RELATIONSHIPS BETWEEN INDICES OF SINGLE, MAXIMAL EXERCISES IN HANDBALL AND JUDO ATHLETES

by

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The aim of the study was to compare handball and judo athletes (n = 36 and 19, respectively) with respect to anaerobic indices supplied by various maximal exercise tests, physical education students (n = 44) serving as reference group. All individuals were subjected to three exercises: conventional Wingate test (WT), a single, supramaximal cycle ergometer exercise consisting of 16 pedal revolutions (16 rev), and a shuttle run (2×25 m).

Maximal power output in WT ranged from 10.89±0.77 W/kg in students to 11.36±0.68 W/kg in judoists ($p<0.05$). The latter had also lowest power output decrement in WT (3.59±0.62 W/kg) compared with other groups ($p<0.05$). Handball players had lowest running time (8.35±0.35 s) compared with other groups ($p<0.05$). Running time in that group was also highest correlated with maximal power output ($r = -0.828$; $p<0.001$), which makes it possible to use the shuttle run in place of WT in handball players.

Key words: Wingate test indices, Correlations, Running test

Introduction

Many team game athletes exhibit an unsatisfactory anaerobic potential which is indispensable for those sports, since, for example, about 24% of the total running distance in football is running at maximum velocity (Cieśliński and Ciepiela 1999). One of the laboratory tests for determining anaerobic capacity is the widely used Wingate test designed by Bar-Or (1987). This test has been applied not only to monitor the training process of competitive

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athletes, but also to assess the anaerobic potential of untrained children, youths and adults (Cieśliński and Ciepiela 1999).

In handball, both alactic and lactic processes of the anaerobic metabolism play a great role, since short, highly intense exertions, like jump-ups, jump-offs, jump-ons, lasting a few seconds, or counterattacks lasting over 10 s, are typical for that sport. Thus, the results of the Wingate test may adequately reflect the anaerobic potential (Jaskólski et al. 1989).

The aim of the study was to compare handball and judo athletes with respect to anaerobic indices supplied by various maximal exercise tests, physical education students serving as reference group.

Material and Methods

A total of 99 male subjects participated in the study. This included handball players, members of National junior representation (n = 36), judoists (n = 19), holders of master class I and II, and physical education students (n = 44), not engaged in competitive sports. The subjects were 18 – 22 years old, their body mass ranging from 58 to 130 kg (judoists), from 73 to 111 kg (handball players), and from 63 to 105 kg (students).

The following maximal exercise tests were applied:

1. Conventional, 30 s Wingate test (WT); mean, maximum and end power outputs (W/kg), time to attain and time to maintain maximum power were recorded (Norkowski et al. 1999);
2. A single, supramaximal cycle ergometer exercise consisting of 16 pedal revolutions (16 rev); peak and maximum power outputs (W/kg), time to attain and time to maintain maximum power were recorded (Norkowski et al. 1999);
3. Shuttle run 2 × 25 m (SRT); running time was comparable to that of performing the 16 rev. test (Norkowski et al. 1999).

Conventional statistical measures were computed (means standard deviations, correlation coefficients, t test for dependent data). For constructing multivariate profiles, the data were standardised against the respective means and standard deviations for students. One-way ANOVA with Newman-Keuls's post-hoc test was used to assess the between-group differences. Correlation

coefficients were compared after z-transformation. The level of $p \leq 0.05$ was considered significant.

Results

Mean values (±SD) of variables studied in three groups of subjects are presented in Table 1. Highest values of maximal power output were noted in judoists and handball players, but only the former differed significantly from

Table 1. Mean values (±SD) of variables recorded in judoists (n = 19), handball players (n = 36) and physical education students (n = 44)

