

## ANAEROBIC CAPACITY OF ATHLETES REPRESENTING SELECTED TEAM SPORTS

by

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Anaerobic capacity was determined in competitive team sport athletes subjected to the standard 30 s Wingate test. The athletes represented volleyball (n = 48), football (n = 74), rugby (n = 64), handball (n = 76) and basketball (n = 54). Maximal power output was highest in handball and volleyball players ( $11.26 \pm 0.79$  and  $11.24 \pm 0.64$  W/kg, respectively), and lowest in football players ( $10.69 \pm 0.67$  W/kg). However, mean power output was lowest in volleyball and football players ( $7.95 \pm 0.46$  and  $8.26 \pm 0.56$  W/kg, respectively) significantly ( $p < 0.05$ ) lower than in other groups.

**Key words:** Team; Anaerobic potential; Wingate test

### *Introduction*

Team sports place high metabolic and motor demands on the competitive athletes. Highly variable loads in the course of a game require the use of all energy sources [1,3,5]. In all team sports there are frequent spurts of highly intense exertions at the expense of both phosphagen and glycolytic processes. Thus, anaerobic capacity is of paramount importance as its level determines the efficacy of a number of game situations.

The aim of this study was to characterise various team sports with respect to power output and selected indices of anaerobic performance recorded in competitive athletes.

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## Material and Methods

A total number of 316 athletes representing various team sports, whose basic characteristics (sport level, age, athletic experience, body height and mass) are presented in Table 1, participated in the study. The athletes were 1<sup>st</sup> or 2<sup>nd</sup> league players, and about 10% of handball and rugby players were actual or ex-members of respective National teams. All Athletes were subjected to the Wingate test during their respective competition seasons, i.e. September 1999 through December 2000.

Table 1. Sport level and mean values ( $\pm$ SD) of athletic experience, age body mass and height of team sport athletes studied

Group	n	Sport level	Athletic experience (years)	Age (years)	Body mass (kg)	Body height (cm)
Volleyball	48	League I	8.08 $\pm$ 3.10	23.69 $\pm$ 3.34	85.06 $\pm$ 5.38	195.39 $\pm$ 5.24
Football	74	League I	8.91 $\pm$ 2.09	23.03 $\pm$ 2.23	75.77 $\pm$ 6.00	178.31 $\pm$ 6.25
Rugby	64	League II	7.43 $\pm$ 2.57	24.32 $\pm$ 2.75	93.3 $\pm$ 11.48	184.75 $\pm$ 6.41
Handball	76	League I	7.96 $\pm$ 2.89	23.45 $\pm$ 3.06	88.26 $\pm$ 6.20	190.17 $\pm$ 4.91
Basketball	54	League I	9.44 $\pm$ 3.31	24.24 $\pm$ 3.31	91.03 $\pm$ 10.54	196.94 $\pm$ 7.46
<b>Total</b>	<b>316</b>		<b>8.35 <math>\pm</math> 3.31</b>	<b>23.70 <math>\pm</math> 2.94</b>	<b>86.29 <math>\pm</math> 10.35</b>	<b>188.24 <math>\pm</math> 9.15</b>

The anaerobic capacity was determined by applying the conventional 30 s Wingate test [4] and using a cycle ergometer (Monark 824E, Sweden) connected on-line to a computer with "Multi Cykloergometr" software [8]. The following variables were recorded:

- Maximal power output ( $P_{\max}$ ; W/kg), defined as the mean of all values not lower than 97.7% of peak power output;
- Mean power output ( $P_{\text{mean}}$ ; W/kg), defined as the ratio of total work output and exercise duration;
- Time to attain maximal power ( $T_{\text{att}}$ ; s);
- Time to maintain maximal power ( $T_{\text{mt}}$ ; s);
- Power output rate (POR; W/kg/s), defined as the ratio of maximal power output to  $T_{\text{att}}$ .

The loads applied were equal to 0.075 kp/kg body mass (0.736 N/kg).

The data was subjected to conventional statistical analysis which included one-way ANOVA and post-hoc Tukey's test for unequal group sizes [9].

### Results

Mean values ( $\pm$ SD) of variables recorded for various team games are presented in Table 2, and the respective standardised means in Table 3.

Table 2. Mean values ( $\pm$ SD) of anaerobic capacity indices in team sport athletes

Group		Maximal power output [W/kg]	Mean power output [W/kg]	Time to attain max. power [s]	Time to maintain max. power [s]	Power output rate [W/kg/s]
1	Volleyball	11.24 $\pm$ 0.64 *2	7.95 $\pm$ 0.46 *3.4.5	5.05 $\pm$ 0.61 *4	2.29 $\pm$ 0.83 *5	2.25 $\pm$ 0.31 *2.4
2	Football	10.69 $\pm$ 0.67 *1.4	8.26 $\pm$ 0.56 *3.4.5	5.46 $\pm$ 0.96 *4	2.60 $\pm$ 0.91	2.01 $\pm$ 0.36 *1.4
3	Rugby	10.94 $\pm$ 0.59	8.78 $\pm$ 0.49 *1.2	5.40 $\pm$ 0.80 *4	2.73 $\pm$ 0.97	2.07 $\pm$ 0.34 *1.4
4	Handball	11.26 $\pm$ 0.79 *2	8.93 $\pm$ 0.66 *1.2	4.45 $\pm$ 0.89 *1.2.3.5	2.58 $\pm$ 0.77	2.63 $\pm$ 0.59 *1.2.3.5
5	Basketball	11.04 $\pm$ 0.81	8.69 $\pm$ 0.62 *1.2	5.06 $\pm$ 0.72 *4	2.78 $\pm$ 0.82 *1	2.22 $\pm$ 0.36 *4
Total		11.02 $\pm$ 0.74	8.55 $\pm$ 0.67	5.04 $\pm$ 0.91	2.60 $\pm$ 0.87	2.26 $\pm$ 0.48

