Effect of physical capacity on the course of fight and level of sports performance in cadet judokas

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B Data Collection
C Statistical Analysis
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Abstract

Background and Study Aim: The goal of the present study was to provide answer to the following question: Is physical capacity in judo contestants at cadet age related to the adopted fighting strategy and the level of sports achievement?

Material/Methods: The study covered eight judo contestants from four clubs throughout Poland. First stage involved registration of their competitive activity level. Based on this record, contestants' fighting activity, effectiveness and level of performance were assessed. Another stage of the investigations focused on evaluation of their aerobic and anaerobic capacity measured by means of testing methods used within *Instytut Fizjologii Człowieka AWF* (the Institute for Human Physiology in the University School of Physical Education in Cracow). The strength of the relationship was concluded based on the value of Spearman's rank correlation coefficient (Rs).

Results: Statistical analysis revealed that the level of anaerobic capacity at the cadet age shows a relationship with the method of fighting. Particularly important indexes here are: total work (TW) and peak power output (expressed in relative values, RPP). TW values were positively correlated with activity and effectiveness of actions during first part of fight whereas RPP was connected with activity in first part of match and high effectiveness during the whole match. No statistically significant correlations were observed between the level of achievement and the value of physical capacity.

Conclusions: 1. Level of anaerobic capacity plays a specific role in the course of fight among judo cadets. 2. Individual functional abilities in judo contestants should be taken into consideration during the process of technical and tactical coaching.

Key words: cadets • judo • course of fight • $\dot{V}O_2max$ • peak power output

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Background

Course of fight – material and time-related characteristics of fight defined by the indexes calculated according to the relevant equations.

Individualization of training, whose goal is to maximally develop natural abilities in individual contestants, is of particular importance in contemporary professional sport. The specific profile of these abilities impacts on selection of the candidates for the given sport or sport competition. In judokas, it determines opportunities to form technical and tactical level. Therefore, scope of variability of indexes for individual motor abilities in elite contestants (national team) should become a dominant component of the model of a champion, whereas their individual values should determine the method of fight.

The statement above can be confirmed by the results of the investigations carried out within the group of judo seniors [1] and juniors [2], which demonstrated significant correlations between components of physical

capacity and indexes of technical and tactical training and the level of sports achievement of the contestants.

At the age of young junior/cadet (15–16 years), contestants participate in international championships for the first time. Based on the review of scarce references about the assessment of aerobic capacity in judo contestants at cadet age, one can assume that the level of maximal oxygen uptake ($\dot{V}O_2max$) in fourteen-year-old judo contestants amounted to 58.7 $mL \cdot kg^{-1} \cdot min^{-1}$ [3]. Maximal anaerobic power ranges from 10.22 at the age of 15 to 11.75 $W \cdot kg^{-1}$ in sixteen-year old judokas [4]. However, there are no results of investigations concerning relationships between physical capacity and tactical and technical training and the level of sports achievement in contestants in this age group. Therefore, it is legitimate to define its effect on effective fight performance.

A fundamental goal of the study was to provide the answer to the following question:

1. Does a correlation exist between the indexes of aerobic and anaerobic capacity and activity and effectiveness of actions during **cadets'** matches?
2. Does a correlation exist between the indexes of aerobic and anaerobic capacity and the level of sports achievement during competition?

Cadets – contestants whose calendar age is 15–16 years.

Material and Methods

The investigations covered 8 judokas from weight categories under 60 kg (n=1), 73 kg (n=5) and under 81 kg (n=2), who were the members of three clubs: *Wisła Kraków* (n=1), *Jordan Kraków* (n=2), *Czarni Bytom* (n=5). Each of the studied contestants had taken at least fifth place in national competitions for young juniors. During selection of persons for the studied group, calendar age (from 14 to 16 years) was taken into consideration. Cadets' competition experience was similar (5 to 7 years).

During eliminations to the Junior Poland Cup (Bytom, 5 April and 12 April 2008) and Junior Poland Cup (Głogów, 26–27 April 2008), tournament matches fought by the contestants were recorded (n=66). During analysis of the matches carried out in the Department of Theory and Methodology of Combat Sports in the University School of Physical Education in Krakow, technical actions by individual contestants were recorded (analysis of selection matches encompassed only those with contestants who were qualified for central competition). The considered elements included actions which were assigned points and this part of a match when a technical action was made. The analysis also included ineffective actions for which judges did not give points. This concerned situations when a contestant considerably threw his opponent out of balance (so-called flying phase was observed). These actions were assigned 0 note. In total, 121 technical actions were recorded. Competition was divided into two parts: phase I: two first minutes of the match, phase II: third and fourth minute. If extra time was used, it was added to the second part of the match.

