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HEART RATE IN THE PHYSICAL EDUCATION CLASS AT LOWER SECONDARY LEVEL

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ABSTRACT. We chose as a subject of this paper "The Dynamics of Effort in the Physical Education Class at Lower Secondary Level" on the grounds that the effort is closely related to the other components of the training process (skills, abilities, physical qualities). The key to success in the practice of physical exercise is the dosage of effort. Before, at the beginning of and during the physical effort, in response to its intensity and duration, the human body makes a number of adjustments to ensure the necessary energy within the shortest time. These adjustments consist in increasing the cardiac output (CO) on the basis of the rise in the HR (heart rate) and the volume of the blood pumped into the aorta during a ventricular systole, ventricular stroke volume (SV) and the blood flow in the muscles employed in the effort. This makes it possible to increase oxygen consumption (VO_2). In submaximal efforts, it was found that the rate of the aerobic production of energy increases with time, while maintaining it constant. The relationship between HR and VO_2max is not linear with low intensity efforts. It tends to become linear with efforts of increased intensity. An explanation for this may be found in the increase of SV. It si important to note that the intensity and duration of the effort as well as the degree of development of the individual's exercise capacity determine the weight of the changes occurring in CO components. In short and intense efforts, both HR and SV increase.

Keywords: heart rate, maximum oxygen level, physical effort, dynamics of effort, physical education class, pulse tester

REZUMAT. ***Frecvența cardiacă în lecția de educație fizică și sport la nivel gimnazial.*** Am ales ca temă a acestei lucrări „Dinamica efortului în lecția de educație fizică la nivelul ciclului gimnazial" pe considerentul că efortul se află în strânsă legătură cu celelalte componente ale procesului de instruire (priceperi, deprinderi, calități motrice). Cheia succesului în practicarea exercițiilor fizice o reprezintă dozarea efortului. Înainte, la începutul și în timpul efortului fizic, ca răspuns la intensitatea și durata acestuia, în organismul uman se produc o serie

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de adaptări menite să asigure în cel mai scurt timp energia necesară. Aceste adaptări constau în mărirea debitului cardiac (DC) pe seama creşterii FC şi volumului de sânge pompat în artera aortă în timpul unei sistole ventriculare, volum sistolic ventricular (VSV) şi a circulaţiei sângelui în muşchii angajaţi în efort. Aceasta face posibilă creşterea consumului de oxigen (VO_2). În eforturile submaximale, s-a constat că ponderea producţiei aerobe a energiei creşte cu timpul, în condiţiile menţinerii constante a acesteia. Relaţia dintre FC şi VO_2max nu este liniară în eforturile de intensitate scăzută. Ea tinde să se liniarizeze odată cu creşterea intensităţii acestora. O explicaţie în această privinţă poate fi creşterea VSV. Este important de menţionat că intensitatea şi durata efortului precum şi gradul de dezvoltare a capacităţii de efort a individului, determină ponderea modificărilor care au loc în componentele DC. În eforturile intense şi de scurta durată, creşte atât FC cât şi VSV.

Cuvinte cheie: frecvenţa cardiacă, nivelul maxim de oxigen, efort fizic, dinamica efortului, lecţia de educaţie fizică, puls tester

Introduction

The activity of physical education and sport, organized for educational and instructive, participative or recreational purposes, becomes nowadays increasingly extensive.

The changes in the conditions of existence of the contemporary man exercise significant influences on the human body, forcing it to adapt its functions to new conditions.

The content of this paper focuses on research whose main direction is the relationship between heart rate and the maximum volume of oxygen. We analyzed the relationship between the dynamics of the heart rate and of the maximum oxygen consumption as well as the possibility of using heart rate in dosing intensity, during physical effort.

During the first three stages, the effort development follows an upward course as revealed by HR and RR (respiratory rate) values which, starting from about 70 beats/min, respectively 16-18 breaths/min, can reach levels of 120-130 beats/min, respectively 20-22 breaths/min. At the end of the third stage, acting in order to attain the specific operational objectives of the lesson entails the highest demands on the body. The downward trend of the values of functional parameters is a physiologically normal one, provided by means of the last two stages during which one tries to bring one's body back to an optimal state so as to continue with school or daily activities. This generates a downward shape of the effort curve, to levels close to those recorded before the start of the class.

