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The Influence of Interval Training on Selected Indicators of Anaerobic Efficiency in Untrained Men

by

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The paper presents results of a 6 week interval training program, performed by 12 young untrained men. The training loads included 6 short (8-10 sec.) running efforts with 30-s. rest periods. The main criteria for evaluation of training effects were changes of selected variables (such as maximal power, total mechanical work) registered during the Wingate test. The applied interval training caused a significant decrease in the time of 6x50m running test and a significant increase of mechanical work values in both the non-lactate and lactate phases of the Wingate test.
Key words: *men, interval training, Wingate test, anaerobic efficiency.*

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Introduction

Short lasting, single or repeated high intensity physical efforts, which one may often see in everyday life, are also typical for many sport disciplines, including team games, combat sports, fencing ect. It was assumed that the internal structure of training load should be adequate to metabolic demands of sports competition, and that game or fight effectiveness in sports competition is closely correlated to physical work capacity. The main objective was to determine whether systematic interval training, including both metabolic pathways of anaerobic energy production (Gastin 2001, Górski 2001, Kozłowski 1999, Wołkow 2007) will cause significant changes in selected variables of anaerobic efficiency.

To answer the research question a 6 week experiment was designed. The exercise protocol included 6 short (8-10 sec.) maximal intensity running efforts with 30 s rest periods between efforts. When defining the training load structure in the context of exercise intensity and work volume as well as time and rest periods, it was assumed, based on empirical date, that during maximal intensity interval training, rest intervals are the major factors determining the scope and direction of adaptive changes (Norkowski 2003).

There is little data available on results of interval training with a load structure similar to that, presented in this paper.

The aim of the research was to determine the influence of interval training with a defined internal structure load on the scope of change in variables describing the non-lactate and lactate phases of the Wingate test.

The research material included 24 students of the Academy of Physical Education in Warsaw, Poland. Their daily physical activity was limited to obligatory physical education classes. The sample was randomly divided into experimental (n=12) and control group (n=12). Mean age of the sample was 23.3±1.5 years, mean height was 178.4±3.5 cm, mean body weight 77.3±3.2 kg. Both groups did not vary in regard to age and anthropometrical features. The research was carried out between March 1, 2006 and May 9, 2006.

The evaluation procedure included the 30 s Wingate test conducted every 5th day of the experiment.

Research methods

The pedagogical experiment method was applied in the research. The experiment was based on a 6 week interval training protocol including 6x 25+25m shuttle runs. Rest periods between sets equalled 30 seconds.

The interval training was performed four times a week (Monday, Tuesday, Wednesday and Thursday). The training loads consisted of 24 repetitions of 25+25 m sprints, which totalled approximately 1200 m. The exercises were carried out on a standard handball field, size 40x20 m. The time of the runs was recorded electronically enabling measurement accuracy of 0,001 sec.

Two tests were applied to evaluate the impact of training on anaerobic efficiency. They included:

- total time of the 6x25+25 meters shuttle run. (evaluation before the experiment and on the last training session in every week of the experiment);
- Wingate test carried out before the start of the experiment and on the day following the last training session in each experimental week.

The Wingate test included a 30 s maximal intensity effort on a MONARK 824E cycle ergometer connected online with a computer software "Multi Cykloergometr" (Staniak 1994), enabling the evaluation of several mechanical variables. The following variables were selected for further analysis:

- relative value of mechanical work [J/kg],
- relative value of maximal power [W/k],
- time of developing maximal power [s],
- time of maintaining maximal power [s].

The cycle ergometer load was set individually and was equal to 0.075 kp/kg of body mass (0.736N/kg m.c). The tests were carried out in compliance with Wingate test methodology (Inbar, Bar-OR, Skinner 1996).

The following criteria were approved to evaluate the results of interval training:

- Mean values of total time of 6 repetitions of 25+25m shuttle run (rest periods not included),
- Mean values of work (J/kg) obtained in the Wingate test in subsequent weeks of the experiment,
- Mean values of maximal power (W/kg) developed in the Wingate test after subsequent weeks of the experiment,
- Mean values of developing maximal power (s),
- Mean values of maintaining maximal power (s).

