Banja Luka, Bosnia & Herzegovina
E-mail: tamarakaralic.ffvis@gmail.com

Ratko Pavlović, Vladan Savić, Jovica Tošić
Faculty Physical Education and Sport, Pale

Orginal scientific paper
UDC: 797.253 (p.p. 30-37)
Doi: **10.7251/SHTSR1203030P**

THE INFLUENCE OF MORPHOLOGICAL, MOTOR AND FUNCTIONAL PARAMETERS IN THE ESTIMATION OF FITNESS INDEX AND MAXIMAL OXYGEN CONSUMPTION

SUMMARY

A very common ways of evaluating the state of physical fitness of the specific population are diagnostic tests on the basis of which we get the necessary information when it comes to overall physical condition of defined population. These diagnostic tests are usually carried out in the laboratory (direct), however, reliable data that are available show highly reliability in performance of some terrain tests (indirect). Depending on conditions on terrain, very often these measurements are performed by evaluation of general ability (2km tests walking 2UKK). To perform this test, it must include data about body height, body weight, BMI, the values of the pulse, walking time during the test. Based on the formula and the use of these data fitness values of the index are obtained, which defines the overall physical condition of the respondents as well as indicators of maximum oxygen consumption (VO^2max). Also, when performing these diagnostic procedures, different influences of certain anthropometric parameters (morphological, motor, functional parameters) are manifested. This research involved the population of the third year students of the Faculty of Physical Education and Sports, who were involved in teaching the sport walking in athletics, in order to determine their physical conditions and the possible influence of certain anthropometric parameters and the results of functional tests.

Key words: *morphological status, diagnostics, fitness index, VO^2max.*

INTRODUCTION

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. 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) 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, Kostic, 1999). 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 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 (Mc Ardle et. all, 2006.).

Table 1. *Categories of men on the basis of VO²max values up to 29 years of age. (Cooper, 1982; McArdle, Katch, Lippincot. 2006)*

Kuper K. 1982	**McArdle, Katch, Lippincot. 2006**	**Physical condition**
Do 32,9 mlO²/kg/min	Do 24,9 mlO²/kg/min	Very weak condition
33-36,4 mlO²/kg/min	25-33,9 mlO²/kg/min	Weak condition
36,5-42,4 mlO²/kg/min	34-43,9 mlO²/kg/min	Moderate fitness
42,5-46,4 mlO²/kg/min	44-52,9 mlO²/kg/min	Kilter
46,5- 52,4 mlO²/kg/min	53mlO²/kg/min	Excellent condition

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 (Nicin, 2003). This test gives us the ability to determine the fitness index (general skills) and evaluation of maximal VO^2 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 investigate the effects of morphological, motor and functional abilities in assessing the value of fitness index and maximal oxygen consumption (VO^2max).

METHOD

Sample of respondents

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 30 male students, 20-21 years old, all those who were present at the time of measurement and who did practical teaching in athletics in sports walking in October, School year 2009/10.

Sample of variables

For the purpose of the research, in order to evaluate functional Fitness index and VO^2max capabilities of the respondents, the following variables were measured: 1. Body height (AVIS); Body mass (AMAS); 3. Body mass index (BMI); 4: The pulse during the fatigue (PULS); 5. 2km walking test (UKK 2km). Based on the obtained data, the multiple regression analysis was done in order to determine the impact of predictor variables on the results of fitness index and maximal oxygen consumption VO^2max.

Description of the experimental work

UKK 2 km walking test was used in order to estimate the fitness index. It is sub-maximal test on the basis of which maximal oxygen consumption is determined (VO^2max). UKK-2km walking test was performed at the stadium of FC Romania. 30 minutes was the time planned for one group in order to perform the test. 5 groups of 6 students had been formed. After a warm-up of 5-10 minutes, the first group approached the task. After completing the task, everything was done according to the procedure, which included measurement of individual pulses, palpation in the region of the carotid artery for 10 sec, the value was multiplied by six and the data were entered in the statistics records. Fitness index and maximal oxygen consumption were determined by indirect method using the formula derived from the 2km walking test.

Table 2. *Categorization on the basis of Fitness index and BMI index (Wilmore, J.H. 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 VO²max (Nićin, 2003)*

a. The formula for calculating the Fitness index for people from 18 to 65 years

Men 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 VO²max (ml / min / kg):

Men = VO²max = 184.9 - 4.65 x time- 0.22 x HR - 0.26 x years -1.05 BMI

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 (FINDX) and maximal oxygen consumption (VO²max). On the basis of their values, we made the appropriate conclusions.

