ANAEROBIC POWER OF HANDBALL PLAYERS REPRESENTING VARIOUS SPORT LEVELS

by

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The aim of the study was to determine the anaerobic power of 7 teams of handball players representing various sport levels. The anaerobic potential was measured by applying the conventional 30 s Wingate test. It was demonstrated that athletes from highly ranked teams exhibited a significantly ($p<0.05$) higher power output than these representing a lower sport level.

Key words: Handball; Anaerobic potential; Wingate test

Introduction

The assessment of physical capacity of athletes is an important issue in modern sports, as it may be used in selection procedures, when screening candidates, or to monitor the efficacy of training loads applied [Czerwiński 1982; Jaskólski et al. 1987; Zeman 1988]

Handball requires a complex engagement of motor and metabolic potentials [Belotti 1978] since for the highly variable character of loads, utilization of all energy sources is indispensable [Bolek and Liska 1981; Czerwiński 1990; Delamarche et al. 1987; Ignatiewa 1981; Mikkelsen and Olsen 1976].Energetic demands of short, very intense bouts of exercise, frequently occurring in the course of the game, are covered by both phosphagen sources and by glycolysis. Those moments of high exercise intensity are interspersed with periods of lower intensities, during which aerobic processes predominate. The data concerning the anaerobic power of world's elite handball players is scarce.

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The importance of anaerobic capacity for handball justifies studies on that issue. Thus, the aim of this study was to determine selected indices of anaerobic power and capacity in 7 teams of handball players representing various competitive levels and to compare those teams in that respect.

Material and Methods

A total number of 197 athletes, representing senior, junior and cadet athletes, 1st and 2nd leagues, and the national team of United Arab Emirates (UAR), were studied. Characteristics of those teams are presented in Table 1. All Polish teams were subjected to laboratory tests during the 2nd round of the 1998/99 season (February, 1999), and 1st round of the 1999/2000 (November, 2000) tournaments.

Table 1. Basic characteristics (means ±SD) of handball teams studied

Team	n	Athletic experience (years)	Age (years)	Body mass (kg)	Body height (cm)
Senior elite	30	7.4 ± 2.3	23.5 ± 2.1	93.5 ± 7.0	192.6 ± 6.7
Junior elite	30	3.7 ± 1.1	18.6 ± 0.9	86.0 ± 7.1	189.6 ± 6.3
Cadet elite	30	2.6 ± 0.5	17.3 ± 0.6	82.0 ± 6.8	190.1 ± 4.9
League 1A	45	9.1 ± 2.3	24.1 ± 3.5	86.9 ± 6.5	189.3 ± 4.5
League 1B	32	8.9 ± 1.8	22.3 ± 1.8	81.8 ± 8.8	186.6 ± 5.7
League 2	30	7.3 ± 2.2	22.2 ± 2.0	84.4 ± 8.2	187.4 ± 5.8
National team of UAR	23	8.7 ± 3.0	24.6 ± 3.0	78.9 ± 11.5	180.8 ± 6.1

Players from UAR were examined in Poland (August, 2000) in the last phase of training prior to their participation in Asiatic Championships, which started 10 days later in Saudi Arabia.

Anaerobic capacity was determined by applying the 30 s Wingate test on a Monark 824E cycle ergometer (Sweden) and on-line ”MultiCykloergometr” software. The following variables were recorded:

- Maximal power output (P_{max}; W/kg), defined as the mean of values exceeding 97.7% of peak power output;
- Mean power output (W/kg);

- Times to attain and to maintain P_{max} (s);
- Power output rate, defined as the ratio of maximal power output to the time to attain P_{max} (W/kg/s).

The tests were conducted according to the original protocol [Inbar et al. 1996], the loads being equal to 0,075 kp per kg body mass. One-way ANOVA was applied to assess the between-group differences, followed by Tukey's test for uneven numbers of observations, the level of $p \leq 0.05$ being accepted as significant.

Results

Mean values (±SD) of variables studied are presented in Table 2, and the results of analysis – in Table 3 and in Fig. 1.