Research results were statistically analysed, with arithmetic means and standard deviations of specific variables calculated. Significance of differences between mean values of subsequent tests of the experimental group were checked with the use of ANOVA for repeated measurements, and between group differences were determined with the use of NIR test, with the significance level set at $p<0.05$. The significance of differences between results of the

experimental and control group was determined based on T-test results for independent samples. All calculations were carried out on STATISTICA™ software [v. 5.5. Stat Soft. USA].

Results

Experimental group:

The training loads applied in the 6 week running interval training (Tab. 1) resulted in:

1. significant decrease of mean time of the 6x25+25m run after the third week of training;
2. maintenance of results in the period between the third and sixths week of experiment.

Table 1

Differences in mean time [s] of the 6 x25+25m run in subsequent weeks of training (experimental group)

	Before training (1)	After Week 1 (2)	After Week 2 (3)	After Week 3 (4)	After Week 4 (5)	After Week 5 (6)	After Week 6 (7)
M	58.87*	58.44*	57.79*	**54.75***	**54.18***	**53.85***	**54.05***
SD	±5.43	±4.79	±4.28	±4.98	±4.33	±3.97	±3.82
*(p<0,05)	4,5,6,7	4,5,6,7	4,5,6,7	**1,2,3**	**1,2,3**	**1,2,3**	**1,2,3**

Legend: M – mean, SD – standard deviation, 1,2,3,4,5,6,7 - measurement periods, * - significant difference **(p<0.05)**

Analysis of mean values of anaerobic power and capacity obtained in the Wingate test after subsequent weeks of training (Tab.2) revealed that:

1. mechanical work (J/kg) – a significant increase of mean values of this variable observed after the third week of experiment. During the last 3 weeks of training, values of work did not change significantly;
2. maximal power (W/kg) – during 6 weeks of the experiment a systematic increase of values of this variable was observed. No significant changes in maximal power were recorded between the sixth and eighth week of the experiment;
3. time of developing maximal power values – mean values of this variable did not change significantly in the course of the whole experiment.
4. time of maintaining maximal power – after the fourth week of the experiment a significant increase of this variable (in comparison to preceeding period) was noticed.

Table 2

Differences in selected variables of the Wingate test after subsequent weeks of the experiment (experimental group)

		Total work [J/kg]	Maximal Power [W/kg]	Time of developing max. power [s]	Time of maintaining max. Power [s]
		M±SD	M±SD	M±SD	M±SD
1	Before training	241.60±22.51* (4,5,6,7)	10.63±0.77 (4,5,6,7)	5.01±0.88	2.37±0.78* (5,6,7)
2	After Week 1	249.25±20.03* (4,5,6,7)	10.60±0.73 (4,5,6,7)	5.06±0.76	2.39±0.82* (5,6,7)
3	After Week 2	254.70±22.80* (4,5,6,7)	10.88±0.80 (4,5,6,7)	5.03±0.78	2.42±0.54* (5,6,7)
4	After Week 3	**271.75±21.18* (1,2,3)**	**11.21±0.76 (1,2,3,4)**	5.02±0.69	2.55±0.74* (5,6,7)
5	After Week 4	**287.12±25.83* (1,2,3)**	**11.96±0.84 (1,2,3,4)**	5.09±0.58	**3.11±1.04* (1,2,3,4)**
6	After Week 5	**291.61±20.47* (1,2,3)**	**12.02±0.67 (1,2,3,4)**	5.08±0.71	**3.05±0.51* (1,2,3,4)**
7	After Week 6	**282.06±20.42* (1,2,3)**	**11.88±0.83 (1,2,3,4)**	5.06±1.06	**3.19±0.81* (1,2,3,4)**

Table 3

Differences in selected variables of the Wingate test after subsequent weeks of the experiment (control group)

