

Medicina Sportiva

The Journal of Romanian Sport Medicine Society

Vol. IX, No. 3 – 2013

15.09.2013

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ISSN 1841-0162

Publisher “Universitaria”, Brestei 156, 200177, Craiova, Romania

Editorial Office Address: University of Craiova, Physical Education and Sports Faculty,
Brestei 156, 200177, Craiova, Romania

Site adress:

<http://www.medicinasportiva.ro>

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A new approach to estimate the anaerobic capacity of the top athletes

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Abstract. In this study, it was achieved a parallel between one of the most used protocol for testing anaerobic effort capacity called the Wingate Test and the Total Work Performed Test, proposed by Szogy and Cherebetiu, which is used in Romania for about 40 years ago in order to estimate the top athletes. For this study the athletes performed only one 45 seconds maximal effort whereas data issued by the Monark cyclo-ergometer soft have been used to obtain both the significant parameters considered by the TW authors and the ones showed by Szogy and Cherebetiu within the Total Work Performed Test. This study results showed high significant positive correlations existed between the Peak Power and the Total Work Performed on 10 seconds also between the Total Work Performed on 45 seconds and the Average Power on 30" ($p < 0.05$ for all correlation coefficients).

Key words: anaerobic capacity, Wingate test, Total Work Performed test, peak power, average power.

Introduction

In this study, it was achieved a parallel between one of the most used technique as to the anaerobic effort capacity called the Wingate test (1,2) and the test proposed by Szogy and Cherebetiu (3), which is used in Romania for about 40 years ago in order to estimate the top athletes. This work objective was not only to have in view the authentication of one of the tests and the non-authentication of the one but also to put into emphasize those parameters which give to the readers the most important information being useful for the training process.

This study's goal was the one to establish if there is a resemblance between the Wingate Test (TW) and the Total Work Performed Test performed by Szogy and Cherebetiu (TWPT). Moreover, the comparative estimation of parameters used within the Wingate Test and of the ones proposed by Szogy and Cherebetiu within the Total Worked Performed Test will lead to the way in which some indication will be issued to choose the optimal testing method on the anaerobic effort capacity depending on the features of sport test.

This two testing types correlation's establishment presents always the disadvantage in the way in which it is impossible to exactly show the

conditions the two tests occur: the match period, testing hours, equivalent environment and physiological conditions, partial determination of sports man to perform the two tests, etc. For the present case, these obstacles were canceled do to the fact the subjects (we're referring to) put into effect only for a time the testing, the last one being understood by both proceedings.

Further on, it is to be mentioned that for this study the athletes performed only one maximal effort whereas data issued by the Monark cycle-ergometer soft have been used to obtain both the significant parameters considered by the WT authors and the ones showed by Szogy and Cherebetiu within the TWPT. It is considered that on these terms, an eventually correlation making evident done between the results of both tests has got a high accuracy degree and it could show the validity and equivalence of the two testing methods (TW and TWPT).

In addition to it, achievement at the same time of the TW and TWPT, tests study led to the issuing of more information relating to the anaerobic efforts intermediary phases: 5 seconds (PP in case of TW), 10 seconds and 20 seconds (Total Work Performed at 10 and 20 seconds from TWPT),

30 de seconds (AP from TW) and 45 seconds (Total Work Performed at 45 seconds from TWPT).

The multitude of shown proceedings and of parameters considered to be defined for anaerobic skills by various authors (4-6) led to a great difficulty to establish a "common language" as to the marks obtained by the athletes during the testing.

In spite of these differences, there are a few testing conditions which are seemed to be important for all these proceedings' authors: the test has to be of maximum intensity in order to allow the highest percentage of energy given by the anaerobic sources and it is to be kept to estimate the body ability to keep the muscles work, as much as possible.

The Wingate test (1, 2) and also the Total Work Performed Test described by Szogy and Cherebetiu (3) are proceedings which use the same maximal pedaling on the cyclo-ergometer. The TW needs a pedaling against a constancy braking resistance that is calculated depending on the body weight (e.g., $0.075 \text{ kp}\cdot\text{kg}^{-1}$). Although the proceeding of TWPT described by Szogy and Cherebetiu initially supposed that the effort to be performed on a gradual load cycle-ergometer, these days, testing took place on the same type of constancy load cyclo-ergometer as WT on which the same braking strength was used (e.g., $0.075 \text{ kp}\cdot\text{kg}^{-1}$).

The two tests suggest different time periods to perform the standard effort: 30 seconds for the TW and 45 seconds for TWPT. Much moreover, difference between them is seen also through the physique parameters and periods of time on which determinations are performed. Thus, WT measures the average power on the periods of time of 5 respectively of 30 seconds whereas TWPT measures the total mechanical work performed on the periods of time of 10, 20 and respectively 45 seconds since the efforts have be done (TWP 10", TWP 20" and TWP 45").

It is to be mentioned the fact that the original version of the TWPT set up a standard effort time of 60 seconds due to the authors' views, establishment of Total Work performed till the end of first minute end of maximal effort gives significant information relating to the lactate limit of subject After a period of 45 seconds, the aerobic energetic systems part is significant to sustain the effort, so that, there is about the same contribution of the two systems, at the end of the

first minute of effort. For this reason, within the Romanian National Institute of Sports Medicine, testing time was diminished from 60 to 45 seconds. It was also imposed by the fact that the athletes bodies hardly tolerated such a period of time of maximal test and giving up of the effort was produced before the ending of testing period recommended by the authors, for many times.