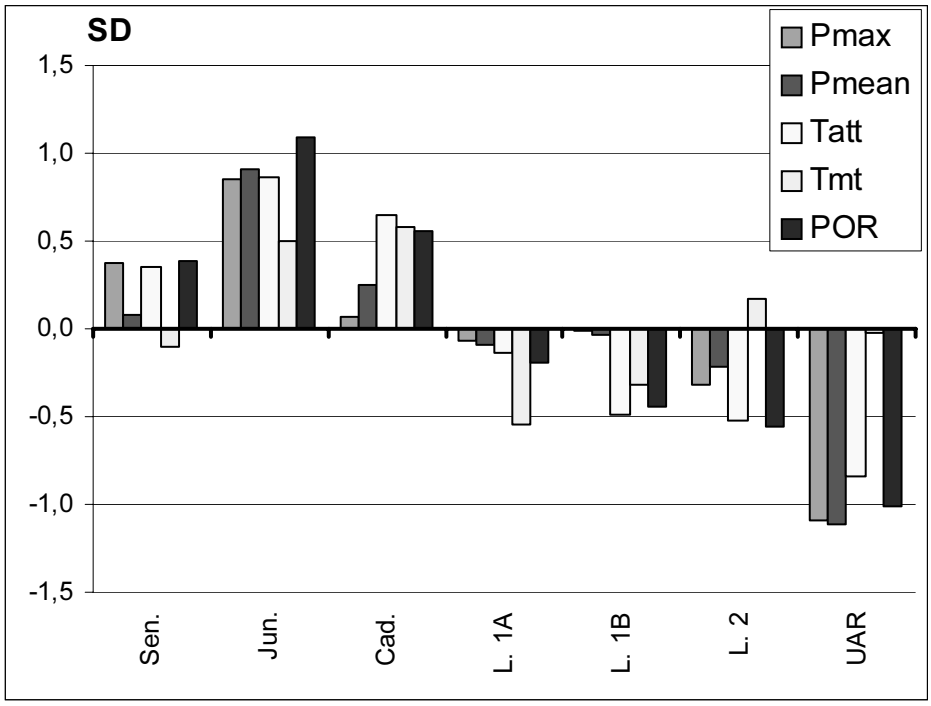

Fig. 1. Mean values of standardised variables recorded in 7 handball teams
Legend: Teams: Sen. – Senior elite (n = 30); Jun. – Junior elite (n = 30); Cad. – Cadet elite (n = 30); L.1A – League 1A (n = 45); L.1B – League 1B (n = 32); L.2 – League 2 (n = 30); UAR – National team of United Arab Emirates (n = 23)
Variables: Pmax – Maximal power output; Pmean – Mean power output; Tatt – Time to attain maximal power; Tmt – Time to maintain maximal power; POR – Power output rate

Table 2. Mean (±SD) anaerobic potential indices determined from the Wingate test, recorded in handball teams

Team	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)
Senior elite (1)	11.45 ± 0.50 * 6.7	8.80 ± 0.41 *2.7	4.37 ± 0.74 * 5.6.7	2.58 ± 0.95	2.68 ± 0.43 * 2.5.6.7
Junior elite (2)	11.86 ± 0.85 * 3.4.5.6.7	9.33 ± 0.63 * 1.3.4.5.6.7	3.90 ± 0.54 * 4.5.6.7	3.20 ± 0.84 * 4.5	3.07 ± 0.60 * 1.4.5.6.7
Cadet elite (3)	11.18 ± 0.88 * 2.7	8.91 ± 0.58 *2.7	4.10 ± 0.55 * 4.5.6.7	3.28 ± 1.08 * 4.5	2.77 ± 0.46 * 4.5.6.7
League 1A (4)	11.06 ± 0.76 * 2.7	8.69 ± 0.48 * 2.7	4.81 ± 0.79 * 2.3	2.13 ± 0.93 * 2.3.6	2.35 ± 0.39 * 2.3.7
League 1B (5)	11.11 ± 0.74 * 2.7	8.73 ± 0.50 * 2.7	5.14 ± 0.82 * 1.2.3	2.37 ± 0.81 *2.3	2.21 ± 0.39 * 1.2.3
League 2 (6)	10.84 ± 0.81 * 1.2.7	8.61 ± 0.57 * 2.7	5.17 ± 0.90 * 1.2.3	2.87 ± 0.96 * 4	2.15 ± 0.42 * 1.2.3
UAR players (7)	10.17 ± 0.72 * 1.2.3.4.5.6	8.04 ± 0.77 * 1.2.3.4.5.6	5.46 ± 0.87 * 1.2.3	2.67 ± 1.04	1.89 ± 0.26 * 1.2.3.4.
Total	**11.12 ± 0.87**	**8.75 ± 0.64**	**4.69 ± 0.91**	**2.69 ± 1.02**	**2.46 ± 0.56**

* Significantly ($p < 0.05$) different from the respective value for other teams (team numbers given in bold)

Table 3. Mean (±SD) anaerobic potential indices determined from the Wingate test, recorded in handball teams (standardised values, vs. respective total means given in the last line)