RESULTS AND DISCUSSION

Table 4. *Descriptive statistics of predictor variables*

	Mean±SD	Min	Max	Range
AVIS	184,44 ± 75,11	163,00	194,00	31,00
AMAS	81,52 ± 10,57	50,00	103,00	53,00
BMI	23,85 ± 2,29	18,86	29,85	10,99
PULS	145,11 ± 20,67	114,00	194,00	80,00
UKK 2km	16,21 ± 1,94	13,55	19,56	6,01

Table 5. *Descriptive statistics criterion (FINDX and VO² max)*

	Mean ± SD	Min	Max	Range
FINDX	97,87 ± 21,33	55,20	128,10	72,90
VO²max	43,06 ± 8,57	30,13	65,12	34,19

Legend: *FINDX-fitness index; VO² max-maximum oxygen consumption*

Variable parameters in Table 4 referred to the values of anthropometric characteristics of students: body height (AVIS), body mass (AMAS), body mass index (BMI) and functional capacity in heart beat frequency (PULS) after the walking test (UKK-2km). The results which indicate the normal Gaussian distribution were achieved, although heterogeneity in terms of height and body weight was seen in the measures of dispersion and in final values of BMI, which resulted in a higher range between min. and max. walking

test results UKK-2km.

Table 6. *Regression Summary for Dependent Variable: FINDX*

	BETA	St.Err. of BETA	t(30)	p-level
Intercpt			3,70	,001
AVIS	-,414	,29	-1,45	,156
AMAS	1,132	,54	2,08	,045
BMI	-1,123	,43	-2,64	,012
PULS	-,752	,07	-10,82	,000
UKK	-,802	,07	-12,20	,000
R= .93	***R²= .86***	***F(5,25)=43,03***		***p< .000***

Table 7. *Regression Summary for Dependent Variable: VO²max*

	BETA	St. Err. of BETA	t(30)	p-level
Intercpt			4,037	,000
AVIS	-,684	,30	-2,269	,030
AMAS	1,243	,57	2,174	,037
BMI	-,843	,45	-1,876	,069
PULS	-,326	,07	-4,425	,000
UKK	-,924	,07	-13,313	,000
R= .92	***R²= .85***	***F(5,25)=38,45***		***p< .000***

However, these data indicate single weaker or good results of total respondents who disrupt the state of affairs. The average height of the sample (AVIS=184,44cm) is an indicator of extreme longitude, with a body mass of about 81.52kg and BMI 23.85, and it reflects a normal body mass index measured in the study sample. Bearing in mind that this is about students of physical education and sports, then this value defines normal body mass of students, and these values are more oriented to non-fat mass, i.e. to muscle mass, skeleton and internal organs. Mean values of functional capabilities, which were measured by pulse after derived walking test, are (PULS=145.11bpm/min) and in range of min. 114 bpm/min to max. 194 bpm/min. It indicates that this test was relatively easy for some students whereas it was too difficult for others, although it is a test of sub maximal burden and age up to 65 years. The Table 5 presents the basic descriptive parameters of Fitness Index (FINDX) and Maximal oxygen consumption (VO^2max). After examining the results shown in the Table 5, 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 which is involved in the experiment is homogeneous. The mean value of the sample FINDX is (Mean=97.87), and the value of VO^2max is (Mean=43.06 ml/O/kg). However, these results reflect a condition that can be described as a condition that exists among students of physical education and sports, and is related to their current physical ability. If we compare the value of the FINDX results with tabular values of recreationists (Table 2), it can be seen that our students have the category of "average". These results are troubling because these are not samples of the population, but people who care about their physical readiness and stamina, and who exercise regularly or are involved in some sport clubs. In fact, research in the last three decades has shown that physical inactivity with negative impacts of everyday life, seriously threatens the health and physical condition of the human body. As a result of the hypokinetic lifestyle, we have a situation that is the most common risk factor for

cardiovascular diseases. It is especially important to note that, given the increasing evidence that physical activity, regular exercise can reduce the risk of chronic disease and death, particularly of coronary heart disease (Paffenbarger et all. 1984). By using case studies of the subjects, we got the conclusion that the total number of students, 10 of them or 33%, had above average fitness index in the range of 110-130 and VO^2max from 46.5 to 52 ml/O/kg, which stands for an excellent condition. Students who had higher values of the fitness index are mainly training some of the winter sports (skiing, biathlon), football, athletics, martial arts and sports that require good physical shape and readiness. Also these sports require maximum oxygen consumption, due to the altitude at which they are training, as well as the zone (aerobic, anaerobic). 20 students (66%) involved in other sports such as volleyball, handball, basketball achieved some inferior fitness index values in the range from 55 to 109 (average and below average), and the value of VO^2max from 30 to 46.4 ml/O/kg (medium and good shape) –Table 1. The BMI was 23.85 with students and it defines normal weight of the sample (Table 2). Students achieved the higher influence of BMI in martial arts (judo) and body building so they have a large but non-fat body mass, where the mass falls to muscle and skeletal mass, yet in general contributes to finding of excessive weight, which was recorded in the maximum values of BMI (29.85).

