

Study regarding the validation of an assessment protocol of VO₂max on cycle ergometer

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Published online: December 25, 2013

(Accepted for publication November 25, 2013)

DOI:10.7752/jpes.2013.04087;

Abstract:

We set out to check the validity of an effort test that is aimed at assessing maximal aerobic power on electromagnetic brake bicycle with male subjects, aged between 20 and 30 years, untrained. The test was implemented at the Faculty of Physical Education and Sport with 8 untrained subjects with a mean age of 23.38 years, mean weight 80.9 kg and height 175.6 cm. The test protocol requires that the subject to follow the next steps: 5 minutes joint gymnastics, pedaling a bicycle at 133 W, then pedaling until exhaustion, the resistance increasing with 23.5 W/min. The evaluation was done using a Polar RS800 cardiofrecventiometer, gas analyzer FitMate PRO and pulse oxymeter Contech WK 50D. The bike model used is the Vision Fitness E3200. Each subject has sustained two effort tests at an interval of rest for 2 hours. Following data statistical analysis it was found a strong correlation between the maximal oxygen consumption and the maximal aerobic power determined for each test.

Key words: untrained, VO₂max, maximal aerobic power, protocol, FitMate PRO, Vision Fitness E3200 bike.

Introduction

In physiology, an often measured parameter is the maximum oxygen consumption. If we look back to check the origins of assessing this parameter we could say it was before year 1923. Until World War II, the maximal aerobic capacity was evaluated during several days by intermittent exercise tests. After 1960 in the assessment process it has been accepted complementary electronic devices which during continuous efforts were instantly determining the composition of exhaled air. A series of testing protocols for maximal oxygen consumption (VO₂max) appeared as a result of induction of continuous efforts in evaluation. Level duration (constant effort intensity intervals), difference of intensity between them and test duration were the criteria that classified the test protocols.

Froelicher et al. compared in 1974 three of VO₂max evaluation tests on 15 subjects: Bruce, Balke and Taylor. This tests have durations beginning from 3 to 31 minutes the VO₂max. It was revealed that the most significantly test was the Taylor protocol. After three years Balke, Bruce, Ellestad and Astrand test protocols were compared on a group of 55 subjects. Both studies have revealed that the oxygen consumption is lower as long as the duration of the VO₂max test is higher.

Maximum oxygen consumption optimal duration was not a problem until 1983, when Buchfuhrer tested different exercise protocols on 12 subjects, with 1 minute levels, on the cycle ergometer and treadmill. According to Yoon B. (etalors, 2007) VO₂max values are given outside the duration range 8-17 min, as it follows: lower values > 17 min and higher values < 8 min. Another study of assessing maximal aerobic power was conducted by WS Myles and RJ Toft, in 1982. They used one minute levels, with growth of 37.5 W, in which the subjects had to pedal at a rate of 75 revolutions / minute (RPM). T. Meyer and his collaborators in 1999 used another charging model: 3 minutes levels, starting at 100 W and increasing with 50 W. The number of subjects was 36 cyclists and triathlon athletes.

Untrained healthy individuals were subjected to an exercise test in evaluation steps of the maximal aerobic power, the load being of 16.3 W / min (100kpm/min). PJ Lattanzio and his collaborators (1997) used another method of assessing the maximal aerobic power. On 16 untrained subjects aged between 19 and 27 years they have conducted a study in which they used a progressive test with a load of 20 to 25 W / min. In 2002 Vercruyssen F. and his colleagues conducted a study in which eight triathlon athletes were evaluated in terms of maximal aerobic power. The cycling test involved a 6-minute warming at 100W, with a growth resistance of 30W every minute. The purpose of the test was to bring the subjects to exhaustion in 8-12 minutes.

Testing maximal aerobic power with different loads (15, 30 and 60 W), Buchfuhrer MJ and collaborators (1983) emphasized that VO_{2max} higher values are obtained using small loads. They concluded that the progressive period of the test should be approximately 10 minutes. Monedero J. and coworkers (2000) used the following test protocol in the evaluation of the maximum aerobic capacity: 3 minutes of cycling with a load of 120 W on a group of 18 subjects. After three minutes the resistance had increased by 40 W, followed by the steps of 8W/s. Subjects were brought to exhaustion performing this physical exercise.

