

## ASTRAND PROGRESSIVE LOAD TEST IN ASSESSING AEROBIC CAPACITY OF ATHLETES

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The most accurate picture of physical preparation is given by aerobic capacity, which is an important factor in planning and dosage of physical load.

The aim of this research was to determine the value of the aerobic capacity of athletes of different sport branches, as well as possible differences in relation to non-athletes.

We analyzed 60 respondents in total, divided into three groups of 20 each. The first group included footballers, the second handball players, and the third- control group were non-athletes.

The maximum aerobic capacity was determined by Astrand's 6 - minute test.

The highest value of  $VO_{2max}$  is recorded with football players 4.26 L/min and this value is statistically significantly higher  $p < 0.001$  compared to the other two groups.

Somewhat lower  $VO_{2max}$  values were found at handball players 4.01 L/min.

The lowest values of  $VO_{2max}$ , both in absolute and relative values, have non-athletes and these values are statistically significantly lower than in the previous two groups  $p < 0.001$ .

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**Key words:** *physical preparation, aerobic capacity, maximum oxygen consumption, physical activity, submaximal test*

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### Introduction

Aerobic ability is an important parameter in the dosage of physical load in health people as well as in the treatment of cardiovascular patients. At the same time, this parameter gives us a picture of physical preparation.

Physical activity of the aerobic type is an integral part of primary and secondary prevention of cardiovascular diseases (1-3).

Individual values of maximum oxygen consumption are the most precise parameters for dosing of physical activity (4).

Aerobic capacity is the main indicator of physical fitness of athletes, and it is limited by maximum oxygen intake ( $VO_{2max}$ ).

Maximum oxygen intake is a factor that limits metabolic processes that transform chemical energy into mechanical ones (5-7).

Proper dosage of physical activity for the purpose of either therapy or training is achieved by using individual values of maximum oxygen consumption.

The functional ability of the cardiovascular system, the respiratory system, and the ability of the tissue to utilize the delivered oxygen, most accurately determines the maximum consumption of oxygen.

The maximum consumption of oxygen is the maximum amount of oxygen the organism consumes in the unit of time at load of progressive intensity, which does not change significantly during the further increase of the intensity of the load (4).

The maximum consumption of oxygen is expressed in liters or milliliters per minute (liters / min, ml / min). This expressed value is the absolute value (8-10).

A more objective and more precise expression of the maximum oxygen consumption is in relative values, since the body weight (ml/TM kg/min) signi-

ificantly influences the maximum oxygen consumption (1, 4).

Aerobic ability is most easily and accurately determined in laboratory conditions by the tests of maximum physical load, and can be carried out either on Thread mill or ergometer bicycle (11).

When the test is to be performed on a large number of subjects, the bench step is an ergometer of choice (11).

By determining the aerobic capacity according to Astrand test our goal is to establish if the type of sport and training affects this important functional parameter that determines the energy capacity.

### Material and methods

The survey included 40 active male respondents (age  $21.2 \pm 0.8$ ) who are actively engaged in sports, 20 football players and 20 handball players. As a control group, 20 male persons of similar age ( $20.9 \pm 3$ ) who do not actively engage in sports, are tested.

The tests were carried out in the specially prepared room of the Sports Center in Leposavić, always at the same time, with the same instruments, using the same technique according to the standard procedure.

We determined the body mass - an anthropological variable with a decimal beam scale. The subjects were barefoot and in sports equipment.

The value of maximum oxygen consumption was determined by the progressive continuous sub-maximal test according to Astrand established protocol.

The test started by measuring the heart rate, pulse and blood pressure in peaceful seating position. Each respondent, after entering the laboratory, sat on a chair for 5 minutes, then approached the measurements. The pulse was measured by the palpable method.

After measuring the pulse and pressure, the participants sat on an ergometer bike, adjusted the seats according to their height, and then started the test with the rhythmic turn of the pedal, at the beginning it was 50 rpm. After 6 minutes the load was increased by 50 Watts. In each 6 - minute cycle, the pulse was measured every minute for the last 30 seconds, and the resulting value was multiplied by 2 to calculate the rate of heart frequency. The blood

pressure was measured at half of each 6 - minute cycle with tensiometer.

The test was interrupted at the moment of the maximum heart rate when we measured a frequency that did not differ for more than five beats per minute in two successive measurements due to the entry of the heart into the stationary state. The test was usually interrupted at a frequency of 130-140 beats per minute. The obtained values were used to read the absolute maximum oxygen consumption from the normograms.

By dividing absolute oxygen consumption with body weight in kilograms, we obtained a relative consumption of oxygen (ml/kg/min).

The statistical processing of all parameters was done by calculating the mean value and the standard deviation, and the obtained parameters are shown in tables and graphics. The statistical significance of the differences is determined by Student's t-test.

### Results

The maximum consumption of oxygen represents the physical capacity of athletes and is often compared to his physical ability.