By applying the regression analysis, we got the impact of variables with high statistical significance ($p < .000$, $p < .001$) in both of the functional tests. Regression analysis showed that for the criterion variable fitness index (FINDX) multiple correlation is R=93, which the common variance between systems with about 86% ($R^2 = .86$) has explained. The rest of 14% of individual differences FINDX criterion variables, have been attributed to other abilities and characteristics of the sample (Table 6). The results give a statistically significant effect of the predictor variable to the criterion set at the level (p=.000). A more detailed analysis of the value of the regression coefficients (BETA) shows the influence, first of all, of body mass variables, AMAS (B = 1.132) with a direct relationship, as opposed to height, BMI, pulse and test 2UKK, which have made a negative impact that is characterized by an indirect relation with respect the criterion (FINDX). This suggests that body weight with its values directly affect the results of the FINDX value, unlike other variables (AVIS, BMI, heart rate, 2UKK) which have an inverse proportionality to the criteria, that is justified in practice, where smaller values of the pulse, the results of the 2UKK test, and especially BMI, have been better indicators of the physical condition of the individual. Direct and indirect effects have been confirmed by the analysis of variance where (F=43.03). Almost identical effect is manifested in variables VO^2max, where multiple regression analysis showed also a high correlation between sets with R = .92, by which 85% (R^2=85) information of the predictor and criterion is determined; in our case VO^2max (Table 7). What is interesting and obtained from Beta coefficient, is the value of body mass, which showed greater direct impact on the value of maximum oxygen consumption. This implies the fact that those respondents who have a higher body mass will have higher value of maximal oxygen uptake and fitness indices, which is mostly wrong. The ability of respiratory and cardiovascular system to transport oxygen to the active muscles regardless of which body weight is the main advantage (Nikolic, 2003; Mazurek and sar.2010). Thinking that the VO^2max is greater if the body weight of the subjects is higher, is wrong. These values of regression function were confirmed by the analysis of variance with the values (F = 38.45). In both cases, the statistical significance of criteria and predictors were tested by the analysis of variance, where values of statistical significance in defining the criteria were obtained, and that guarantees a direct linear stochastic interactions of connections, and thus also confirms the validity of these diagnostic procedures and their implementation in practice on the field.

Certain studies that have treated the population of the student body (Stojiljkovic, 2005; Tongprasert & Wattanapan, 2007; Mazurek et al. 2010; Pavlovic, 2011) have shown that students who have smaller FINDX and VO^2max values are at increased risk of cardiovascular diseases. Factors that limit the VO^2max. are central (MVS max., that is the maximum amount of blood the heart is able to pump in one minute and the maximum O^2 content in arterial blood). The last data shows the ability of the blood to receive O^2, which depends on the amount of hemoglobin (Hb), respectively oxyhemoglobin (Hbo ^{2})-the amount of hemoglobin saturated with oxygen. Peripheral limiting factor is the diffusion capacity of the O^2 in tissues and depends on the difference in the partial pressure of O^2 (PO^2) between capillaries and mitochondria. Here are included the peripheral blood flow and enzymatic activity of muscle cells, which depend on the type of muscle fibers (Wilmore & Costill, 1999, Hoeger, Hoeger & W, S. 2002, Nikolic, 2003). As central so are peripheral limiting factors in the huge dependence of heritage, age, gender, muscle mass, the composition of the body, their fitness status and the type and character of the simulator loads. Genes play a decisive role in sporting activities that require high values of VO^2max, however, numerous studies have shown that aerobic capacity, stroke volume of the heart, oxidative capacity of skeletal muscle lipid oxidation, phenotypes can be changed with training (Cheng et all., 2003; Blair La Monte & Nichaman, 2004). In global terms, FINX values, from average 97.87 index units and relative consumption of 43.06 ml/O/kg, are indicators of still insufficient physical activity, given that is about FFVS students, and that they are involved in sport clubs. However, maybe greater responsibility can be found in the way of working among sport clubs which do not pay enough attention to the physical preparation, i.e. training process is not carried out in the best possible way, because after all only a commitment to teaching can contribute to major advances in terms of the development of physical fitness. In order to prevent cardiovascular diseases, it would be necessary to increase student's awareness of the possible consequences, as well to draw attention to introduce their sports coaches from the master with their condition in order to remove possible shortcomings in the training process on time, which is clearly insufficient or inconsistent with physical abilities development and upgrades.

