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Original Article

Evaluation of fitness index and maximal oxygen consumption of students using the UKK 2 km walk test

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Abstract:
One of the factors that, in the modern way of life and work, has an important role in preserving the abilities and health of the human body is certainly a physical activity. A very common way of assessing the state of aerobic fitness of a particular population are diagnostic tests on the basis of which we receive the necessary information when it comes to general physical condition of a defined population. This diagnostic evaluation is usually performed in the laboratory (direct methods), however, available and reliable data are about high reliability in the performance of some field tests (indirect methods). Depending on the field conditions, very often these measurements are performed using estimates of general ability (test UKK 2km). To perform this test data about body height, body weight, BMI, the values of the pulse rate and walking time during the test must be contained in it. Based on testing using the UKK 2km are obtained Fitness Index values (FINDEX) and maximal oxygen consumption (VO^2max) of students of the Faculty of Physical Education and Sport, in order to determine and define the physical condition of respondents. The results showed that the fitness index (101.89) in the upper zone average (101.89) and VO^2max = 47.26 reflects good shape
Key words: *field testing, diagnostics, aerobic fitness, UKK 2km*.

Introduction

Insufficient physical activity is a major health problem of one nation, a factor that greatly contributes to the emergence and development of chronic diseases and disorders, before all of the cardiovascular system, heart and blood vessel diseases, diabetes occurs (Blair, La Monte & Nichaman, 2004). There are many reasons for the scientific research of man's mental and physical abilities, such as: determination of certain parameters to assess the current capabilities as the basis for the development and implementation of training programs in the future, determining the effects of certain exercise programs, exercise programs verification. Human body is very complex and dynamic self-regulating system. It is complex because it consists of a series of integrated linked sub-systems (cardiovascular, respiratory, nervous system) where impaired function of one system leads to impaired function of the other system. The self-regulating because it can independently of optimal regime of life activity when changing external or internal conditions. It is dynamic because it can change its state under the influence of other external factors (Blagajac Stejić, and Ćorovic, 1991). In physical education, one of the reasons for the psychophysical research of the human abilities is the determination of certain parameters in order to evaluate the current capabilities among the respondents of the population defined. On the basis of obtained results it can be determined the current state of psychological and physical abilities of the examined population, furthermore, a plan and some of the training program can be proposed. Some authors (Wilmore & Costill, 1986, Nikolic, 2003, Misigoj-Durakovic, 2008; Sharma, Subramanian, & Arunachalam, 2013) believe that functional capabilities (cardiovascular fitness and cardiovascular endurance) are accepted as the most important indicators of active health. Athletes, as part of their physical preparation must train components of fitness (cardio-respiratory endurance, muscular endurance, muscular strength, flexibility, body composition). Each sport requires these components to some extent, because it cannot be any progress in the skill of any kind of sport, if it is not accompanied by the development of appropriate capabilities: strength, endurance (cardio-respiratory and muscular) and flexibility so that these components are taken as the most important physical skills (Cooper, 1982, Olja & Tuxwort, 1995). Although there is no complete agreement, in the Unated States most authors believe that the components of physical fitness are: cardiovascular endurance, muscular endurance, muscular strength, mobility and Body Composition (Brick, L.G. 1996, Stojiljković, 2005). American Association for Health, Physical Education, Recreation and Dance (AAHPRED, 1989) agrees with these components and for their testing suggests the following tests: 1. Aerobic endurance- walking-jogging one mile (1609m), 2.The strength and endurance of muscles in the abdomen-raising in upper position (crunches), 3.The strength and endurance of muscles of the upper body-chin ups; 4.The mobility of the lower back and hips in a forward bend- sitting position; 5.Body Composition-skin folds. The difference between the definitions of the components of fitness by local authors in relation to American version is in body composition. Body composition cannot be treated as

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physical ability, but can be changed under the influence of exercise focused on the development of the mentioned abilities (strength development is usually accompanied by an increase in muscle mass, increase of aerobic endurance is often accompanied by a reduction of subcutaneous adipose tissue). It can be an indirect indicator of the level of body fitness while on the other hand body composition can influence the physical ability and health (Guerra, Ribeiro, Costa, et al.2002; Mc Ardle et. all, 2006.)