Team	Maximal power output	Mean power output	Time to attain max. power*	Time to maintain max. power	Power output rate
Senior elite (1)	0.378 ± 057	0.078 ± 0.64	0.351 ± 0.81	-0.107 ± 0.93	0.392 ± 0.77
Junior elite (2)	0.850 ± 0.98	0.906 ± 0.98	0.868 ± 0.59	0.50 ± 0.82	1.089 ± 1.07
Cadet elite (3)	0.068 ± 1.01	0.250 ± 0.91	0.648 ± 1.19	0.578 ± 1.06	0.553 ± 0.82
League 1A (4)	-0.068 ± 0.87	-0.093 ± 0.75	-0.131 ± 1.02	-0.549 ± 0.91	-0.196 ± 0.70
League 1B (5)	-0.011 ± 0.85	-0.031 ± 0.78	-0.494 ± 0.89	-0.313 ± 0.79	-0.446 ± 0.70
League 2 (6)	-0.321 ± 0.93	-0.218 ± 0.89	-0.527 ± 1.05	0.176 ± 0.94	-0.553 ± 0.75
UAR players (7)	-1.091 ± 0.83	-1.109 ± 0.89	-0.846 ± 1.14	-0.019 ± 1.02	-1.017 ± 0.46
Total	**11.12 ± 0.87**	**8.75 ± 0.64**	**4.69 ± 0.91**	**2.69 ± 1.02**	**2.46 ± 0.56**

* The signs of values were reversed in order to keep the same trend for all variables

Maximal power output (P_{max}): Highest mean values were observed in the junior and senior athletes (11.86 ± 0.85 and 11.45 ± 0.50 W/kg, respectively), and lowest in UAR players and in 2nd league athletes (10.17 ± 0.72 and 10.84 ± 0.81 W/kg, respectively). The value for UAR players was significantly ($p<0.05$) lower than for all other teams. On the other hand, junior elite were significantly superior to all other Polish teams. Unexpectedly, senior elites were not significantly different from 1st and 2nd league teams.

Mean power output (P_m): As in the case of P_{max}, highest mean value was registered in the junior elite players, and lowest in UAR players (9.33 ± 0.63 and 8.04 ± 0.77 W/kg, respectively). The former was significantly ($p<0.05$) higher, and the latter – lower than in other teams. The other teams did not differ significantly from each other in that respect.

Time to attain P_{max}: Best (shortest) times were registered in all three elite teams, which differed significantly ($p<0.05$) from those in other teams.

Time to maintain P_{max}: Highest values were registered in junior and cadet elite teams (3.28 ± 1.08 and 3.20 ± 0.84 s, respectively), and lowest in 1stA league players (2.13 ± 0.93 s). Several significant differences were found, but they were not as clear as in case of previous variables (cf. Table 2).

Power output rate:

Highest mean output rate was registered in the junior elite team, and lowest ($p<0.05$) in the UAR team (3.07 ± 060 and 1.89 ± 0.26 W/kg/s, respectively). That rate decreased with decreasing team rating. The values for senior and junior elite teams were significantly ($p<0.05$) higher than in other teams.

Table 3 and Fig. 1 presents mean values of all variables studied for individual teams, standardized against the respective overall means and standard deviations for all teams combined. It can be seen that all elite teams are superior to all other teams with respect to power output and anaerobic capacity indices. Moreover, those indices seem to differentiate other teams according to the league rank.

Discussion

The presented results indicate that handball teams of various ranks markedly differ regarding their capacity to perform short, maximal anaerobic

exercise bouts. This statement is very important taking into consideration the fact that the tests were carried out in the competitive period, when the athletes should posses a high level of anaerobic potential.

Since a relatively large cohort was studied (a total of 220 subjects), and a well pronounced relationship between the magnitude of anaerobic capacity and sport level was demonstrated, it might be concluded that developing anaerobic fitness meets the energetic demands of handball.

When considering Polish handball teams, two points are to be emphasized:

- Junior and cadet elite teams exhibited significantly better characteristics of power output and anaerobic capacity,
- League (1st and 2nd) teams were not differentiated significantly regarding those variables.

Those facts are indicative of an appropriate selection of youth to handball teams but, at the same time, of inappropriate training procedures regarding anaerobic power. This pertains particularly to senior teams, which are poorly differentiated despite much longer athletic experience than junior teams.

Power and anaerobic capacity indices observed in this study are by 5 – 15% better than those reported by other authors [Jaskólski et al. 1987; Jastrzębski 1989]. This might be due to the fact that the other studies were rather fragmentary and involved small numbers of athletes (from 10 to 20) representing low or moderate sport levels (2^{nd} or 3^{rd} leagues).

Resuming, it should be emphasized that the presented material and resulting conclusions represents only a fraction of the area associated with handball. Obviously, such issues as the aerobic potential and technical and tactical abilities must not be neglected when analyzing factors, which determine the quality of a handball team. The number of subjects in this study, their age and sport level characteristics, thus make the presented results representative and justify the conclusions.

Conclusions

1. Establishing norms for various indices of anaerobic power and capacity of handball players seems to be indispensable;

2. A predefined level of anaerobic potential should be one of the criterions when screening candidates for competitive handball;
3. A lack of significant differences in power and anaerobic capacity indices, between teams representing various levels of competitive advancement, should prompt a detailed analysis of the efficacy of anaerobic training.

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