

METHODS AND MEANS OF DEVELOPMENT OF AEROBIC ENDURANCE OF ATHLETES

Preliminary communication

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Abstract

The subject of this study refers to aerobic endurance of athletes under the influence of a training process, that is, to methods and means for increasing aerobic endurance of sportspeople. The aim of the study is to present specific methods and means which are used in methodology of aerobic endurance of athletes development. The subjects were 80 athletes from athletics club "Leposavic", ranging from 21 – 29 years of age. This research survey has longitudinal character and it is defined by parallel groups. The first programme was used with the first experimental group EXG1 and its concept was based on the principles of continuous running. The second programme was used with the second experimental group, EXG2 and its concept was based on the principles of discontinuous running. The third programme was used with the third experimental group EXG3 and its concept was based on the principles of individual use of continuous and discontinuous running. EXG0 was a control group, and the rest were experimental. Each group had 10 male and 10 female athletes. The groups were made by a random choice. The results indicate that methods of work for aerobic endurance increase can be continuous (steady or distance), changeable or interval and every method can have a couple of variants.

Keywords: *aerobic endurance, training methods, athletes.*

INTRODUCTION

Aerobic exercising represents different exercises and physical activities which stimulate activities of the heart and lungs long enough in order to produce useful effects in the human organism. The main aim of aerobic exercising is to increase maximum oxygen quantity which a body can spend within a certain period of time (De Vries, 1976). Aerobic effects are provided in the easiest way by applying natural forms of movement (walking, running, going on foot), cyclical exercises (cycling, swimming, ski running) and other activities (Stefanović & Stefanović, 2016; Malacko, 2000; Ozolin, 1996). Aerobic exercises influence increase of aerobic abilities efficiently, contribute to preservation and improvement of health; remove and/or ease health problems; increase work abilities and lengthen active work life and life time (Petkovic, 2003).

Every human activity is based on energy consumption. A body produces energy by burning nutrient values – fat, carbohydrates and proteins. Oxygen is necessary for burning food. A body can store food reserves mostly in the form of fat layers. Thanks to this ability a human can live without food for a couple of days, even for a couple of weeks. However, oxygen reserves cannot be stored in the human organism. This is the reason why it is necessary to convey oxygen constantly to the human organism and it is provided by constant breathing. The more intensive muscular activity, the more groups of muscles it includes, the larger oxygen consumption.

There is enough oxygen in the atmosphere which surrounds us. However, not all the people have equal ability to convey necessary quantities of oxygen to all their organs and systems, especially not during more intensive body activities. Majority of people can convey enough oxygen only for doing their usual everyday work and life activities, but not for performing more intensive muscular activities. The criterion for our ability is a range between our minimum demands and our maximal capacities. The most physically able people have the biggest range, that is the biggest reserves of aerobic activities.

Aerobic ability is necessary for everyone — disregarding their profession and usual everyday burdens. We should bear in mind that aerobic ability is the best and the most efficient life insurance. Systematic aerobic exercising is the key to aerobic ability increase. Aerobic exercising is the exercising which contributes to the increase of

aerobic abilities (Duthie, Young & Aitken, 2002; Stefanovic, 2012). It is characterised by the following physiological characteristics: engagements of large muscle groups and period of exercising.

Engagement of large muscle groups – leg muscles, trunk muscles, arm muscles and shoulder zone muscles (at least 1/6 to 1/7 of the total body musculature) in a dynamic order where effort and stretching alternate rhythmically;

Exercising lasts from 30 to 60 min of continuous aerobic activity. Duration of activity is proportionally opposite to the intensity load – low intensity activities can last longer. Low and medium intensity activities of longer duration are recommended to middle-age and old-age people and people with low level of functional abilities (Milanović et al., 2013). "The effect of general endurance" is achieved more completely by longer duration of activities and by increase of fat layers burning – optimum intensity of load is dosed within the limits of 60% to 85% of maximum heart rate frequency, but it is also performed by energy consumption from 5.2 to 7.5 kcal/min/kg.

