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Original Article

Validity evaluation of a new anaerobic performance field test

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Abstract:
The aim of this study was to assess the validity of a new field test for the evaluation of anaerobic performance in adults. During the 30s of the Skipping Test (SkipTest) the number of foot contacts (NFC) and the fatigue index (%FI) were recorded. The above parameters were compared with the variables of mean power output (MPO) and fatigue index (%FI) of the Wingate Anaerobic Test (WAnT). Additionally, the participants' blood lactate (BLa) and heart rate (HR) were recorded after the completion of both tests. Thirteen (n=13) physically active males aged 22.5±3.4yrs participated in the present study. The Pearson's correlation was applied for the evaluation of the testing variables interaction and the t-test was used for the assessment of the differences among the measured variables. The r value between the MPO and NFC was 0.32 while the %FI during the WAnT and the SkipTest was correlated as low as 0.36. Also, significantly high correlations were observed between participants' BLa (r=0.95) and HR (r=0.83). Additionally, the t-test shows that the BLa values were similar after the WAnT and the SkipTest. In conclusion, although the Skipping Test has a questionable validity, the findings of this study showed that it is an effective and easy to administer field test for the evaluation of the anaerobic performance.
Key words: anaerobic metabolism, performance, fatigue, lactate.

Introduction

Anaerobic tests are divided into tests which measure anaerobic power and capacity (Vandewalle et al., 1987). The anaerobic capacity tests can be classified according to whether they attempt to quantify anaerobic performance, or provide a work estimation of anaerobic capacity (Gastin, 1994). Currently, the Wingate Anaerobic Test (WAnT) is considered to be the most reliable and valid test and it is used in a number of laboratories and in a variety of sports for the evaluation of the muscle power generation during short term exhaustive exercise. The classification of the WAnT as an anaerobic test has been based on indirect assessments concerning the contribution of anaerobic energy metabolism in performance and it includes reports of oxygen deficits and oxygen debt (Inbar et al., 1996), blood lactate concentration (Bar-Or, 1987) and muscle lactate concentrations (Jacobs et al., 1993).

The anaerobic capacity tests are subdivided into maximal oxygen debt test and all-out constant load tests (Simoneau et al., 1983). However, there are discrepancies in the literature regarding the measurement of the anaerobic capacity. Most of the tests that are designed to measure the characteristics of the anaerobic performance are time dependent. These tests were extensively used in order to evaluate the anaerobic capacity of the involved muscle groups. However, the duration of the tests has generally been based upon the belief that maximum lactate production can be achieved within 40s time period (Margaria et al., 1964).

During the last decades a number of sport specific anaerobic field tests have been developed (Borsetto et al., 1989; Wragg et al., 2000; Thomas et al., 2002). However, parameters such as wind velocity, ambient temperature and humidity as well as the track conditions are likely to differentiate the athletes' optimum performance in the field tests.

The new method suggested for the evaluation of the anaerobic performance in adults would not necessarily be conducted by experienced personnel, it was rigidly controlled in administration and it was not limited by external influences such as the testing surface, the type of shoes or the possible error in the time taken. The aim of the present study was to assess the validity of easy to administer testing method, which could be used in order to evaluate the neuromuscular as well as the metabolic determinants of anaerobic performance in healthy and physically active young adults. Thus, this research's hypothesis was based on the fact that the proposed testing method for the assessment of the anaerobic performance is valid and accurate.

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Materials and Methods

Test Description

The proposed method for the evaluation of the anaerobic performance was based on the speed and agility training “Skipping Paw Drill” (a repetitive muscular activity from the legs), which has been applied in a variety of sports such as athletics, soccer, handball, basketball and tennis. The new field test named “Skipping Test” (SkipTest) requires only a small vertical displacement of the subject's body center of gravity. From a high knee position, the testing purpose was to lower the foot in order to hit the ground with the ball of the foot and get it up as quickly as possible. In turn, the foot’s effort from the ground should bounce the leg up into the high knee position parallel to the ground. The hands are supported and fixed on the wall or in a handle bar with the arms in 120^o flexion of forearms while the head must be in upright position with the trunk angle in about of 45^o (Figure 1).

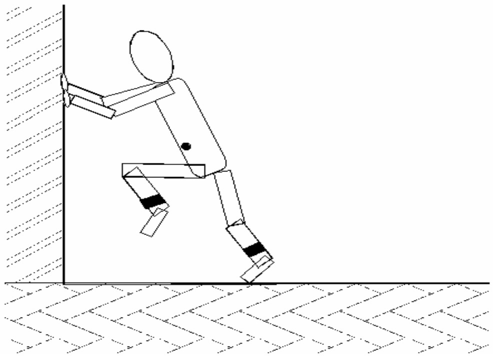

Fig. 1. Graphical representation of the Skipping Test.

