions, derived from the obtained results, are as follows:

➢ The analysis of the values of the heart rate and blood lactate concentrations, obtained in the STEP and HI-LO aerobics classes, revealed that both activities were predominantly of an aerobic and/or moderate anaerobic nature.

➢ Some indicators suggest that the disturbed body haemodynamic balance

(caused by the extensive overhead arm motions), as well as the elevated emotional excitement of the participants in the aerobics session induce a moderate disproportion between the heart rate values and the actual engagement of the oxygen energy resources (oxygen consumption) in gymnasts. This phenomenon is manifested as the elevated heart rate response which is not proportional to the actual value of the lactic acid concentration in the blood.

➢ The HI-LO and STEP aerobic dance programmes are exercise activities of a fairly equal energy demands if executed with respect to the actual individual demands and the present characteristics of participants.

➢ Such an equivalency of energy demands of both aerobic dance programmes (HI-LO and STEP) allows for equal application possibilities, as well as for expecting similar transformational effects. The latter primarily depends on the actual endurance capacity of an individual and on the actual load or exercise intensity each individual is exposed to.

➢ A somewhat larger range (dispersion) of results of the heart rate and blood lactate concentration obtained in the HI-LO aerobics class with regard to the results registered in the STEP aerobics class, may be a reinforcing contribution to an assumption that the latter is an activity for which the exercise intensity (energy demands) can be more accurately prescribed. Therefore it is regarded as more adjustable to individual needs of participants.

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