Positive health-preventive effects therefore are achieved by application of aerobic exercising programme where oxygen consumption is big enough (Radak et al., 2013). Aerobic programs are aimed, first of all, at positive influence they have on improvement of cardiovascular and respiratory systems (increase of aerobic abilities), as well as to the increase of capacities of tissues for energy oxygen transfer.

A large number of scientists all over the world dealt with the issues of examining endurance while running and walking. Many studies have demonstrated that walking exercise positive influence on aerobic capacity and the association between walking and the risk of all-cause mortality may be partly due to reduced risk of cardiovascular disease (Hamer & Chida, 2008). As a result of the study, 12-week treadmill-based (MT) and track-based walking training (TT) showed positive effects such as increases of VO₂max and muscular endurance (Sung, E., 2017).

METHODS

The subject of this study refers to the development of aerobic endurance of athletes under the influence of training procedures, that is, to methods and means of increase of aerobic endurance of athletes.

The aim of this study is to present specific methods and means used in the methodology of development of aerobic endurance of athletes.

Experimental method was applied in this research survey of longitudinal character. It was defined by parallel groups where EXG0 was a control, and the rest were experimental groups. The subjects were 80 athletes from athletics club "Leposavic", ranging from 21 – 29 years of age. All of the groups had 10 male and 10 female athletes, which were selected by random choice. The first programme was used with the first experimental group EXG1 and its concept was based on the principles of continuous running. The second programme was used with the second experimental group EXG2 and its concept was based on the principles of discontinuous running. The third programme was used with the third experimental group EXG3 and its concept was based on the principles of individual use of continuous and discontinuous running.

Control of development of the endurance level

Possibilities and ways of control of development of the endurance level, that is, control of the cardiovascular system adaptation, are numerous in practice. There is the whole range of various methods which at the large number of cases use values of heart frequency and other parametres such as:

- maximum oxygen consumption,
- maximum oxygen debt,
- maximum accumulation of lactic acid in blood,
- oxygen pulse,
- maximum values of lungs ventilation,
- minute heart volume,
- oxygen saturation of blood,
- degree of blood chemistry change,
- time of static or dynamic effort endurance,
- specific exercises and efforts, specific body activities etc.

It is known that during effort endurance of long duration, besides normal condition of cardiovascular system, a significant role is played by metabolic efficiency of oxygen consumption and nervous system stability, that is, when we talk about children and young people, power of motive for high-quality performance of their physical abilities.

Cardiovascular system as a factor which limits duration of load in the period of growth and development is adapted to periods of work and rest alternating. Oxygen consumption does not reach its maximum values when higher and lower intensity of load alternate in longer periods of time (Stefanović & Stefanović, 2017). The oxygen necessary for physical effort is almost completely used up in the function of high intensity effort during low intensity effort (during change of running into walking oxygen debt made during running is compensated during walking). In these forms of movement, this factor does not limit their duration. Since running and walking are natural needs of a human (as natural forms of locomotion), they cannot be classified as specific forms of movement for any physical activity. From this point of view, the ability of a human to keep these movements continuous can be observed and defined. Cooper started exactly from the human need to move as long as they can when he designed his test of running and walking abilities. Since cardiovascular system is a limiting factor for long movement (locomotion) of humans, it is considered that duration of walking and running is a specific way of checking their condition. In practice of the largest number of sports activities, walking and running lie in their basis and duration of walking and running is important for successful conducting of the activities. Research of abilities for longlasting perfor-

mance of natural forms of movement, such as walking and running, is significant in the area of kinesiology. It is possible to classify all functional tests into at least three groups:

- Recovery tests are those where loads smaller than submaximal intensity of performance are used and they are used for monitoring regulative ability of vegetative nervous system.
- Aerobic ability tests which are used to measure maximum oxygen consumption. Regarding the way of measuring there are two groups of tests: direct and indirect tests of aerobic abilities.
- Anaerobic capacity tests, where besides measuring of maximum oxygen consumption, enzyme structure, lactate concentration, energy consumption, etc. are estimated.