Heart rate (HR)

"Before, at the beginning of and during the physical effort, in response to its intensity and duration, the human body makes a number of adjustments to ensure the necessary energy within the shortest time".

"These adjustments consist in increasing the cardiac output on the basis of the rise in the heart rate and the volume of the blood pumped into the aorta during a ventricular systole, ventricular stroke volume and the blood flow in the muscles employed in the effort. This makes it possible to increase oxygen consumption. In submaximal efforts, it was found that the rate of the aerobic production of energy increases with time, while maintaining it constant. The relationship between heart rate and maximum oxygen consumption level is not linear with low intensity efforts. It tends to become linear with efforts of increased intensity. An explanation for this may be found in the increase of the ventricular stroke volume".

So, physical effort results in cardiac output increase. It is important to note that the intensity and duration of the effort as well as the degree of development of the individual's exercise capacity determine the weight of the changes occurring in cardiac output components. In short and intense efforts, both heart rate and ventricular stroke volume increase." (www.medicinasportiva.ro)

Oxygen extraction (a-v O_{dif})

"There are two main parameters that determine the size of a-v O_{dif}, namely the amount of O_2 carried by the blood and the consumption need existing in the muscles engaged in the effort. Arterial oxygen varies little as compared to its level in the state of rest of 20ml dl^{-1} even in the case of a higher variation of exercise intensity. But what gives the a-v O_{dif} value is O_2 content in the venous blood, which is somewhere around 12-15 ml dl^{-1} in a state of rest and which decreases during the maximum intensity exercise down to 2-4 ml dl^{-1}.

From the time O_2 reaches the muscles involved in the effort, the equivalent of the blood hemoglobin, myoglobin, the mitochondrial content and the *aerobic* enzyme apparatus of the muscles will further condition the a-v O_{dif}, the dynamics of their activity being, of course, determined by the intensity of the effort. Recruitment size and the type of muscle fibres engaged in sustaining the physical effort definitely influence the oxygen *demand*. Therefore, the physiological motivation for the use of heart rate in estimating and determining the dosage of exercise intensity lies in the way in which the heart, through its action of pumping blood into the arteries, compensates for the changes in the dynamics of peripheral circulation. Without the adjustments of the heart rate

and ventricular stroke volume, central blood circulation would be very much affected. An increased peripheral resistance would cause high blood pressure, whereas increased vasodilation of peripheral vasculature would result in low blood pressure.

Adrenaline and noradrenaline are the hormones by which the control of the sympathetic nervous system acts on heart rate and on the force of contraction of the myocardium. It can be seen that catecholamine secretion in the blood increases in proportion to the intensity of exercise.

The relationship between heart rate and maximum oxygen consumption level is not linear. This is because the cardiac output adjustment to maximum oxygen consumption level is achieved by variations in heart rate and ventricular stroke volume.

Hypothesis

In this experiment, we started from the hypothesis that, by planning the dynamics of effort according to the requirements and principles for exercise in the physical education class, striving towards a balance and an optimal combination of the volume, intensity, complexity, density and purity of the effort, it would most certainly be directed at reaching maximum shape and the continuous increase in capacity. However, to achieve this goal, objective tools and techniques for monitoring the dynamics of the effort throughout one or several classes are required.

Goals

The research goals were, first of all, to determine the current state of knowledge on the subject as reflected in specialized literature and research works, then to identify parameters such as: warm-up time, time of maximum effort, and ending time, setting out record-keeping documents and instruments for effort dynamics assessment (quantitative, qualitative indicators) as well as monitoring the dynamics of effort as scheduled for students.

Materials and methods

The experiment took place as part of the instructive and educational process, during the classes of physical education and sport of 5th, 6th, 7th and 8th grades, with the observance of the school year structure, following the proposed work hypotheses.