Variable	Judoists	Handball players	Phys. ed. students
30 s Wingate test			
Mean power output (M_s/kg)	8.99 ± 0.54	8.83 ± 0.90	8.67 ± 0.50*
Maximal power output (M_m/kg)	11.36 ± 0.68	11.23 ± 0.84	10.89 ± 0.77*
Time to attain maximal power ($t_{att}M_m$; s)	4.69 ± 1.11	4.61 ± 0.73	5.23 ± 1.08*
Time to maintain maximal power ($t_{mt}M_m$; s)	2.17 ± 0.93	2.39 ± 0.79	2.53 ± 0.90
End power output (M_e/kg)	7.77 ± 0.53*	6.79 ± 0.56	6.72 ± 0.62
Max - end power output difference ($M_m - M_e$)	3.59 ± 0.62*	4.44 ± 0.61	4.17 ± 0.83
16 Revolutions test			
Maximal power output ($16M_m$/kg)	10.95 ± 0.64	11.01 ± 0.86	11.08 ± 0.73
Time to attain maximal power ($16t_{att}M_m$; s)	5.02 ± 1.04	4.89 ± 0.82	5.10 ± 0.95
Time to maintain maximal power ($16t_{mt}M_m$; s)	2.30 ± 0.79	1.85 ± 0.80*	2.25 ± 0.72
Running test, 2 × 25 m			
Running time (t_{pp}50 m; s)	8.65 ± 0.38	8.35 ± 0.35*	8.55 ± 0.29

* Significantly ($p<0.05$) different from the respective values in both other groups

students in that respect. Athletes from these two groups attained maximal power output in shortest time. Judoists differed significantly ($p<0.05$) from both other groups in having highest power output at the end of the Wingate test and in the

total power decrement (difference between maximal and end outputs). On the other hand, handball players differed significantly ($p<0.05$) from both other groups in maintaining maximal power output in the 16-rev test and in having attained shortest time to run the 2×25 m distance. All these relations are made clear in the multivariate profiles (Fig. 1) obtained by standardising mean values for the groups studied against means and standard deviations recorded for physical education students.

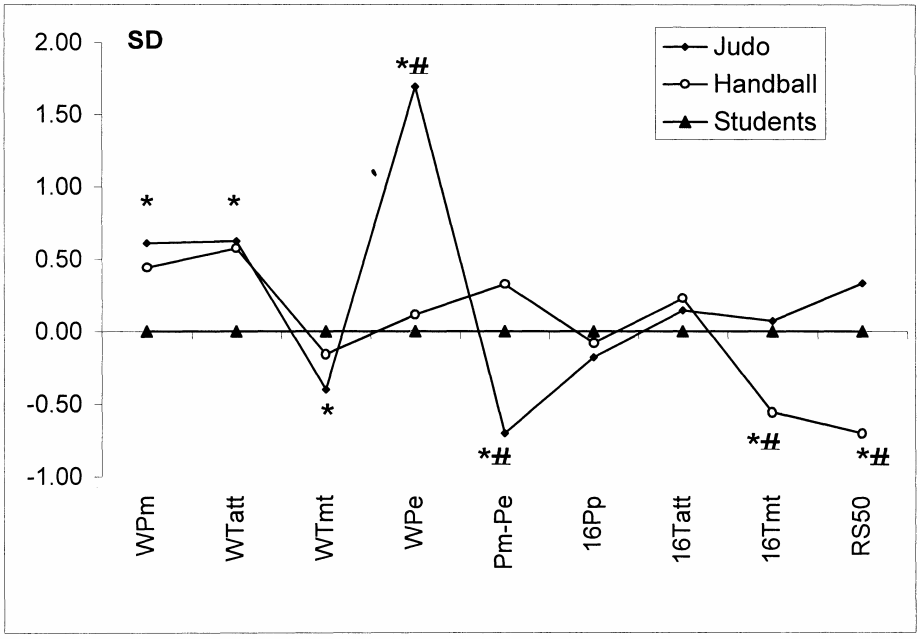

Fig. 1. Multivariate profiles for judoists (n = 19) and handball players (n = 36) obtained by standardising against respective means and standard deviations recorded for physical education students (n = 44)
WPm – Maximal power output/kg in the Wingate test; WTatt – Time to attain maximal power output in the Wingate test; WTmt – Time to maintain maximal power output in the Wingate test;
WPe – End power output/kg in the Wingate test; Pm-Pe – Total decrement in power output/kg; 16Pp – Peak power output/kg in the 16 rev test; 16Tatt - Time to attain maximal power output in the 16 rev test; 16Tmt - Time to maintain maximal power output in the 16 rev test; RS50 – Running time in the 2×25 m test.
* Significantly ($p<0.05$) different from the respective value for students; # Significantly ($p<0.05$) different from the respective value for other groups

Maximal power output was higher in WT than in the 16-rev test in judoists (by 3.6%; $p<0.001$) and in handball players (by 2.0%; $p<0.01$). Correspondingly, time to attain maximal power was higher in judoists (by 0.4%; $p<0.05$), and time to maintain maximal power – in handball players (by 22.6%; $p<0.01$), all by t test for dependent data.