Tests for development of aerobic abilities

Maximum oxygen consumption (VO₂ max) is a basic measure for aerobic capacity or aerobic power of a human body. It is defined as maximal quantity of oxygen which a human organism is capable of consuming in a minute, that is, the oxygen quantity which cannot be increased when the intensity of work is increased. Maximum oxygen consumption is measured in millilitres of oxygen in one minute. However, since body mass significantly influences the value of maximum oxygen consumption, relative consumption measured in milligrams of oxygen in a minute per kilogram of body mass, is used as more reliable measure.

Every kilogram of body mass increases absolute oxygen consumption by coefficient of regression from 20 ml to 34 ml. Simultaneously, relative oxygen consumption decreases with coefficient of regression of about 0,43 ml. Oxygen pulse, defined as quantity of oxygen measured in millilitres which a human organism consumes in relation to one heart cycle, is often calculated out of the oxygen consumption value.

Maximum values of oxygen pulse depend to a large extent on the degree of training fitness of examinees. It ranges from 11 to 18 ml for the untrained persons, whereas the trained ones can reach the values of 26 ml and more. Oxygen consumption measurement is performed directly and indirectly.

Depending on the equipment, it is possible to make difference between three types of oxygen consumption direct measuring:

- intermittent type of load with an open system,
- intermittent type of load with a closed system and
- continuous type of load with an open system.

Taylor intermittent test on a treadmill is the oldest maximum consumption test. The examinee moves by tempo which is increased during the test in the following way:

5,6 km/h, 10% slope, duration 15 min., 11,2 km/h, without a slope, duration 3 min. During the third minute the exhaled air is collected into the Douglas bag and its content is analysed, after a 10-minute rest, speed of a track is km/h, and the slope is 2%, then 5% and finally 7.5%. Pauses of rest between loads are increased.

If at two successive measuring approximately the same oxygen consumption values are obtained, that is, if they do not differ in more than 150 ml, it can be said that maximum oxygen consumption is reached. Since measuring equipment has been improved Taylor test had a couple of modifications, among the others Horvat's modification, where load of examinees is performed with constant slope of 5% and speed of 2 km/h, 5 km/h and 7 km/h for women, that is 9 km/h for men.

Means for development of general (aerobic) endurance

The first week of preparation

Load for the first day of training

- aerobic capacities
- anaerobic lactate capacities
- total number of exercises – push ups
- total number of leg lifting exercises

Programme of work for the first day of training

In the morning:

- Long-distance running tempo in the sections from 100 to 150 metres in different ways (hips forward, backwards, legs crossed in front and at the back, change of pace, hops, with turning round for 180 and 360 degrees and similar exercises).

- Exercising with stretching and relaxation of the engaged musculature with the emphasis on hamstrings muscles.

- Individual check up of the ball handling technique without movements or intensive swings.

- Group revision of the technique of half strength dribbling, passing and hitting the ball.

- Exercises for relaxation of the engaged muscles.

In the afternoon:

- 22 sections of 300m medium tempo running – last 30 metres speed up to the middle of maximum speed

- After each section do relaxation exercises while walking with particular attention on breathing

- Start each following section after reducing the pulse to 121/min.

In the evening:

- 5 series of 8 individual tempo push ups

- 5 series of 36 leg lifting in supine position

- Do the series alternately

- Start each following series after reducing the pulse to 121/min.

RESULTS AND DISCUSSION

When defining the level of physical effort, that is, the level of load and ability of cardiovascular system to support itself, two forms of energy creation – aerobic (with oxygen) and anaerobic (without oxygen) are taken into account. On the basis of these forms of energy creation several types of endurance can be defined:

- Short-term endurance developed when the load is between medium and submaximal intensity lasting from about 45 seconds to 2 minutes. Energy is mostly created in the anaerobic way.

- Medium length endurance developed when medium intensity load lasts from 2-8 minutes. Energy is created in both the anaerobic and in the aerobic way.

- Long-term endurance developed with low to medium intensity of load and lasts longer than 8 minutes without break. Energy is created exclusively in the aerobic way.