		Total work [J/kg]	Maximal Power [W/kg]	Time of developing max. power [s]	Time of maintaining max. Power [s]
		M±SD	M±SD	M±SD	M±SD
1	Before training	247.78±10.41	10.60±0.57	5.06±1.33	2.27±0.94
2	After Week 1	243.91±12.86	10.51±0.58	5.01±0.80	2.22±1.15
3	After Week 2	231.18±14.04	10.66±0.76	5.06±1.38	2.36±1.10
4	After Week 3	241.05±11.29	10.36±0.71	5.08±0.80	2.31±1.17
5	After Week 4	252.19±9.05	10.71±0.55	5.05±1.56	2.17±1.20
6	After Week 5	238.04±10.24	10.48±0.65	5.04±1.12	2.28±0.88
7	After Week 6	241.78±10.41	10.68±0.57	5.08±1.41	2.35±0.92

Legend (tab. 1-2): M – mean, SD – standard deviation, 1,2,3,4,5,6,7 - measurement periods, * - significant difference **(p<0.05)**

Control group:

Analysis of changes of mean values of variables of the Wingate test after subsequent weeks of training (Tab. 3) showed a lack of significant differences in the course of the whole experiment.

Comparison of experimental and control group results:

1. mechanical work (Fig. 1) – in the period from the third to the sixth week of the experiment, mean values of mechanical work varied significantly between the experimental and control group.
2. maximal power (Fig. 2) - in the period from the third to the sixths week of the experiment, significant increase of mean values of maximal power was observed in the experimental group.
3. time of developing maximal power (Fig. 3) – in the course of the whole experiment, no significant differences between compared groups were recorded.
4. time of maintaining maximal power (Fig. 4) – in the period between the fourth and sixths week of the experiment, mean values of this variable were significantly higher in the experimental group than in the control group.

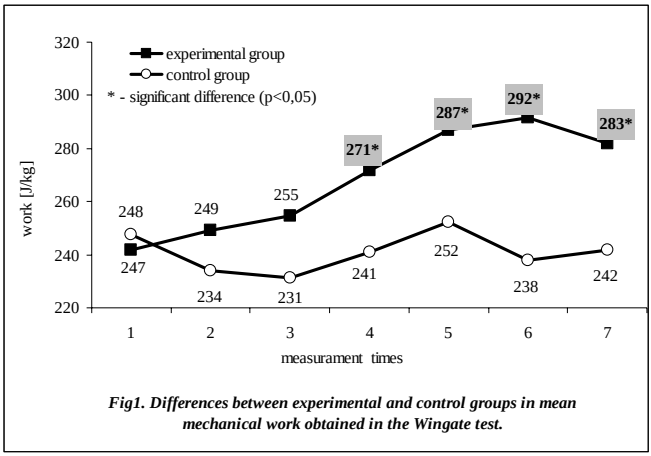

Fig1. Differences between experimental and control groups in mean mechanical work obtained in the Wingate test.

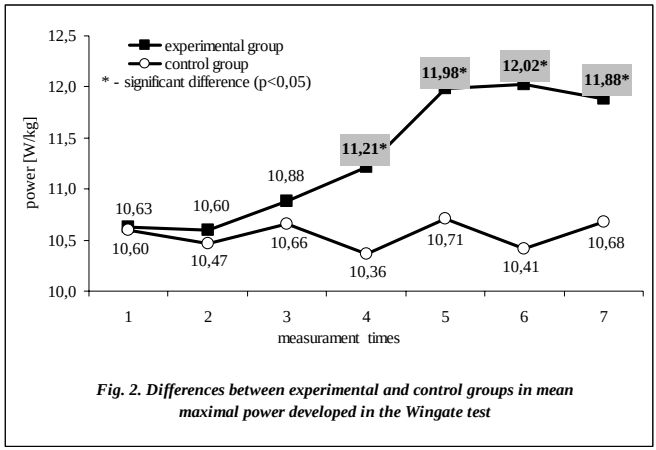

Fig. 2. Differences between experimental and control groups in mean maximal power developed in the Wingate test