The highest value of the maximum oxygen consumption expressed in absolute units (l/min) was recorded in the footballers 4.26 l/min and this value is statistically significantly higher ( $p < 0.001$ ) compared to the other two groups (Table 1), as demonstrated by the Student's t-test.

The results of the relative maximum consumption of the oxygen are shown in Table 2. The highest value (51.78 ml/kg/min) is determined in footballers and this value is statistically significantly different from the other two groups ( $p < 0.001$ ). Such high values of the absolute and the relative maximum oxygen consumption of a football players show that football is a demanding sport with quite a lot of aerobic periods during the game. Handball players compared to non-athletes have statistically significantly higher values of these two parameters (absolute and relative maximum consumption of oxygen) which shows that quality and controlled daily training significantly elevates the aerobic power of the respondents.

**Table 1.** Mean values of aerobic capacity in tested groups l / min.

Examinees	VO <sub>2max</sub> /l/min	SD
Football players	4.26	0.15
Handball players	4.01	0.21
Non-athletes	3.21	0.18

**Table 2.** Average values of aerobic capacity in examined groups, relative value per ml/kg/min.

Examinees	VO <sub>2max</sub> /ml/kg/min	SD
Football players	51.78	1.22
Handball players	46.12	1.71
Non-athletes	40.93	1.20

## Discussion

High values of aerobic capacity (absolute and relative) are necessary for achieving good results in sport, so their determination is an important parameter of fitness and physical ability (4, 5, 8, 10).

Aerobic capacity is the most important indicator of the functional capabilities of all systems involved in the supply, transport and energy transformation of oxygen (4).

The damage of any of these links will affect the athletes' aerobic abilities (5, 12). The maximum values of aerobic capacity in athletes are observed around the age of 20-22. nevertheless, the system of training and work of athletes in later years, can also lead to a slight increase of maximal aerobic abilities of athletes.

Analyzing our experimental groups, we see that the highest values of the absolute maximum oxygen consumption (51.78 ml/kg/min) and the relative maximum oxygen consumption are met with the football players.

Diaz also came to similar results (11) by measuring the maximum consumption of oxygen in Mexican footballers (53.8 ml/kg/min).

Vishoff analyzed Norwegian national team players (60 ml/kg/min), and found significantly higher average values of maximum oxygen consumption.

This great difference between our respondents and the respondents interviewed by the authors mentioned above can be explained by the ranking of the participants' competition.

Generally speaking, the high values of the maximum aerobic capacity of the football players in relation to the handball players and control group

can be explained by the efforts and reinforced training that football requires from the player. In order to meet these high energy demands that sport requires, athletes must have a more efficient energy system.

Because of this, handball players have lower values of maximum oxygen consumption compared to football players, and statistically significantly higher than non-athletes.

All this supports the claim that training is the most important factor in the development of aerobic capacity.

## Conclusion

The values of maximum oxygen consumption are important parameters for assessing the physical fitness of athletes.

By analyzing this parameter, it is possible to determine the level of fitness with certainty, check the quality of the training and evaluate the possible results. The higher values of the maximum oxygen consumption are a predisposition of greater success.

In our work, the highest value of absolute and relative maximum oxygen consumption is encountered among the football players, and the reason should be sought in the type of sport and mode of training.

The values of absolute and relative maximum oxygen consumption are significantly higher among athletes compared to non-athletes, which is a sure sign that the value of this parameter is strongly influenced by training.

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doi:10.5633/amm.2019.0102**ASTRANDOV PROGRESIVNI TEST OPTEREĆENJA U PROCENI  
AEROBNOG KAPACITETA SPORTISTA***Ljubiša M. Lilić, Slađana Milošević, Božidar Stojiljković*

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Najprecizniju sliku fizičke pripremljenosti daje aerobni kapacitet. On je važan faktor u planiranju i doziranju fizičkog opterećenja.

Cilj ovog istraživanja bio je određivanje vrednosti areobnog kapaciteta sportista različitih sportskih grana, kao i eventualnih razlika u odnosu na nesportiste.

Ukupno smo analizirali 60 ispitanika podeljenih u tri grupe od po 20. Prvu grupu sačinjavali su fudbaleri, drugu rukometaši, a treću kontrolnu grupu nesportisti.

Maksimalni aerobni kapacitet određivan je Astrandovim šestominutnim testom.

Najveću vrednost  $VO_{2max}$  konstantovan je kod fudbalera 4,26 L/min. Ova vrednost je statistički značajno veća  $p < 0,001$  u odnosu na ostale dve grupe.

Nešto niže vrednosti  $VO_{2max}$  su konstatovane kod rukometaša 4,01 L/min.

Najniže vrednosti  $VO_{2max}$ , kako u apsolutnim tako i relativnim vrednostima, imaju nesportisti i one su statistički značajno manje nego kod prethodne dve grupe  $p < 0,001$ .

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**Ključne reči:** fizička pripremljenost, aerobni kapacitet, maksimalna potrošnja kiseonika, fizička aktivnost, submaksimalni test

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