Selected correlation coefficients between studied variables are shown in Table 2. The times to attain or to maintain maximal power output were significantly correlated with power output indices only in judoists. On the other hand, running time (2×50 m) was highly significantly correlated maximal power output in handball players ($r = –0.828$; $p<0.001$) and in judoists ($r = –0.685$; $p<0.01$).

Table 2. Correlation coefficients between selected variables

Correlated variables	Judoists n = 19	Handball players n = 36	Students n = 44
Time to attain × time to maintain max. power in WT	**0.527**	0.313	0.285
Time to attain max. power and end power in WT	**0.576***,[a]	-0.336	0.046
Time to attain max. power × mean power in WT	**0.519***,[a]	-0.203	-0.074
Time to maintain max. power × mean power in WT	**0.543** [a]	0.050	0.190
Time to attain max. power in the WT and 16 Rev tests	**0.763** [a]	0.030	**0.475** [a]
Running time × max. power output in WT	**-0.685**	**-0.828***	-0.205
Running time × time to attain max. power in 16 Rev test	-0.055	**0.441**	-0.112 [a]

WT – Wingate test; 16 Rev – 16 revolutions test
Significant ($p<0.05$) correlations are marked in **bold**; * Significantly ($p<0.05$) different from the respective value for students; [a] Significantly ($p<0.05$) different from the respective value for handball players

Discussion

On the whole, judoists attained best results in the Wingate test. This pertains, in the first line, to maximal and end power outputs. However, judoists tended to maintain maximal power output not as long as other groups, which was in accordance with the negative correlation between maximal power output and the time to attain P_{max} (Jaskólski et al. 1989). In all probability, such results

are the effect of specific judo training, aimed at improving the anaerobic potential. It should be noted that the mean and maximal power outputs were comparable to those reported by Sterkowicz et al. (1999) for 15 senior judoists from a club in Cracow. However, our judoists were inferior to the latter ones regarding the times to attain and to maintain P_{max}.

In contrast, handball training aims, predominantly, at improving the aerobic potential, and anaerobic speed-strength loads are insufficient and, probably because of that, handball players proved somewhat inferior to judoists. Their results were, however, comparable to those reported by Ryguła et al. (1997).

The short, 16 rev test did not differentiate the three groups studied, except handball players, who maintained maximal power output for a significantly shorter time than other groups. On the other hand, handball players proved significantly best in running the 2×25 m distance, which is one of the specific elements of training in that sport. This, in turn, has resulted in a quite high correlation between running time and maximal power output in the Wingate test ($r = –0.828$) which makes it possible to replace the Wingate test by the much simpler running test.

Judoists were characterised by smallest difference between the maximal and end power outputs in the Wingate test, as well as by moderate, positive correlations between mean power output and either time to attain or time to maintain maximal power output ($r = 0.519$ and 0.543, respectively). No such correlations were observed in both other groups (see Table 2). Moreover, that characteristic power decrement may serve as an index of maintaining anaerobic power and is influenced by both anaerobic and aerobic capacities (Jaskólski et al. 1989).

A high anaerobic power output depends on phosphagen content in working muscles and on neuro-muscular co-ordination. Furthermore, maintaining that high output level requires not only generation of energy from anaerobic lactate metabolism, but also a fast processing of metabolic products (Jaskólski et al. 1989).

In summary, the three groups of subjects studied, markedly differed not only in mean indices recorded in the Wingate or 16 rev tests, but also in the relationships between various indices.

Conclusions

1. Specificities of handball and judo athletes were reflected by much faster running of the former and lower decrement of power output in the latter.
2. The very high correlation between running time and maximal power output in the Wingate test observed in handball players is a prerequisite for replacing the non-specific Wingate test by running 2×50 m, a more specific test for that sport.

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