The research was conducted in 2 stages, the first test being performed during the period 20-30 November 2012, and the second during the period 10-20 March 2013 at primary and middle school "Octavian Goga" of Oradea. In both occasions, the tests were performed on the same selection of children to see the changes that had occurred and whether there had been any improvements in the meantime.

The experiment was performed on groups of children, under the same conditions in both the initial and the final tests.

The research included 4 samples, namely 5th, 6th, 7th and 8th grades. There were 5 students randomly selected, and the tests were performed at three different times of the class: **beginning of the exercise, peak of the exercise** and **after the exercise**, on which occasions we measured their heart rate and maximum volume of oxygen.

Work intensity by levels of effort with pulse-area control. I started from the premise that the oxygen debt is recovered more quickly than HR, therefore HR values were accurately determined with the help of the pulse tester.

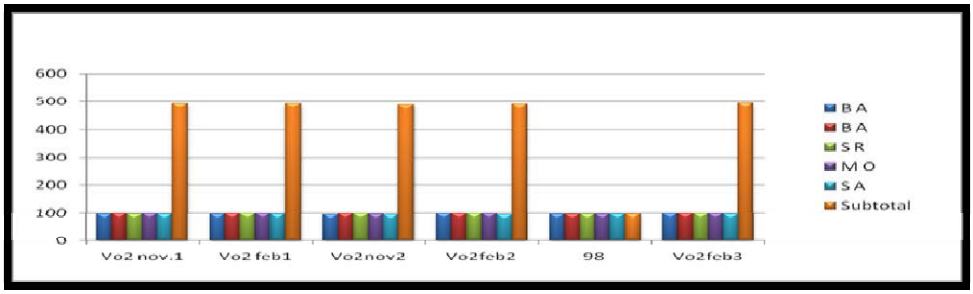

Chart 1 – Maximum Volume of Oxygen in grade 6th B

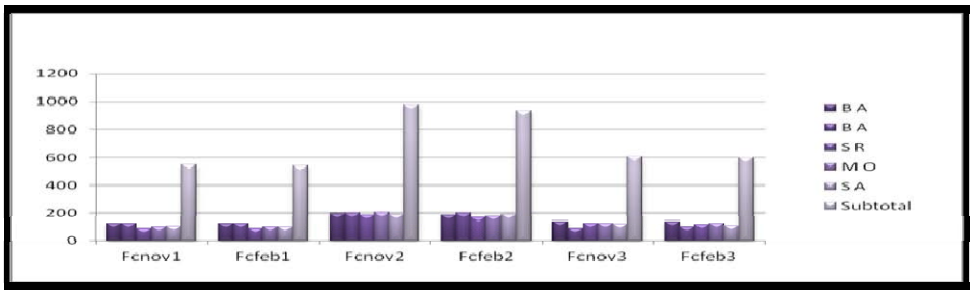