Physical inactivity and obesity in children and adolescents are considered as independent risk factors for the development of lifestyle related disorders like coronary artery disease, diabetes, hypertension in later life. Anthropometry is generally considered as the single most easily obtainable, inexpensive, and noninvasive method that reflects body composition (Tarnus, & Bourdon, 2006). Body composition measures like height, weight, BMI, waist and hip circumference, body fat percentage (BF%) and fat free mass (FFM) are also accepted globally amongst the sensitive indicators of health status of children and adolescents (Chatterjee, Chatterjee, & Bandyopadhyay, 2006). Cardiorespiratory fitness (CRF) or VO2max reflects the functional capabilities of the heart, blood vessels, blood, lungs, and relevant muscles during various types of exercise demands. CRF is related to the ability to perform large muscle, dynamic, moderate-to-high intensity exercise for prolonged periods. Can be defined as the amount of oxygen from the blood by the heart to pump and transport the active muscle, and also, and how effectively the muscles use oxygen obtained (www.howtobefit.com). It is the efficiency of the heart, lungs and vascular system to deliver oxygen to the active muscle that contracts to physical work could take place for some time. For his capacity to bring oxygen to active muscles are affected by many physiological parameters, including heart rate, blood pressure and maximum oxygen consumption. Due to an increase in aerobic capacity increases and general metabolism, muscle metabolism, hemoglobin increases, venous blood flow is improved and others. (www.asmi.org).

In sports practice a different number of index or methods is used in order to estimate physical fitness (fitness abilities), aerobic and anaerobic systems. All diagnostic tests for assessing fitness abilities are divided into direct (intensity and then is measured the maximum time during which he is able to maintain a given intensity, for example: Shutlle Run, Conconi test) and indirect (the scope of activities is given to the respondent and then is measured time for which the respondent perform a certain task, for example: Cooper test, UKK-2km). Depending on intensity, given tests are divided into maximal and sub-maximal. Which tests will be used, depends on the population being tested, whether they are athletes or amateurs. It also depends on the test requirements, whether they need some special conditions, or some terrain tests that have a high correlation with those in the laboratory. To measure the recreational endurance, tests of sub-maximal intensities are more suitable. UKK 2km walking test is used more and more in Europe and in our country in order to measure amateurs' endurance (EUROFIT test battery for adults 18-65 years old). These tests are recognized as the endurance tests and they are based on the assessment of maximal oxygen consumption. There is no doubt that the test on the treadmill is the most accurate in the laboratory. In terms of terrain outdoor research, UKK-2km walk test is the most appropriate to use, because it allows simultaneously testing of more respondents with high reliability of the results (Stojilkovic, et al.2005). This test gives us the ability to determine the fitness index (general skills) and evaluation of maximal VO² max oxygen consumption. The final test result is influenced by: gender, age, body height, body weight, heart pulse and time achieved during the final test.

Since students of the Faculty of Physical Education and Sports are the sports active population, a homogeneous group, the idea for the study arose precisely from the necessity to use the test-UKK 2 km evaluate the aerobic abilities of students.

Material and method

Participants

The research was conducted among the population of third year students of the Faculty of Physical Education and Sports in East Sarajevo. The sample of respondents consisted of 54 male students, 20-21years old, average height (Body Height = 182,85 ± 68,01 cm; body mass (body weight = 80,00 ± 8,42kg) and body mass index (BMI = 23,16 ± 2,04kg / m²).

The sample of variables

For research purposes aerobic capacity (cardiovascular fitness) were measured by the following variables:

1) Pulse in the load (PULSE-bpm)
2) Fitness Index (Findex);
3) The maximum oxygen consumption (VO²max-ml / kg / min)

Description of the experimental work

To estimate the capability of anaerobic fitness index and maximal oxygen consumption (VO²max) test was used UKK 2 km walk (submaximal test). The time that was scheduled for the test of a group accounted for about 30 minutes. Formed a group of 6 to 9 the respondents. After a warm-up of 10 minutes of brisk walking in the 200m first group approached the execution of the task. After completing the task all went according to the further procedure, which included individual metering pulse palpation in the area of the carotid artery for 10 sec, and the value is multiplied by six, and the data were entered in the records. Fitness calculate the index and

determination of maximal oxygen uptake realized the indirect method using formulas derived from UKK 2 km walk test (Oja & Tuxworth, 1995).