The subject was instructed to move his leg as fast and often as he could during the 30s time-period of the test. The resistance loading during the SkipTest was the 1.5% of the subject's body mass and was applied with ankle weights which were fastened around the lower calves of the subjects’ legs. The counting of the foot contacts and the timing of the test started with the first contact of the dominant leg on the ground. The researcher used manual observation in order to count the number of foot contacts of the subjects during the test. The estimation of the anaerobic performance of the SkipTest was based on two parameters: i) the anaerobic performance by counting the number of foot contacts (NFC) throughout the 30s time period and ii) the percentage of fatigue index (%FI) or the power drop off by using the formula R_I - R_F / R_F x 100, where R_I is the amount of foot contacts in the initial 5s of the test and R_F the amount of foot contacts in the final 5s of the test. The reliability study of the SkipTest determines the appropriate duration of the method which reflects the anaerobic metabolism assessment as well as the most adequate resistance load which will not affect negatively the leg action of the subjects during the test (Mantzouranis et al., 2012). The validity of the suggested testing method will be assessed by comparing it with the standard Wingate Anaerobic Test which is an "all-out" test and it is globally used for the evaluation of the anaerobic performance (Ayalon et al., 1974).

Instruments

A Monark Ergomedic *894E* Peak Bike was employed in this study in order to evaluate the measured variables during the Wingate Anaerobic Test (WAnT). The cycle ergometer was mounted on a steel frame modified with toe-clips on the pedals and interfaced with a computer. The subjects’ Peak Power Output (PPO), the Mean Power Output (MPO) and the Fatigue Index (%FI) of the WAnT were recorded with the use of Anaerobic Test *894E* Software, (version 081001). The Polar *RS100*^{TM} transmitter measured the subjects’ heart rate with digital displays and it analyzed the data by using the Polar Pro Trainer 5 software. The Dr. Lange (*mod. LP 20*) mini Photometer was used in order to analyze the capillary blood and evaluate the lactate concentration of the subjects.

Data collection

Upon firstly reported to the lab (room temperature 21-22^{o}C), the subjects received verbal instructions as to the testing procedures but they were not informed about the specific purpose of the experiment. During the first session the subject's physical and physiological parameters of age, body mass, stature, skinfolds fat thickness as well as thigh and calf circumferences were measured. The testing sessions were carried out from the 12:30-17:00pm with a standard of 48h time interval between each session. Each subject randomly performed one WAnT and one SkipTest in a counterbalanced order and they applied a standard warm-up program. In each testing session capillary samples were taken 3min post-exercise from a prewarmed finger of the subject's preferred hand, measuring the blood lactate concentration while the max heart rate was recorded during and immediately after the completion of both tests.

Participants

Thirteen (n=13) healthy and physically active male volunteered to take part in this study in response to a request for participants. All of them were involved in some type of vigorous sport activity at least four times per-week but none had a high degree of a specialist training. The majority of this study's participants had previous experiences of laboratory procedures and they were familiar with the tests involved. The nature of the experimental protocol was fully explained to each subject but they were not informed about the specific aim of the study. The mean values (± standard deviation) concerning the age, the stature and the body mass were 22.5±3.4yrs, 177.2±5.6cm and 82.8±10.8kg respectively.

Statistical analysis

The data normality was checked by using the Van der Waerden's method, while the variables' normal distributions were confirmed by the probability P-P plots. The statistical design for the variables which were estimated from the Skipping Test (Number of Foot Contacts & Fatigue Index) and the measured variables obtained from the Wingate Anaerobic Test (Mean Power Output, Power Drop Off) were based on the Pearson's *r* correlation coefficient analysis. The dependent samples *t*-test was used in order to compare the statistical differences in mean values of the assessing variables derived from the SkipTest and the WAnT. All statistical analyses were carried out by employing the SPSS 17.0 for Windows, (*SPSS Inc., Chicago, IL, USA*). The statistical significance was defined at 5% ($p<0.05$).

Results

The correlation of coefficients between the measured data of the samples' anaerobic performance derived from the Skipping and the Wingate tests are illustrated in Table 1.

Table 1. Correlation of coefficient (*r*) between the measured variables obtained from the Wingate (WAnT) and Skipping (SkipTest) experimental trials.

WAnT	**SkipTest**	***r***
MPO (Watt)	NFC (reps/30s)	0.32
FI (%)	FI (%)	0.36
BLa ($mmol.l^{-1}$)	BLa ($mmol.l^{-1}$)	0.95*
HR ($b.min^{-1}$)	HR ($b.min^{-1}$)	0.83*

**p < 0.01*

Abbreviations: MPO=Mean Power Output, NFC= Number of Foot Contacts, FI= Fatigue Index, BLa=Blood lactate concentration, HR=Heart rate.