Chart 2 – Heart Rate in grade 6th B

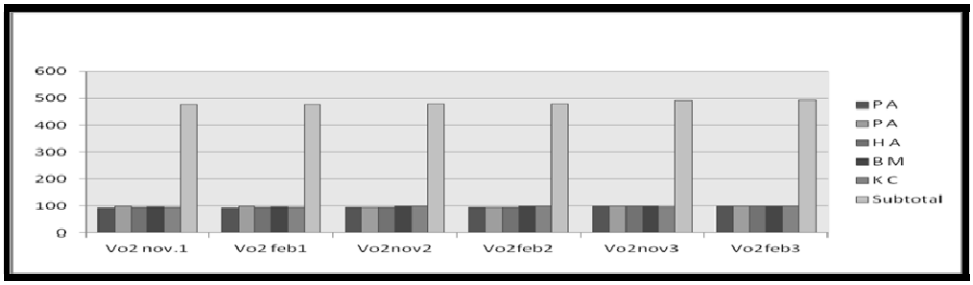

Chart 3 – Maximum Volume of Oxygen in 8th grade

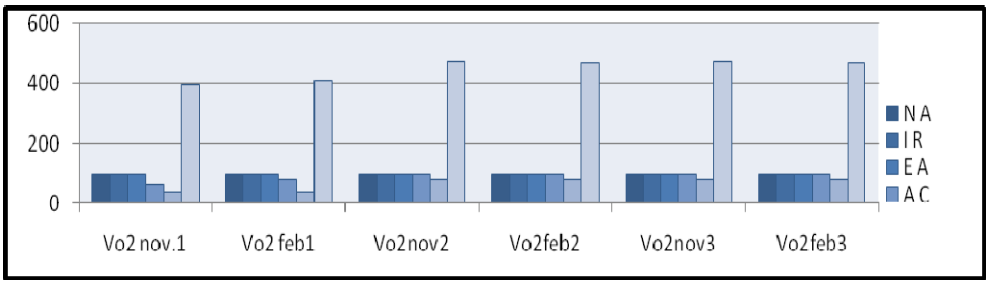

Chart 4 – Heart Rate in 8th grade

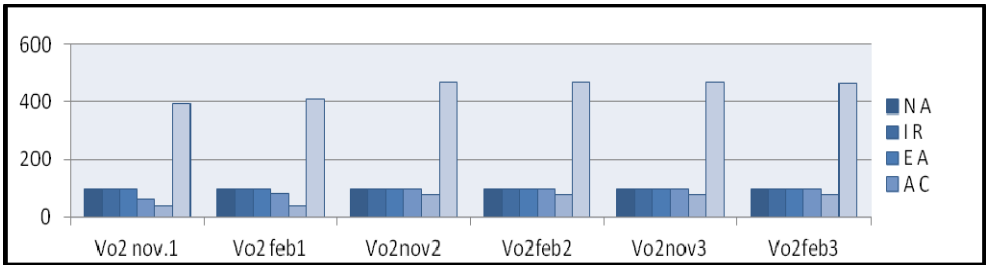

Chart 5 - Maximum Volume of Oxygen in 5th grade

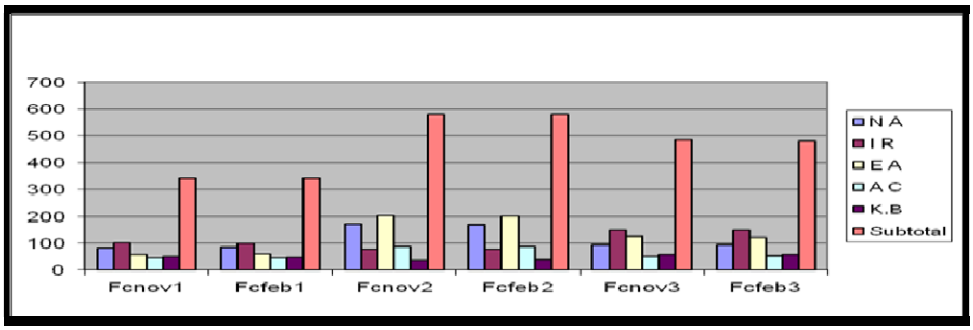

Chart 6 – Heart Rate in 5th grade

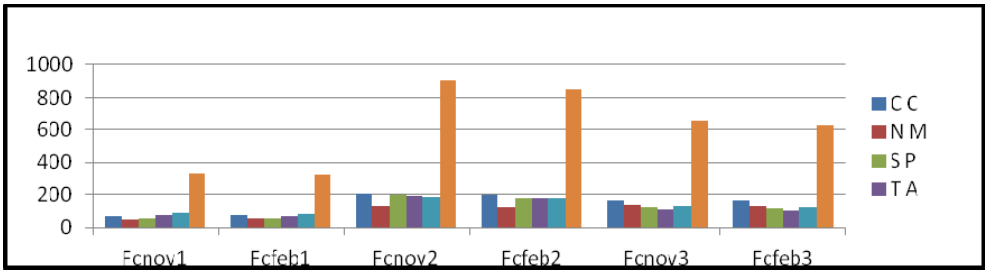

Chart 7 – Heart Rate in 7th grade

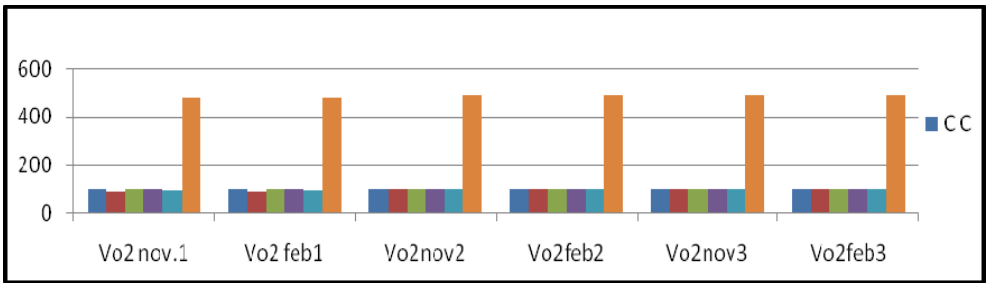

Chart 8 – Volume of Oxygen in 7th grade

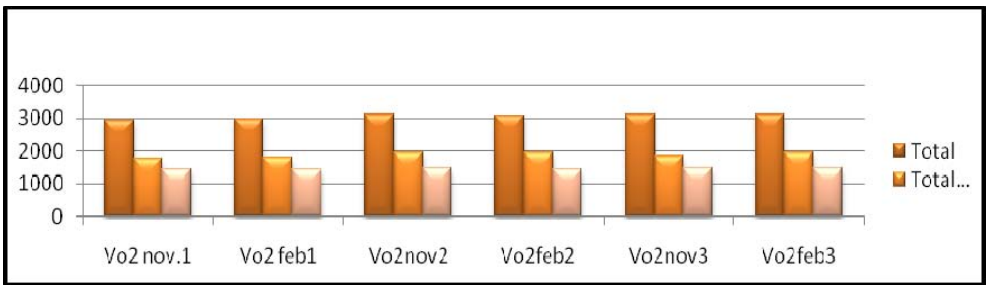

Chart 9 – Total girls and boys Maximum Volume of Oxygen

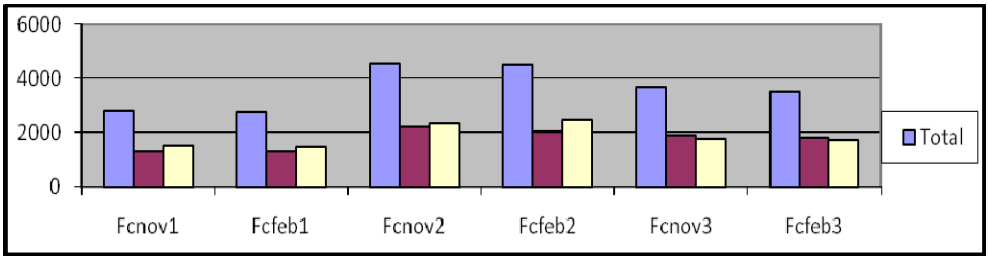

Chart 10 – Total girls and boys Heart Rate

Discussion

All research results help to confirm the hypothesis, namely that, by planning the dynamics of effort according to the requirements and principles of exercise in the physical education class, striving towards a balance and an optimal combination of the volume, intensity, complexity, density and purity of the effort, it will certainly be directed at reaching maximum shape and the continuous increase in capacity. Also, to achieve this goal, objective tools and techniques for monitoring the dynamics of the effort throughout one or several classes are required.

The pulsations recorded were an accurate indicator of the intensity of the work performed, as well as of the recovery after effort. The use of the pulse tester allowed us an objective control of HR and of the duration between repetitions which led to improvement in the performance of the members of the experimental group as compared to the control group.

Measurement of the heart rate by using the pulse tester is a very good overall indicator of exercise intensity and can serve as an effective referral system for both the student and the teacher.

Conclusions

In conclusion, we can say that the use of the heart rate in the determination and dosage of the intensity of physical effort is a good tool, because it reflects with high fidelity the amount of oxygen consumption required to produce energy. It is noted that, with submaximal efforts, maintaining a constant intensity during the exercise is done through a rise in the share of aerobic energy production, in the context of intensified blood circulation in the muscles involved in the effort.

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