Results are calculated from the time of 2 km walking, heart rate (HR) at the end of walking, body mass index (BMI) and age. Categorization and values Fitness Index (Findex) and maximal oxygen consumption (VO^2max) are presented in Tables 1, 2 and 3.

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Table 1. Categories of men on the basis of VO^2max values up to 29 years of age. (Cooper, 1982; McArdle, Katch, Lippincot. 2006)

Cooper, K. 1982	*McArdle, Katch, Lippincot. 2006*	*Physical condition*
Do 32,9 mlO^2/kg/min	Do 24,9 mlO^2/kg/min	Very weak condition
33-36,4 mlO^2/kg/min	25-33,9 mlO^2/kg/min	Weak condition
36,5-42,4 mlO^2/kg/min	34-43,9 mlO^2/kg/min	Moderate fitness
42,5-46,4 mlO^2/kg/min	44-52,9 mlO^2/kg/min	Kilter
46,5- 52,4 mlO^2/kg/min	53mlO^2/kg/min	Excellent condition

Table2. Categorization on the basis of Fitness index and BMI index *(Wilmore, et all. 1986)*

FITNESS INDEX Values	**Categories according to BMI (Body Mass Index)**
<70 ..... well below average	<20 ..... below optimum weight
71-89 ..... slightly above the average	21-25…..normal weight
90-109 ... average	26-30 ..... chubby
110-130 .. slightly above average	31-40…….fat
> 130 ..... well above average	> 40 ..... pathology

Table 3. The formula for calculating the Fitness Index and VO^2max for people from 18 to 65 years (Oja, & Tuxworth, 1995*)*

a. The formula for calculating the Fitness index

Men FINDEX= 420 - (11.6 + min +0,2 x sec x + 0.56 xHR + 2.6 x BMI) + 0.2years

b. The formula for calculating maximum oxygen consumtion - VO^2max (ml/min/kg):

Men VO^2max = 184.9 - 4.65 x time- 0.22 x HR - 0.26 x years -1.05xBMI

The main statistical operations were performed in Statistica 6.0 package through which we calculated the basic central and dispersion parameters and determined the value of fitness index (FINDEX) and maximal oxygen consumption (VO^2max). On the basis of their values, we made the appropriate conclusions.

Results and discussion

Table 4. Descriptive statistics of variables

	Mean±SD	***Min***	***Max***	***Range***
PULS (otk/m)	141,17 ± 19,61	99,00	189,00	90,00
UKK 2km (min)	15,21 ± 1,94	13,23	17,56	4,33
FINDEX	101,89 ± 21,33	59,22	138,10	78,88
VO^2max (ml/O/kg)	47,26 ± 8,57	37,13	68,12	30,99

The parameters of the variables relating to the value of the anthropometric characteristics of students - Body Height, Body Weight, Body Mass Index (BMI) (defined in the sample of respondents) and the value of the pulse (PULS) after walking test (UKK-2km), the Fitness Index (FINDEX) and the maximal oxygen consumption (VO^2max) are presented in table 4. The obtained values indicate a normal Gaussian distribution, although in the dispersion measures can be felt heterogeneity in terms of height and body mass, and therefore in the final values of BMI, which resulted in a greater range between the min. and max. walking test results UKK-2km.