On the basis of the collected data, indexes which determine the activity and effectiveness of actions among the study participants were calculated. Activity index (WA) was calculated from the formula: WA=ΣA/NW, where: ΣA is a total of the attacks, NW – number of matches the contestant fought. Activity index calculated for phase 1 was WA1, with WA2 for phase 2. Another index, RWA (difference in the activity index), was also implemented to reflect variability of activity during competition. It was calculated as: RWA=WA1-WA2. Efficiency index (WS) is an arithmetic mean of the notes for attacks (WS1 as calculated for phase 1 of the match and WS2 for the second phase). The ddifference in the efficiency index was calculated from the formula: RWS=WS1-WS2.

Level of sports achievement was differentiated according to the following point scale:

for selection matches: 1st: 1st place – 3 points, 2nd place – 2 points, 3rd place – 1 point, 5th place – 0.5 points;

for central competition: 1st place – 7 points, 2nd – 5 points, 3rd – 3.5 points, 5th – 1.5 points, and 7th – 0.5 points.

Another stage in the investigations encompassed measurement of indexes which define aerobic and anaerobic capacity of the body. The tests were performed in an air-conditioned room in the Department of Physiology and Biochemistry in the University School of Physical Education in Krakow on 7th May 2008.

The examinations involved e.g. biometric measurements (BH – body height, BM – body mass) and assessment of body composition (LBM – lean body mass, FM – fat mass, PF – percentage fat content). Body height was measured by means of Martin type anthropometer with accuracy of readings of 1 mm, body mass was measured by Sartorius F 1505 – DZA scales (Germany) with the accuracy of 1 g. Lean body mass was calculated by deducting of fat mass from body mass. Percentage fat content was calculated according to the formula given by Slaughter et al. [5]. This was used for evaluation of fat mass.

Wingate test was employed to evaluate anaerobic capacity [6]. Main exercise was preceded with 5-minute warm-up using bicycle ergometer with individually

Table 1. Statistical characteristics of chronological age, experience and basic parameters of somatic build in the study participants (n=8).

	Average	Minimum	Maximum
Age (years)	15.0	14.0	16.0
Competitive experience (years)	6.1	5.0	7.0
Body height (cm)	177.4	170.0	185.0
Body mass (kg)	71.7	56.5	82.4
Lean body mass (kg)	65.2	52.4	72.8

Table 2. Characteristics of indexes of activity, effectiveness and the level of achievements among the study participants (n=8).

	Average	Minimum	Maximum
WA	1.7	0.6	2.6
WA1	1.2	0.4	2.4
WA2	0.9	0.3	2.0
RWA	0.6	0.2	1.2
WS	4.5	3.3	6.3
WS1	5.3	3.3	8.5
WS2	3.0	0.0	7.0
RWS	2.3	–3.0	8.5
PO	2.9	0.0	9.0

chosen intensity of 50% $\dot{V}O_2$max at pedaling rate of 60 rpm, three 5-second maximal accelerations at 2nd, 4th and 5th minute. Two minutes after the warm-up, the participants performed 30-second maximal physical exercise. The goal for a studied person was that they should achieve, at possibly shortest time, maximal rhythm of pedaling and maintain it as long as possible.

During the test, a computer was employed to evaluate mean power (MP), total work (TW), **peak power output** (PP), fatigue index (FI) [7], time to reach peak power (TO PP) and time to maintain peak power (TU PP).

Before anaerobic exercise and at the third minute after completion of the exercise, blood test samples were taken from earlobe to determine lactic acid (La) level by means of an enzymatic method using mini-photometer plus DR Lange LP – 20 by Dr Lange (Germany).

Maximal minute oxygen uptake ($\dot{V}O_2$max) was measured by means of direct methods [1]. Graded exercise test on bicycle ergometer was preceded by three-minute warm-up at intensity of 110 W and pedaling frequency (RPM) of 60rpm, after which power was incremented with 20W every 2 minutes. The exercise was performed until the studied subject was unable to maintain the rhythm signaled with the metronome (±2RPM). The following parameters were measured during the test: duration of exercise (DE), minute ventilation (V_E), respiratory quotient (RQ), frequency of respiration (FR), tidal volume (TV), minute oxygen uptake ($\dot{V}O_2$) and heart rate (HR). Duration time of the graded exercise test (DE) and $\dot{V}O_2$max were treated as indexes of current and potential capacity-related abilities of the body. Before the test and 3 minutes after completion of the test, blood tests were taken, which was used to determine lactic acid (La). The examinations were carried out in the certified laboratory in the Department of Physiology and Biochemistry at the University School of Physical Education in Cracow. Graded exercise test was made using ER 900 D – 72475 BIT2 bicycle ergometer manufactured by Jaeger (Germany). Wingate test was carried out using Monark 834 E bicycle ergometer (Sweden).