A comparison of two assessment tests were compared by Amann, M. et alors in 2004. Test 1: 150W + 50W/min and Test 2: 20W + 25 W / min. Both tests have been supported by the same lot of riders (15) at a recovery period of 48 hours. As a result, no significant differences between the tests, in term of results, were identified.

Method

Measurement devices for maximum oxygen consumption come to rescue when they are available. Thus, I've tried to determine the maximum effort consumption and maximum aerobic power, on a bicycle with electromagnetic brake using a professional exhaled gas analyzer named FitMate Pro from Cosmed.

I have reported the testing protocol to tests described above.

FitMate Pro was compared with the Douglas system of VO_{2max} assessment in 2006 by Nieman D.C. and his colleagues. In their study no significant differences between the two assessment methods were found..

Our study was conducted on 8 male subjects, with a mean age of 23.38 ± 0.89 years (\pm std.dev.), mean weight of 80.09 ± 8.84 kg and height $175.63 \pm 7, 45$ cm.

Subjects were clinically healthy at the time of assessment, each declaring on their own responsibility (by written statement) that they are capable for exercise.

Even so, during the tests subjects were assisted by skilled health personnel.

A few conditions were set for subjects to participate at this tests. In the study did not enter subjects who:

- the day before evaluation had made intense effort;
- the day before evaluation had consumed alcohol or caffeine;
- have had health issues (especially cardiovascular);
- had the age outside the range 19 – 30 years.

The first evaluations were: the height, the weight and blood pressure. After that, the subjects have entered the test room, where they got information about the testing protocol.

For each subject the seat height was adjusted according the individual particularities.

The bike model used in this study is Vision Fitness E3200.

The seat height (the distance between the highest point of the saddle and the axis center of the pedals arms) is calculated by multiplying with 0.885 the interior length of the interior member.

After 5 minutes of gymnastics for joints, the chair is adjusted, the cardio belt of Polar RS800 watch is fixed, the gas mask of the FitMate PRO device and the pulsoximeter Contech WK 50D.

After personal data of the subject is introduced in the FitMate device, the following parameters are recorded: the heart rate, the oxygen consumption and the oxygen saturation of the blood (SpO_2) by turning on simultaneous the devices named above.

Maintaining for 6 minutes a frequency of 75 RPM (rotations/min), with a load of 133 W (corresponding to level 4 of the bicycle resistance), subject starts pedaling on the Vision Fitness E3200 bike.

The test is based on power increasing per each floor with 23.5 W for 6 minutes. Each level lasts one minute in a progressive way.

The subject has to perform each level at maximum of what is capable of.

The main task is to maintain pedaling at a frequency of 75 rpm throughout the test.

The subject ceases the effort when is not able to maintain the requested task.

The support on the bicycle horns is based on subject's preference, except the one on the forearms.

The leg contact on the pedal is taken with the sole.

Subjects were encouraged to reach the moment of exhaustion and maintain a steady respiratory rate.

At the end of the test, the subject remains on the bike for 3 to 5 minutes so the return of post-exercise cardio respiratory function can be assessed.

The exercise tests were conducted at a temperature of 24 degrees Celsius, 33% humidity and atmospheric pressure of 751.5 mmHg in the gym of the Faculty of Physical Education and Sport, in Iasi.

The lack of accommodation with cycling specific effort was an impediment for some subjects in reaching the highest point of exhaustion through the fact that they have accused inferior limb pain*.

Results

After the effort tests each subject's data were analyzed with the used devices software, determining the parameters at several points of the effort.