The average height of the sample (AVIS = 182.85 cm) is an indication of extreme longitude, and with the body weight of 80 kg and a BMI value of 23.16, it depicts a normal body mass index measured in the study sample (Wilmore, Buskirk, Digirolamo, & Lohman, 1986). Bearing in mind that these are students of PE and sport, then this value defines normal weight of students and these values are more rooted in lean mass, i.e. muscle mass, skeleton and internal organs. Mean values of functional abilities measured by pulse after performing the walking test is PULS=141.17 beats/min and ranges from min. 99 beats/min. to max. 189 beats/min., indicating that this test was relatively easy for certain students while for some it was too difficult, although it is a test of submaximal burden and for the 65 years of age. After examining the results shown in Table 4, it can be concluded that the values of central and dispersion parameters for the assessment of Fitness Index and VO^2max indicate that the group involved in the experiment, is still homogenous. The mean FINDEX value of sample amounts Mean = 101.89, and the value of VO^2max is Mean=47.26 ml/O/kg. However, these

results illustrate a situation that can be characterized as a state that is present among students of Physical Education and Sport and is related to their current physical ability. Fitness index values are within the limits that are slightly above the average for males (Mitić, 1998).

If we compare the value of the FINDEX results with the tabular values of recreationists (Table 2) it can be noticed that the students of East Sarajevo have an "average" category. These results are worrying because these are not examples of the total population, but of people who take care of their physical preparedness, fitness and mainly regularly exercise some form of recreation or are involved in sports clubs. Milojević and Jakonić (1991) studied the effects of motion activities of 81 students of Physical Education in Novi Sad, where they recorded high values of maximum oxygen consumption (46.88 ml/kg/min at the initial measurement and 50.66 ml/kg/min in the final measurement), and they came to the conclusion that the physical activity is the first indicator of an increase in maximal oxygen uptake. Although in comparison with previous research, our students achieved a lower average oxygen consumption, however, they are still in the range of average values in the studies previously carried out by some authors (Mišigoj-Duraković and associates, 1999; Živanić, 2004; Venkata, Suryakumari, Sudhakar & Balkrishna, 2004; Heyward, 2006; Tarnus & Bourdon, 2006).

In fact, research in the last three decades has shown that physical inactivity with a negative impact of everyday life is seriously threatening the health and physical condition of the human body. As a result of hypokinesian lifestyle we have a situation that it is the most common risk factor for cardiovascular diseases. It is especially important to note, bearing in mind the growing number of evidence, that physical activity and regular exercise can reduce the risk of chronic diseases and death in particular of coronary heart diseases (Paffenbarger et all. 1984; Kingwell & Jennings, 1993).

Considering the analysis of individual cases within the actual sample of respondents, it can be concluded that from the total number of students, 30 of them (55%) have a fitness index above the average (range from 110-140) and VO²max. (from 46.5 to 68ml/O/kg), which represents an excellent shape (Cooper, 1982; McArdle, Katch, Lippincot, 2006). Students who had the higher value of the fitness index mainly train some of the winter sports (skiing, biathlon), football, athletics, handball, martial arts or sports that require good physical condition, physical fitness. Also, these sports require a large maximum oxygen consumption, given the altitude at which they train (winter sports) as well as the area where they train (aerobic, anaerobic). Somewhat lower values of Fitness Index achieved 20 students involved in other sports (45%), such as volleyball, basketball, ranging from 59 to 109 (below average and average) and values of VO²max. from 30 to 46.4 ml/O/kg, moderate and good fitness (Table 1). A higher BMI were realized by the students of martial arts (judo), bodybuilding, who posses a large body mass or that lean mass, where the mass goes to skeletal and muscle mass, yet in general, they contribute to a finding of excessive weight which also recorded maximum values of BMI (27.15 kg/m²). From this arises the fact that the higher value of maximal oxygen consumption and fitness index have those respondents who have a higher body mass, which is generally misunderstood (Kline, Porcari, Hintermeister, Freedson, Ward, Mc Carron, et al., 1987). As the main advantages are cited the abilities of the respiratory and cardiovascular systems to transport oxygen to the active working muscles, regardless of the weight (Nikolić, 2003; Mazurek and associates, 2010).