- Speed endurance developed with submaximum and maximum intensity load lasting for about 6-45 seconds. Energy is mostly created in the anaerobic way. The highest speed in the period of the set time or on the set distance should be kept when doing cyclical exercises (running, cycling, and so on) and maximally fast movements should be performed when doing acyclical exercises (for example sports games).

- Intensive endurance is developed with high to submaximum intensity and number of its repetition is large. Such exercises develop endurance and strength simultaneously.

- Basic endurance is developed by exercising which leads to general fatigue. In that case, energy comes from oxygen (aerobic) processes.

Endurance and adaptation of cardiovascular system to physical effort can be developed only when necessary degree of fatigue is reached by doing appropriate exercises and when exercising is

performed continuously in longer period of time. Methods which stimulate adaptation of cardiovascular system to physical effort can be different:

- continuous method (where for example, constant intensity running lasting from 3 to 25 minutes is applied),

- changeable method (where changeable intensity running lasting also from 3 to 25 minutes is applied),

- fartlek (or the running game) where intensity which has not been planned in advance also changes and is dependent on terrain configuration mostly in nature and it also lasts from 3 to 25 minutes,

- interval method where the load should be dosaged in the following ways:

- Load lasting from 8 to 15 minutes continuously and then there is a break which does not lead to complete rest and then another load follows. Intensity should be medium.,

- Load lasting from 2 to 8 minutes also with incomplete rest but with high and submaximum intensity of load,

- Load lasting from 5 seconds to 2 minutes with incomplete rest and with submaximal and maximal intensity.

Roughly speaking, pauses of rest should not lead to complete recovery in all types of load and new load should follow only after the pulse is about 120-130 beats in a minute. During development of endurance of children and young people, the obligatory principle is to increase the range first and then the intensity of load. Certainly, this kind of endurance is strictly general and not special endurance. When choosing the exercises, both cyclical and acyclical exercises have to be done, therefore, running and sports games, exercises on gymnastic apparatus, elementary games, body shape exercises, etc.

In order to enable meaningful handling of all the changes (organ systems and mechanisms) used when running in the educational process of teaching at the faculty of Sport and Physical Education, it is necessary to have information about physical fitness of students in the space of endurance in single phases of that process. Necessary information can be obtained only by adequate measuring procedures (Stefanović, Stefanović, & Okiljević, 2016).

It is very important to develop endurance systematically and continuously from the first days of school. Participation of particular disciplines in the teaching programme of physical education is different what cannot be seen in the table 1.

Generally speaking about typical load, it can be said that short-term loads of maximum intensity lasting 3-8 seconds (running – sprint on 20-60 m) develop 100% speed, 60% strength, 20% local endurance and 10% general endurance. Repetition of loads of maximum intensity lasting 30-60 seconds (sprint 200-400 m) develops 50% speed, 20% strength, 70% local endurance and 30% general endurance. Loads of medium intensity lasting 80-120 seconds (running on 500-600 m) develop 10% speed, 10% strength, 70% local endurance and 100% general endurance. Loads of medium intensity lasting for 2-8 minutes develop 50% of local endurance and 100% general endurance.

Table 1: Athletic disciplines in physical education programs

Features included:	General endurance	Speed endurance	Strength endurance
Running on 100 m	10%	30%	60%
Running on 400 m	20%	40%	40%
Running on 800 m	30%	50%	20%
Running on 1500 m	40%	40%	20%
Sports games - football, handball, basketball	50%	30%	20%

CONCLUSIONS

On the basis of the previous presentation, the following conclusions can be made:

- Endurance can be defined as the ability to endure a specific physical activity and as the ability of a human organism to resist muscular fatigue.
- Basic characteristics of work on improvement of aerobic endurance is represented by medium and high intensity long-term activities. Therefore, it includes wide range of work with critical intensity.
- Methods of work for aerobic endurance increase can be continuous (steady or distance), changeable and interval and every method can have a couple of variants.
- Continuous method, changeable method, repetition method, fartlek and interval method are the most efficient for development of general (aerobic) endurance.
- Aerobic effects are provided in the easiest way by applying natural forms of movement (walking, running, going on foot), cyclical exercises (cycling, swimming, ski running) and other activities.

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