Synoptically, the data of the study is represented as it follows:

Table no. 1 - Statistical Indicators

	Average	Standard deviation	Asymmetry coefficient (C_{as})	Coefficient of variation (C_v)
VO_{2max} (ml/kg/min)	47,80	8,49	-0,43	17,76
Heart rate at VO_{2max} (bătăi/min)	176,12	8,47	-0,46	4,81
Maximal aerobic power (W)	351	51,13	-0,85	14,57
Expiratory flow VO_{2max} (l/min)	125,70	24,72	-0,24	19,67
Respiratory frequency VO_{2max} (resp/min)	45,93	7,31	0,57	15,91

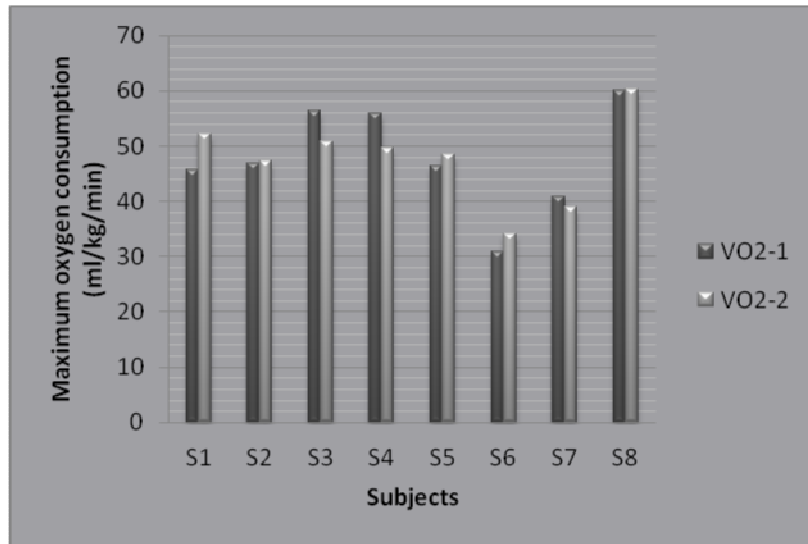


Fig. 1 - Maximum oxygen consumption (VO2-1 - VO_{2max} determined in the first test; VO2-2 - VO_{2max} determined in the second test; VO_2 - ml/kg/min; T - min)

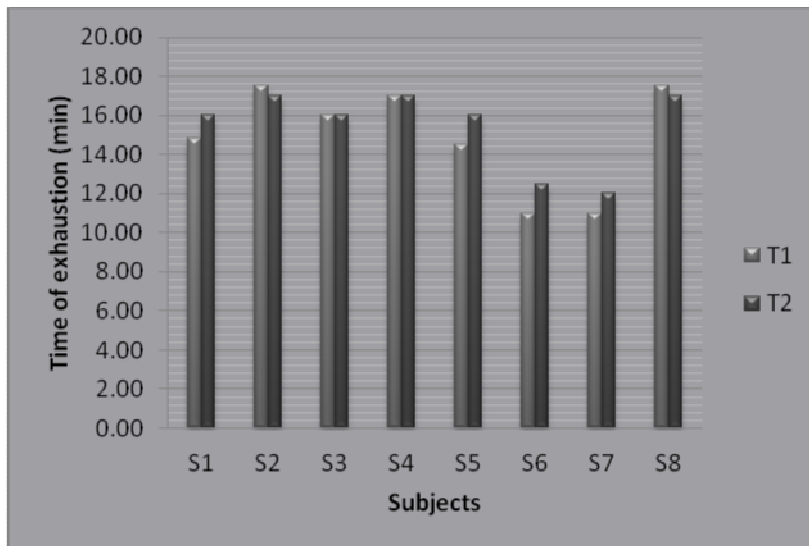


Fig. 2 - Time of exhaustion (T1 - the test moment of achieving VO_{2max} in the first test; T2 - the test moment of achieving VO_{2max} in the second test; T - min)

Following the stress test applied, the subjects achieved a maximal oxygen consumption of 47.81 ml / kg / min (± 8.49 ml / kg / min, \pm SD).

The individual results and the test durations are shown in Fig. 1 and 2.

The Pearson asymmetry coefficient (CAS) of the data sequence has a value of -0.43, which is a small negative asymmetry, predominantly high values of VO_{2max} .