CONCLUSION

The study was conducted in order to determine the influence of parameters on the value of anthropological fitness index and maximal oxygen consumption in order to verify the influence of variables defined as eligible in the diagnostic field tests and also to examine the physical condition of students based on their values of FINDX and VO^2max. Analysis of BMI reflects the incorrect state status of the respondents, especially in the case of the respondents in the training process, as is the case in our study, where the extremely high values of the index, over 29 in fact, is the result of one of the components of the so-called body mass- non-fat mass. General state of the physical shape of the students' sample is categorized based on the fitness index in range of average (97.87), but still insufficient, considering that this is a population of students of physical education and sports who are engaged in sports activities and sport clubs. Attention must be paid to upgrade their physical capabilities in terms of raising awareness about the advantages of good physical condition of each individual, the potential adverse effects that may result in extremely unpleasant consequences. This is the period when it can affect the physical condition that is accompanied by physical exercise aimed at college, with the exception of involvement in

sports clubs. Our sample's VO^2max value (43.06) implies mediocre shape, so that the energy is associated with the high fitness index. As stated earlier and the regression analysis results showed, it is the fact that central and peripheral limiting factors have great influence on the fitness index parameters and maximal oxygen consumption. They depend on the heritage, age, gender, muscle mass, body composition, their fitness status and the type and character of the simulator load, so that these changes can be made only by training that should cause adaptive changes with both women and men of all ages (Wilmore & Costill, 1999).

REFERENCE

1. Bijelić, B. (2006). Potrebe za valorizacijom elemenata vježbanja u rekreaciji. *Sport Mont, (br.10,11/IV),* str. 406-411. Podgorica.
2. Blair, S.,N., La Monte, M.J., & Nichaman, M., Z. (2004). The evolution of physical activity recommendations: How much is enough? *American Journal of Clinical Nutrition*, 79 (5): 913-920.
3. Cheng YJ, Macera CA, Addy CL, Sy FS, Wieland D, Blair NS (2003). Effects of physical activity on exercise tests and respitratory function. *Br J Sports Med* 37:521-8.
4. Cooper, K. (1982). *The Aerobics Way*. New York, Bantam Books, Inc. 1982.
5. Hoeger WWK, Hoeger SA. (2002). Cardiorespiratory endurance assessment. In: Hoeger WWK, Hoeger SA, (Ed.). *Principles and labs for physical fitness. 3rd ed. Ontario*: Wadsworth; 143-162.
6. Kostić, R. (1999). *Fitnes-teorija, metodika, praksa*. Niš: Filozofski fakultet.
7. McArdle W. D., Katch, F. I., Katch, V. L. Lippincott Williams and Wilkins (2006). These aerobic fitness classifications are based on relative VO2 (ml/(kg*min). *Essentials of Exercise Physiology*, 3rd ed., Philadelphia, PA USA, p. 453.
8. Mazurek K.1, Żmijewski P.2, Czajkowska A.3, Lutosławska G. (2010). Cardiovascular risk instudents with different level of aerobic capacity. *Biology of Sport*, Vol. 27, (2):105-109.
9. Mišigoj-Duraković, M. (2008). *KINANTROPOLOGIJA - biološki aspekti tjelesnog vježbanja*. Zagreb: Kineziološki fakultet.
10. Nićin. Đ. (2003). *Fitness*. Beograd: Univerzitet BK - Fakultet za menadžment u sportu.
11. Nikolić, Z. (2003). *Fiziologija fizičke aktivnosti*. Beograd: Fakultet sporta i fizičkog vaspitanja Univerziteta u Beograd.
12. Oja, P., Tuxworth, B. (1995). *EUROFIT FOR ADULTS, assesment of health-related fitness*. Tampere: Committe for the Development of sport and UKK Institute for Health Promotion Research Finland.
13. Paffenbarger RS Jr, Hyde RT, Wing AL, Steinmetz CH. (1984). A natural history of athleticism and cardiovascular health. *JAMA*, 252: 491-495.
14. Stojiljković, D. (2005). *Fitness.* Beograd: Fakultet sporta i fizičkog vaspitanja.
15. Tongprasert, S., Wattanapan, P. (2007). Aerobic Capacity of Fifth-Year Medical Students at Chiang Mai University. *J Med Assoc Thai* Vol. 90 (7): 1411-1416.
16. Wilmore, J.H., Buskirk, E.R., Digirolamo, M., Lohman, T. (1986). Body composition. A round-table. *Physican and Sports Medicine* (14).
17. Wilmore, J.H., & Costill, D.L. (1999). Physiology of sport and exercise (Seconde Edition). Champaign, IL: *Human Kinetics*.