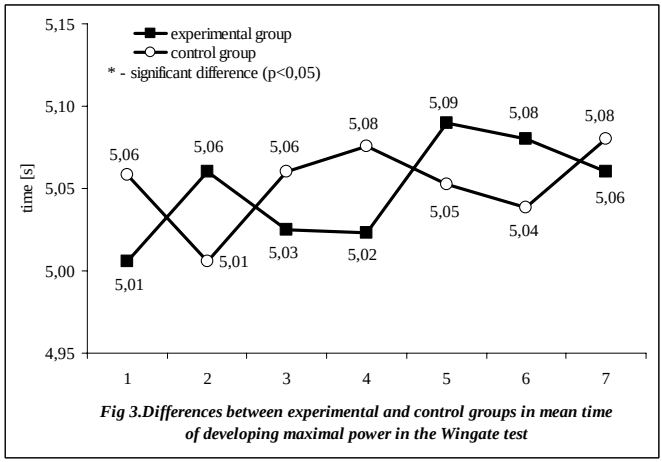

Fig 3.Differences between experimental and control groups in mean time of developing maximal power in the Wingate test

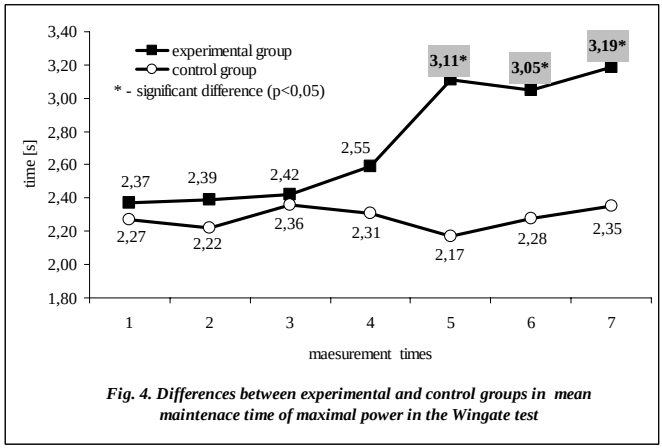

Fig. 4. Differences between experimental and control groups in mean maintenace time of maximal power in the Wingate test

Discussion

Research results indicate that the applied training protocol in the experiment, caused a significant improvement of time of the 6x25+25m run and a significant increase of maximal power and mean power in the Wingate test. Analysis of changes of work performed in the non-lactate (time of developing Pmax. + time of maintaining Pmax.) and lactate (time of decrease Pmax.) phase of the Wingate test showed increases of 16-25% were recorded. Most of all it should be emphasized that the training load applied in the present experiment (8-10 s of work and 30s rest period) significantly increased anaerobic capacity through streamlining both systems (phosphate and glycolytic) of ATP re-synthesis. The obtained result are well supported by the literature claims of significant dependency between the volume of work executed in the non-lactic phase during maximal efforts lasting up to 10 seconds and effectiveness of the phosphate system, as well as the presence of strong positive correlations between the volume of work during 30 s continuous efforts and glycolylic activity (Wołkow 2007, Żołądź 2001). Comparing training changes of mean values of work executed in the non-lactate (25%) and the lactate (16-18%) phase of the test, recorded in the present research to results of interval training of the same structure executed by male handball players (Norkowski, Tkaczuk 2002, Norkowski, Buśko 2004), where 10-12% changes of these parameters were registered, one may claim that better results of non-athletes may be determined by their lower initial capacity in this area. Considering the relevance of rests periods in this experiment in comparison to results presented by Norkowski (2003), where, identical running distance was applied, yet 45s and 15s rest periods were used, it may claim that 30s rest periods applied in this experiment enabled to reach similar improvements in both types of anaerobic metabolism.

Comparing these research results to other data in the field of anaerobic capacity training, it should be underlined the training effects in maximal power and mechanical work are similar to results of Linossier (1993, 1997), Simoneau (1987), Stathis (1994) and Norkowski, Zghidi (2004). They executed interval training on a cycle ergometer and claimed significant increase of maximal power and total work obtained in the Wingate test.

Conclusions:

1. The applied interval training protocol used in this research was effective in increasing both anaerobic power and capacity.

2. The described training load in this experiment may be applied in the development of anaerobic power and capacity in sport disciplines characterized by high intensity type competitive efforts.

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