Certain studies involving the population of university students (Watanabe, Nakadoma, Maeda, 1994; Stojiljković, 2005; Tongprasert & Wattanapan, 2007; Pantelić, Savić, Ranđelović, 2008, Mazurek, et al., 2010; Pavlović & Branković, 2011, Pavlović, Savić & Tosic, 2012) have shown that students who have less value of FINDEX and VO² max. are at increased risk of cardiovascular diseases (Kingwell & Jennings, 1993; Kokkinos, et al., 1995; Guerra, Ribeiro, Costa, et al., 2002; Sadhan, Koley, Sandhu, 2007; Sharma, Subramanian & Arunachalam, 2013). In the report of the American Department and Centre for Disease Control and Prevention (US Department of Health and Human Services, Centers for Disease Control and Prevention, taken from Physical activity and Health, 1996) the following fact is pointed - moderate and regular physical activity and fitness have a very big role in preventing the development of blood pressure, a suitable type of activity reduces the value of blood pressure for both male and female persons of different ages. Many times it has been proven that applied and programmed physical activity has a positive effect on blood pressure (Stein, Ehsani, Domitrovich, Kleiger & Rottman, 1999), which is reflected in the reduction of both systolic (an average of 3.84 mmHg) and diastolic blood pressure (an average of 2.58 mmHg) (Whelton, Chin, Xin & He, 2002). Factors that limit VO² max. are central (MVSmax., and the maximum amount of blood the heart is able to eject during one minute and a maximum content of O² in arterial blood). The latter is evidence of the ability of blood to receive O², which depends on the amount of hemoglobin (Hb), precisely oxyhemoglobin (HbO²) - the amount of hemoglobin saturated with oxygen. The peripheral limiting factor is the diffusion capacity of O² in tissues, and it depends on the difference in partial pressure of O² (PO²) between the capillaries and the mitochondria. This also includes the peripheral blood flow and enzyme activity of muscle cells, which depend on the type of muscle fibers (Wilmore & Costill, 1999; Hoeger, W & Hoeger, S., 2002; Kearns, Mckever, John, Abe, & Brechve 2002; Nikolić, 2003). As well as the central, the peripheral limiting factors are also in a huge dependence on the heritage, age, gender, muscle mass involved in the work, body composition, training status and the type and character of training loads. Genes play a decisive role in sports activities that require a high-value VO² max, however, numerous studies have shown that aerobic capacity, cardiac output, oxidative capacity of skeletal muscle and lipid oxidation, are phenotypes which can be changed by the training (Cheng et al. 2003; Blair, La

Monte & Nichaman, 2004). In order to prevent cardiovascular diseases, it would be necessary to increase students' awareness of the possible consequences and to draw attention to meet their coaches from parent sports with their condition in order to have time to eliminate possible shortcomings in terms of the training process, which is clearly inadequate or is not in accordance with the development and upgrading of physical abilities (Tulppo et al. 2003; Osei-Tutu & Campagna, 2005).

Conclusions

The study included evaluation of students' aerobic abilities (cardiovascular fitness) using test UKK 2km. To estimate aerobic capacity was applied Fitness Index (FINDEX) and maximum oxygen consumption ($VO^2max.$). Based on these results it can be concluded that the general situation of aerobic (cardiovascular) fitness of students on the basis of Fitness Index in the upper zone of average (FINDEX=101.89) is still (un)satisfactory, considering that this is a population of students of physical education and sport, who are engaged in sports activities, through teaching and extra-curricular activities, mainly sports clubs. Also the value of maximal oxygen consumption of the students ($VO^2max=47.26$) implies a fairly good fitness, so that this consumption is closely linked to the Fitness Index. Attention must be directed at upgrading their aerobic capacity in terms of raising awareness about the benefits of good physical condition of each individual, the possible unintended consequences that may result in extremely unpleasant consequences. All the more because this is the period when it can still be affected, in a much greater extent, to the physical condition which is accompanied by aimed physical exercise at college, with the exception of involvement in sports clubs. As stated earlier, a great impact on these parameters of fitness index and maximal oxygen consumption have both central and peripheral limiting factors, then, in an enormous scope, heritage, age, gender, muscle mass involved in the work, body composition, status of training. The abilities also depend on the type and character of training loads so that these changes can be performed only by the training that should change adaptation challenges for both women and men of all ages (Wilmore & Costill, 1999; Venkata, et al. 2004).

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