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SELECTED ASPECTS OF THE ASSESSMENT OF ANAEROBIC CAPACITY BY APPLYING THE WINGATE TEST

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Physical education students (n=24) were subjected to the 30 s Wingate test twice, on two consecutive days, one of the tests (1) starting at full resistance (0.74 N/kg body mass), the other (2) - starting at low resistance, gradually increasing to full within 2 - 3 s. One group of subjects (A; n=13) performed the tests in the order 1-2, the other (B; n=11) in the reversed order. The tests were performed on a Monark cycle ergometer and recorded by using Multicard E30 system. Basic mechanical variables were recorded - momentary and peak power, peak time, time of sustaining peak power, total work output and power drop curve. It has been found that the mode of starting the test significantly affects the assessment of the anaerobic capacity and therefore results obtained by those two options of the test are not comparable to one another. The results obtained suggest that although in the low resistance option higher values of the mechanical variables can be attained, the high resistance one enables a more precise assessment of subject's anaerobic capacity.

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Key words: Anaerobic capacity - Wingate test

Introduction

The increasing intensity of training loads, essential in the preparation of athletes to competitions like team games, combat sports, tennis, table tennis, etc., requires a high level of anaerobic capacity and methods of its assessment. The latter is being accomplished with the use of laboratory exercises, one of the most popular ones being the so-called Wingate test [1].

Many studies have demonstrated that the Wingate test lasting 30 s enables a reliable assessment of the phosphagen and lactate-anaerobic components, as well as of the dynamics of power output diminishing with the steady depletion of substrate stores in muscles and with mounting fatigue [1-4,7,9].

Various options of the Wingate test differ basically by the mechanical criteria of starting the test (e.g. [1,10]), which may seriously affect the test result and thus the assessment of the subject's anaerobic capacity. The aim of this study has thus been the evaluation of differences between options proposed by Bar-Or [1] and by Zdanowicz [10], regarding the test outcome.

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Material and Methods

Twenty-four physical education students volunteered to participate in the study which had been approved by the local Commission of Ethics. None of the subjects practised competitive sports. They were randomly assigned to two groups and subjected to the 30 s Wingate test twice, on two consecutive days. Test 1 started at full resistance, i.e. 0.74 N/kg of body mass, and in order to facilitate the performance of the test, the position of the right pedal was 35° vs. ground. Therefore, recording the first revolution started with pressing the right pedal down [10]. Test 2 started at a low resistance which gradually increased to the full one within 2 - 3 s, and from that moment on the work duration and output were recorded [1]. Physical characteristics of subjects and the experimental protocols, i.e. the sequence of tests in the two groups, are presented in Table 1.

Table 1
Characteristics of two groups of subjects performing the Wingate test and the experimental protocols applied

Group	n	Age (years)	Body mass (kg)	Body height (cm)	Experimental protocol Day 1	Day 2
A	13	20.8±0.8	72.6±4.9	180±6	Full resistance	Low resistance
B	11	21.5±1.0	72.8±5.1	179±5	Low resistance	Full resistance

Every subject has been instructed on the performance of the tests. Exercises were performed on a Monark cycle ergometer with a mechanical control of the flywheel resistance. The times of revolutions were recorded by using an electromagnetic sensor coupled to the Multicard E30 system. The tape speed was 50 mm/s which enabled time measurements with an accuracy of 0.01 s.

Both options of the test were preceded by a warm-up lasting 5 min (75 W, 50 rpm). During the warm-up the subjects performed two bouts lasting 5 s each, at individually maximal pedaling rate and at full test load. Next, following a 5 min rest in sitting position on the ergometer, the test started. Immediately after the test, the intensity was reduced to 50 W and 50 rpm for one min, in order to avoid the orthostatic effect. After that, the subjects rested for 4 min in supine position.

The following variables were recorded:
- Power output of consecutive pedal revolutions,
- Mean power values for 3 s-intervals (from these, power drop curves were constructed),
- Peak power (in W and W/kg body mass) - attained at peak pedaling speed,

- Peak time (tuz) - in which peak pedaling rate (tm) was attained,
- Time of sustaining peak power (tm ≤ tut ≤ tm+0.01 s),
- Total work output (in J) in 30 s,
- Power drop index (PDI, %) - computed from the formula: PDI = (MAX – MIN) / (MAX), where (MIN) and (MAX) correspond to lowest and highest mean power values, respectively, recorded in 3 s-intervals.

Conventional statistical methods were used to analyze the data, the level of $P \leq 0.05$ being considered significant.