Material and Method

The Romanian National and Olympic teams run over a pre-participation examination, every six month, at the Romanian National Institute of Sports Medicine (Bucharest, Romania). This study analyzed the results from 450 top athletes obtained during the assessment of the effort capacity, between January 2008– December 2010. The subjects were accordingly divided to the specifics of the athletic trial, in four groups.

Group 1: 162 athletes participating in alactic anaerobic disciplines (100m, 200m sprints, 100 m hurdles, vertical jumps). The female group contained 85 athletes and the male group contained 77 athletes.

Group 2: 62 athletes participating in anaerobic trials, but with an important lactic component: 400m sprints and 400m hurdles runners. The female group was made of 31 athletes, and the male group contained 31 athletes.

Group 3: 156 athletes participating in sports with mixed energogenesis, aerobic and anaerobic: middle runners 800m and 1500m but also football and handball. The female group had 64 athletes, and the male group had 92 athletes.

Group 4: 70 athletes participating in high endurance: marathon and race walk, of which 35 were women and 35 men.

For every each team, interpretations have been separately for achieved for feminine and masculine subjects. There was the following final teams structure: alactic anaerobic tests - girls team (85) and boys team (77), lactic anaerobic tests - girls team (31) and boys team (31), mixed energogenesis tests - girls team (64) and boys team (92), aerobic tests girls team (35) and boys team (35).

The testing protocol. The assessment of the anaerobic capacity was performed on a Monark 894-E, bicycle ergometer, wired to a computer using original, manufacturer-delivered software (Sports Medicine Industries, Inc. (SMI) (St. Cloud, MN) (Power software), software which can graphically represent the basic parameter of a

Wingate testing: the power. The resistance applied to the cycle-ergometer was calculated for each subject according to their body weight (kg multiplied with 7.5%). The data from each subject was introduced in the SMI Program software.

Before collecting the data, and before applying the break on the wheel, the athlete pedaled without resistance for a few seconds, trying to reach the maximum speed in order to overcome the wheel's inertia. Right after that, the assistant released the break weight and the software started collecting the data. All the subjects pedaled as fast as they could over a time span of 45 seconds. The athlete was verbally encouraged during the entire testing and was told every 5 seconds the time left until the end of the effort.

Data analyses. The Monark bicycle soft performed counting of pedaling cycles, multiplies the pedaling number with the wheel circumference and with the strength applied on the wheel, then the resulted value is divided to 5 in order to obtain an average power on each 5 seconds time period.

The registering values analysis allows showing of the parameters proposed by TW: Peak Power - PP (the highest value of average power measured on each time period of 5 consecutive seconds), Average Power -AP (average power registered during the 30 seconds of maximal effort), Minimum Power - Pm (the lowest value of average power measured on each time period of 5 consecutive seconds), Power Drop (difference between the highest and the lowest value of power measured on time period of 5 seconds) and the fatigue index - FI (being a result of dividing the difference done between the Maximal Power and the Minimal Power to the Maximal Power, this result being multiplied with 100). The registering powers are expressed into Watt/s.

Within this study testing fulfillment, the pedaling time period was extended to 45 seconds whereas the cycle-ergometer going on to registered for the whole testing period. Subsequent to it, results issued by soft have been used in order to obtain also the parameters recommended by Szogy-Cherebetiu: the total work performed (TWP) registering during the period of time of 10, 20 and 45 seconds. In this way, the total work performed for the proposed time periods (TWP 10", TWP 20", TWP 45") is calculated by summing of the efforts performed for each 5 seconds time period issued by soft, which result from the average power values.

Subsequent to it, it is expressed TWP into kgm as an absolutely value (changing watt into kgm using formula $1 \text{ watt} = 6.11829727787 \text{ kgm/min}$) and into kgm/kg body weight as a unitary or a relative (the TTR value is divided by the subject's weight expressed into kg).

Within this study there were followed up the relative values (kgm/kg body weight) obtained both for the TW (PP, AP) parameters and for the TWPT (TWP 10", TWP 20", TWP 45") ones.

The kg-body value was not used for the fatigue index because of the fact it represents a percentage value.

The statistical analysis was performed using the standard statistical analysis of the Microsoft Excel software and included: medium values, standard deviations (SD) and value intervals for the parameters measured.

The comparison between the levels of these parameters for each separate group was done using the Student test.

The correlations between parameters were evaluated through the Pearson correlation method and the level of signification was considered at $p < 0.05$.

Results

Peak Power. The peak power (PP) expressed as a relative size (W/kg body weight) registered the following values per studied teams: aerobic feminine tests 7.21 ± 0.94 , aerobic masculine tests 7.93 ± 1.69 , feminine mixed energogenesis tests 7.75 ± 1.21 , masculine mixed energogenesis tests 9.61 ± 1.57 , feminine alactic aerobic tests 8 ± 1 whereas for masculine 10.13 ± 1.68 , feminine alactic aerobic tests 8.93 ± 1.48 whereas for masculine 11.57 ± 1.96 .

The plotting shows that the athletes trained for the alactic anaerobic tests get the highest values, being followed by the lactic anaerobic tests ones and by the mixed energogenesis tests ones, whereas these parameter lowest values to be registered for the athletes teams who take part in the aerobic tests.

Average Power. Further on , it is to be mentioned the fact that the Average Power parameter per kg body weight per 30", that is recommended by the Wingate test protocol register the same rising trend as the Peak Power on the way in which the respective sports require a bigger aerobic metabolism and an aerobic one into a low percentage.