The *r* value between the measured variables of MPO and NFC was as low as 0.32. Similarly, the correlation analysis revealed that the coefficient between the MPR obtained from the WAnT and the NFC as measured during the SkipTest was low (r=0.30). In addition, the calculated % of Fatigue Indices during both WAnT and SkipTest were correlated as low as 0.36. In contrast, the Pearson's correlation coefficient was significantly higher in participants' BLa (0.95, $p<0.01$) and HR (0.83, $p<0.01$) values after both the WAnT and the SkipTest. The dependent samples *t*-test revealed that MPO, which primarily reflects the subjects' anaerobic capacity during the WAnT, was significantly different than the NFC which estimates the anaerobic performance during the SkipTest ($p<0.001$). Likewise, the subjects' FI in the WAnT was significantly higher than the percentage of power drop off as calculated during the SkipTest ($p<0.001$), while the subjects' BLa concentrations were significantly different after the SkipTest and the WAnT testing trials. Contrary to the above findings, the subjects' max Heart Rate values did not present any significant difference after the SkipTest and the WAnT. The overall *t*-test results of the recorded and calculated variables in both tests are presented in Table 2.

Table 2. The *t*-test analysis table illustrates all the measured and estimated variables obtained from WAnT and SkiPTest, (mean, 95%CI).

	WAnT			**SkipTest**		
Variables	Mean	95%CI		Mean	95%CI	Sig.
MPO (Watts)	630.5	585.8-675.3	NFC (reps/30s)	118	110-127	p<0.001
FI (%)	59.8	55.3-64.3	FI (%)	28.2	22.4-33.9	p<0.001
BLa ($mmol.l^{-1}$)	8.1	7.7-8.4	BLa ($mmol.l^{-1}$)	7.5	7-7.9	p<0.001
HR ($b.min^{-1}$)	178	170-187	HR ($b.min^{-1}$)	178	174-182	p=0.89

Abbreviations: MPO=Mean Power Output, MPR=Mean Pedal Rate, NFC= Number of Foot Contacts, FI= Fatigue Index, BLa=Blood lactate concentration, HR=Heart rate.

Discussion

The validity assessment of the Skipping Test was primarily based on the comparison of the measurements of this testing method in relation to the anaerobic capacity parameters obtained from the Wingate Anaerobic Test. In spite of the fact that the participants with high mean power output in the WAnT achieved a high number of foot contacts in the SkipTest while the subjects with low mean power output had lower performance during the new test, the low coefficient of correlation between the above variables casts doubt on the validity of the Skipping Test. However, the correlation of coefficients between the recorded times in the running or swimming field tests and the mean power output from the WAnT ranging from -0.75 to 0.58 still exist and a large number of sport scientists are used to employing these tests in order to evaluate their athletes' anaerobic performance (Bar-Or, 1987; Maxwell & Nimmo, 1996).

According to the literature, the fatigue index was higher in the Wingate Anaerobic Test than the generated power drop-off which was calculated during the Skipping Test (Sahlin, 1986). Moreover, the recorded mean values of the fatigue index during the SkipTest were approximately the half than the power drop-off during the WAnT. In addition, it was observed that the recorded blood lactate concentrations after the SkipTest and the WAnT were above the onset of $7mmol.l^{-1}$ which confirms that the participants performed both tests with maximal intensity. From the physiological point of view, the high correlation of peak blood lactate concentrations obtained after the evaluated tests leads us to the fact that the SkipTest, similarly to a vertical multi-jump test, is an "all-out" exercise which exhausts the anaerobic lactic performance (Sands et al., 2004). The maximal heart rate in both tests ranged from 155 to $197b.min^{-1}$ and it was recorded immediately after each test completion. This study's finding is considered to be a characteristic of fatigue profile for these dynamic muscular exercises. The reported high correlation of the subjects' maximal heart rates between the WAnT and the SkipTest is due to the ankle weight resistance load which was applied in the SkipTest, confirming the all-out nature of the new test (Green & Dawson, 1993)

Conclusion

In summary, the Skipping Anaerobic Performance Test has the advantage that it is not limited by environmental factors, it is familiar to the majority of physically active adults and it can be apply to a wide range of sport activities. However, the questionable validity of the studied in relation to the Wingate test makes us unable to justify that the proposed method is the most valid field test. Because of the fact that the Skipping test seems to be an effective and easy to administer method, future research could lead to the establishment of this method as a standard test for the evaluation of neuromuscular and metabolic determinants of anaerobic performance.

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