

EVALUATION AND COMPARISON OF VO₂MAX ASSESSMENT MODELS IN HIGH SCHOOL STUDENTS

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Annotation. The purpose of this study was to evaluation and comparison of VO₂max assessment models in students. Thirty students from high schools of Ardabil city were selected randomly and served as subjects in this study (age: 15.73±0.69 year, height: 169.46±8.1 cm, weight: 61.70±9.32 kg). Subjects were divided into two groups. In one group Rockport test was used to estimate their VO₂ max and in other group Balk test was used for the same purpose. Also, the VO₂max of both groups were examined by a standard treadmill test and the results were compared with the results of field tests. The one way of ANOVA and Tukey's post-hoc tests were used for data analysis (p>0/05). The results showed that there were significant differences between the results of the field tests and standard treadmill test (Bruce: 40.93±5.83 vs. Rockport: 58.71±2.73 and Balke: 52.09± 6.18). As a result of these findings it was concluded that the regression equations used in this study used is not suitable for 15-17 (yr) boys and does not estimate their aerobic power correctly.

Key words: Maximal Oxygen uptake, Aerobic power, Physical fitness, tests.

Introduction

In today's world, physical activities allocate special places for people to work out in order to improve their health. Different exercise among children and adolescents are so important. Children with better physical condition have also higher fitness and health in adulthood.

Among various physical activities, aerobic is especially important. Students with high aerobic power are more successful in aerobic activities and endurance sports such as running, football, swimming. Cardio-respiratory fitness tests may help to identify risk factors for chronic respiratory diseases and designing training programs. Therefore, based on aim of the protocols of these test, these tests can be used by physicians, exercise physiologists and trainers. The tests that used to determine cardio-respiratory fitness often consist of running or walking on treadmill or pedaling on ergometer.

The maximum oxygen consumption index or VO₂max is use for measurement of aerobic power. Maximum oxygen uptake (VO₂max) is defined as the highest rate at which oxygen can be taken up and utilized by the body during severe exercise. It is one of the main variables in the field of exercise physiology, and is frequently used to indicate the cardio-respiratory fitness of an individual [2].

There are several investigations dealing with the measurement of maximal oxygen uptake in athletes and non-athletes. Bassett et al (2000) studied the limiting factors for maximum oxygen uptake and determinants of endurance performance [2]. Chatterjee et al (2006) investigated the validity of the 20-m multi stage shuttle run test for the prediction of VO₂max in junior Taekwondo players of India. They concluded that the 20-m multi stage shuttle in its original form should not be applied for the studied population as a significant difference exists between the results obtained from direct and indirect methods [5]. Chatterjee et al (2009) in another study validated the applicability of the 20-m multi stage shuttle run test (20-m MST) in young football players. They concluded that the 20-m MST in its original form may be applied for the studied population. However, for more accuracy, they recommend the newly derived equation based on the present data as a valid method to evaluate aerobic fitness in terms of VO₂max within young Football players [6].

The measurement of VO₂max is important, as in many athletic events a large amount of the energy needed to perform the exercise is produced through the use of oxygen. Others find that testing and improving on their personal fitness numbers gets them motivated to work harder. For this purpose, different tests are designed, including field-tests (step test, Rockport test, 12 min run test) and laboratory test (ergometer and running on treadmill) [1, 9]. But, field tests due to the simple and easy application are applicable between athletes and non-athletes. [7]. Also, the laboratory tests are often expensive and require the attention of highly trained personnel. Hence, when field tests were properly designed and these tests have high validity and reliability, can be used instead of the complex and costly tests. In addition, field tests that are used in schools may not have validity and reliability for use in adolescents. Therefore, the purpose of this study was to evaluation and comparison of VO₂max assessment models in high school students.

Methods

Subjects

Thirty students from high schools of Ardabil city were selected randomly and served as subjects in this study. Subjects were divided into two groups. In one group Rockport test was used to estimate their VO₂ max and in other group Balk test was used for the same purpose. Also, the VO₂max of both groups were examined by a standard treadmill test and the results were compared with the results of field tests. Before participating, subjects' parents were informed of the potential risks and gave their written informed consent to participate their children in this study, which

was consistent with the human subject policy of the Ardabil research center. Subject characteristics were as follows (mean \pm SE): (age: 15.73 \pm 0.69 yr, height: 169.46 \pm 8.1 cm, weight: 61.70 \pm 9.32 Kg).