Results

The results obtained in two groups of subjects are presented in Table 2. In Group A, significantly higher values of peak power, work output and peak time were noted in Test 2, i.e. when the exercise started from a low resistance, as compared with Test 1. Similar relations were observed also in Group B and this was reflected in the power drop curves (Fig. 1).

Table 2
Mean values (±SD) of mechanical variables recorded in two groups of subjects performing the Wingate test according to two different protocols

Variable		Group A (n=13) Test 1	Group A (n=13) Test 2	Group B (n=11) Test 2	Group B (n=11) Test 1
Peak power	W	752±59	812±59	808±73	747±70
	$W \cdot kg^{-1}$	10.4±0.7	11.2±0.7**	11.1±0.9*	10.3±1.0
tuz	s	2.82±0.43	1.73±1.12**	1.21±0.30***	3.31±1.05
tut	s	3.05±1.37	3.21±1.42	2.89±1.41	2.87±0.96
Work output	kJ	17.6±1.1	18.5±1.1*	18.2±1.2	17.2±1.1
	$kJ \cdot kg^{-1}$	243±12	255±10*	250±15**	237±14
PDI	%	39.9±6.2	42.7±6.0	41.2±5.2	38.7±5.8

PDI - Power drop index; tuz - Peak time; tut - Time to sustain peak power; Significantly different from the respective value in Test 1 at P<0.05 (*), P<0.01 (**), or P<0.001 (***)

Discussion

The results obtained in this study suggest that the mode of starting the Wingate test significantly affect the assessment of subject's anaerobic capacity. This pertains both to the values of mechanical variables and to the slope of the power drop curve.

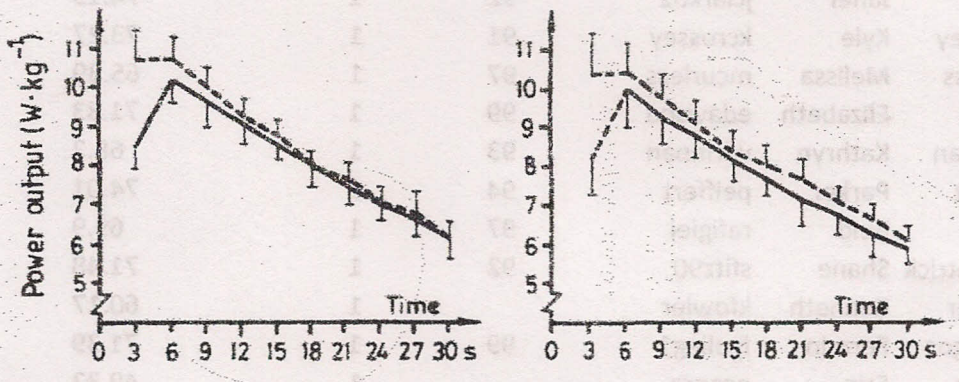

Fig. 1
Power drop curves in 30 s-Wingate test performed twice by two groups of subjects. Sequence of tests: Group A - Test 1 / Test 2; Group B - Test 2 / Test 1
Test 1 (solid line) - start from a low resistance; Test 2 (dotted line) - start from a full resistance. Vertical bars denote SD's.

According to the original protocol of Bar-Or [1], upon command "start" the subject starts pedaling at fastest rate possible, at the flywheel resistance set low and gradually increasing up to the full value within less than 3 s so as to counter the flywheel inertia. At that moment the recording starts. The subject is supposed to pedal as fast as possible from the very beginning.

As follows from our observations, athletes, especially those practising strength/speed sports, attain very high pedaling rates in the first two seconds of the test, due to the low resistance applied. This certainly facilitates fast pedaling when the flywheel resistance is set at full load.

In contrast to that, the execution of the test according to Zdanowicz [10], with the full flywheel resistance being set from the beginning, enables a gradual attainment of peak power [8]. It is to be emphasised that the power drop curve in that case meets the requirement of Bar-Or that the shape of the curve resembled an inverted "U".

At a low initial resistance, the subjects attained higher values of mechanical variables measured (cf. Table 2 and Fig. 1). Similar results were reported also by other authors who applied conditions corresponding to Test 1 [5,6,10] or to Test 2 [2-4,7].

It may be concluded from the values reported here that both options of the Wingate test enable an assessment of the subject's power potential and anaerobic capacity but the results obtained with the two options cannot be compared with one another. The lack of significant differences in the level of the power drop index indicates that the fatigue curve is independent of the mode of execution of the Wingate test despite differences in measured values between the two options.

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