\* Significant ( $p < 0,05$ ) differences between groups marked by numbers

*Maximal power output:* Highest values were noted in handball and volleyball players (11.26  $\pm$  0.79 and 11.24  $\pm$  0.64 W/kg, respectively), and lowest in football players (10.69  $\pm$  0.67 W/kg). Only that latter mean differed significantly ( $p < 0,05$ ) from the abovementioned highest ones.

*Mean power output:* Highest value was noted in handball players (8.93  $\pm$  0.66 W/kg) and lowest in volleyball players (7.95  $\pm$  0.46W/kg). The values for rugby, handball and basketball players were close to each other and differed significantly ( $p < 0,05$ ) from those for volleyball and football players (cf. Table 2).

*Time to attain maximal power output:* Handball players achieved shortest values, i.e. were significantly ( $p < 0,05$ ) superior to all other groups.

Table 3. Mean values of anaerobic capacity indices standardised against overall means and standard deviations

Group		Maximal power output [W/kg]	Mean power output [W/kg]	Time to attain max. power [s] *	Time to maintain max. power [s]	Power output rate [W/kg/s]
1	Volleyball	0.270	-0.895	-0.018	-0.356	0.208
2	Football	-0.472	-0.432	-0.461	0.0	-0.520
3	Rugby	-0.135	0.343	-0.395	0.149	-0.395
4	Handball	0.297	0.567	0.648	-0.022	0.770
5	Basketball	0.0	0.208	-0.021	0.206	-0.083

\* The signs were changed in order to keep the same orientation of all variables

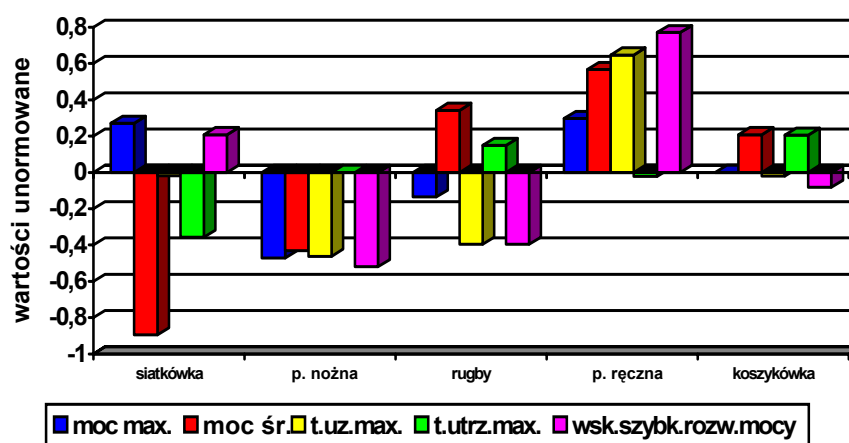


Fig. 1. Mean values of anaerobic capacity indices, standardised against overall means and standard deviations, recorded in team sport athletes:

P max – Maximal power output; P mean – Mean power output; t att. Pmax – Time to attain P max; t mt Pmax - Time to maintain P max; P outp. rate – Power output rate

*Time to maintain maximal power output:* Only the extreme values ( $2.29 \pm 0.83$  and  $2.78 \pm 0.82$  s), recorded for volleyball and basketball players, respectively, differed significantly ( $p < 0.05$ ) from each other.

*Power output rate:* Fastest development of power output rate was noted for handball players ( $2.63 \pm 0.59$  W/kg/s), who differed significantly ( $p < 0.05$ ) in that respect from all other groups. Lowest values were noted for football and rugby players ( $2.01 \pm 0.36$  and  $2.07 \pm 0.34$  W/kg/s, respectively).

## Discussion

The presented results show that various team sports are differentiated with respect to the capacity of athletes to perform short, maximal, anaerobic exercises. When confronting these results with those reported by other authors, a higher mean power output was recorded for handball players compared with data presented by Czerwiński [2]. For football players, the results were similar to those of Jaskólski [5], but lower than those of Zieliński [10]. For basketball players, the results were higher than those reported by Juraś [6] for whites ( $10.13 \pm 1.49$  W/kg) but lower than he found for blacks ( $11.51 \pm 1.65$  W/kg). The results for rugby players are comparable with those reported by Reilly [7], while no reports were found regarding volleyball players.

Since the athletes studied represented high sport levels (1<sup>st</sup> and 2<sup>nd</sup> leagues) and had a fairly long athletic experience ( $8.35 \pm 3.31$  years), the following factors might have contributed to the observed differences between groups:

- Individual genetic potential which might have played a role in selection for specific games,
- Specificity of competition loads,
- Specificity and intensity of training loads.

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