Testing procedures

Subjects alternately attended in laboratory of physical education of university of Mohaghegh Ardabil for perform one of the Bruce, Balke and Rockport tests. For sufficient recovery, tests were performed with an interval of 48 hours. The standard Bruce protocol consisted of 3-minute increments of treadmill speed and incline during which subjects could not support their weight on the handrails. The ergocycle ramp protocol was individualized with continuous gradual work rate (watts) increments to achieve maximal power output within 8 to 12 minutes of test duration, as recommended by guidelines for exercise testing [2].

In Rockport test, subject walk as fast as possible for 1 mile. After he has completed the mile, immediately take his pulse rate. Also his body weight was measured for the VO₂max calculation. VO₂max score calculated using the following equation:

$$\text{VO}_2\text{max} = 139.168 - (0.388 \times \text{age}) - (0.077 \times \text{weight in lb.}) - (3.265 \times \text{walk time in minutes}) - (0.156 \times \text{heart rate}) + 6.318 \text{ [8, 9].}$$

In the Balke test, markers placed at set intervals around the track to aid in measuring the completed distance. Subjects run for 15 minutes, and the distance covered is recorded. Walking is allowed, though the participants must be encouraged to push themselves as hard as they can. VO₂max score calculated using the following equation: VO₂ = 6.5 + 12.5 x kilometers covered [2].

Statistical methods

General characteristics of the subjects were presented as means and standard deviations. The one way of ANOVA and Tukey's post-hoc tests were used for data analysis ($p > 0/05$). Statistical analysis was conducted using SPSS version 16.0 for Windows.

Results

The characteristics of subjects are shown in table 1. The results of ANOVA test of subjects are shown in Table 2. The results showed that there are significant differences between results of Balke, Rockport and Bruce tests ($P=0.00$). Also, the results of post-hoc showed that there are significant differences between Bruce and Balke tests ($p=0.00$) and between Bruce and Rockport tests ($p=0.00$) (Tables 3 and 4).

Table 1. The characteristics and body composition of subjects

Variable	Age	Height (cm)	Weight (kg)	Body Fat (%)
Result	15.73 \pm 0.69	169 \pm 8.01	61.7 \pm 9.32	14.54 \pm 3.87

Table 2. The results ANOVA test for comparison of the mean VO₂max

Sources of change	Sum of squares	df	Mean square	F	sig
Between groups	3469.314	2	1734.657	60.702	0.00
Within groups	1628.867	57	28.577		
Total	5098.180	59			

Table 3. Results of Tukey HSD test to compare the treadmill test with average VO₂max in the 1600 m and Balke tests ($n=11$)

Variable	Mean difference	Standard error	Sig	%95 Confidence interval	
				Lower Bound	Upper Bound
Treadmill and 1600 m	-17.77800*	1.69046	0.00	-21.8460	-13.7100
Treadmill and balke	-11.16467*	1.69046	0.00	-15.2326	-7.0967

* The mean difference is significant at the 0.05 level.

Table 4. Results of LSD test to compare the treadmill test with average VO₂max in the 1600 m and Balke tests ($n=11$)

Variable	Mean difference	Standard error	Sig	%95 Confidence interval	
				Lower Bound	Upper Bound
Balke and treadmill	11.16467*	1.69046	0.000	7.0967	15.2326
Balke and 1600 m	-6.33361*	1.19895	0.004	-11.3106	-1.9161

* The mean difference is significant at the 0.05 level.

Discussion

The results show that there are significant differences between the results of Rockport, Balke tests and Bruce test. As a result of these findings it was concluded that none of the regression equations used in this study used is not

suitable for 15-17 (yr) boys and does not estimate their aerobic power correctly. It seems that regression model with a new design based on field test results for each of Rockport and the Balke tests used in this study. It is concluded that Rockport and Balke tests should not be applied for Students. However, we recommend the newly derived equation based on the present data as a valid method to evaluate aerobic fitness in terms of VO₂max within the high school students.

In conclusion, although Rockport and Blake are simple tests, but based on the results of present study, using other equations for calculation of aerobic capacity of adolescents is suggested or it is better to use other protocols.

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