Peak power output – maximal power generated by the body during anaerobic test.

Table 1 presents characteristics of age, experience and fundamental parameters of somatic build among the study participants.

During analysis of the results, STATISTICA package software was utilized. Spearman rank correlation coefficient (Rs) was employed for statistical analysis [8].

Results

As results from the analysis of the data contained in Table 2, the contestants performed 1.7 technical actions

Table 3. Indexes of anaerobic capacity in judo contestants(n=8).

	Average	Minimum	Maximum
TW (J·kg^{-1})	260.5	248.0	276.0
RPP (W·kg^{-1})	11.2	10.4	11.6
FI (%)	45.0	35.6	51.9
TO PP (s)	4.6	3.6	5.4
TU PP (s)	3.3	2.4	4.8
LA 3 min after WAnT (mmoL·l^{-1})	13.1	10.9	15.0
Δ LA 3 min after WAnT (mmoL·l^{-1})	11.3	8.9	13.2

Table 4. Indexes determined during graded exercise test in judo contestants (n=8).

	Average	Minimum	Maximum
VO_2max (mL·kg^{-1}·min^{-1})	43.5	36.6	49.5
HRmax (bpm)	189.1	177.0	197.0
HR_{TDMA} (bpm)	160.3	152.0	167.0
%HRmax (%)	84.8	82.1	86.8
% $\dot{V}O_2$max (%)	71.0	68.2	76.4
Δ LA (mmoL·l^{-1})	8.0	6.4	9.6

per match on average, with the dispersion of this index from 0.6 to 2.6. In first part of match, average attack activity (WA1) amounted to 1.2 actions per match, whereas individual results ranged from 0.4 to 2.4. Difference in activity index (RWA) ranged from 0.2 to 1.2, with mean value of 0.6.

Efficiency index (WS) for the whole match averaged 4.5 points per technical action and ranged from 3.3 to 6.3. For the first two minutes and two last minutes (plus extra time) it amounted to 5.3 and 3.0, respectively. Difference in efficiency index (RWA) ranged from –3.3 to 8.5, with mean value of 2.3.

Index determining the level of achievement (PO) showed values from 0.0 to 3.3, with mean value of 2.9 points.

Total work in Wingate test performed by cadets in relative approach amounted to 260.5 J·kg^{-1}, with its range for individual results from 248.0 J·kg^{-1} to 276.0 J·kg^{-1}. Relative peak power (RPP), being at the level of 11.2 W·kg^{-1}, was characterized by higher dispersion, from 10.4 to 11.6 W·kg^{-1}. Fatigue index (FI) showed values from 35.6 to 51.9%, with the mean value of 45%.

Mean values of time to reach (TO PP) and maintain (TU PP) maximal anaerobic power amounted to 4.6 and 3.3s, respectively, with the minimal and maximal values being respectively: TO PP: from 3.6 to 4.4s, TU PP: 2.4 to 4.8s.

After Wingate test, increase in lactic acid concentration in blood (Δ LA 30 s) was 11.3 mmoL·l^{-1} on average, whereas individual results for this index after anaerobic test ranged from 10.9 to 15.0 mmoL·l^{-1} (Table 3).

Average level of maximal oxygen uptake ($\dot{V}O_2$max) per minute expressed in relative values amounted to 43.5 mL·kg^{-1}·min^{-1}. Individual value of this index ranged from 36.6 to 49.5 mL·kg^{-1}·min^{-1}. The range of results for $\dot{V}O_2$max values points to big differentiation of potential aerobic abilities of the body to tolerate exercise. Maximal heart rate (HRmax) reached 189.1 bpm on average, and at the threshold of decompensated metabolic acidosis (HR_{TDMA}) this value was 160.3 bpm, which accounted for 84.8% of maximal heart rate (%HRmax). Percentage of oxygen uptake at TDMA (%$\dot{V}O_2$max) amounted to 71.0% $\dot{V}O_2$max on average. Graded exercise caused an increase in lactic acid concentration in blood (Δ LA) by 8.0 mmoL·l^{-1} on average (Table 4).

No statistically significant correlation between the level of achievement (PO) and the values of physical capacity indexes was observed. However, indexes which define the method of fighting correlated very significantly (0.7≤Rs>0.9) with anaerobic capacity indexes (Table 5).

Statistically significant relationships were observed between total work (TW) and:

- activity index in first phase of match (WA1, positive correlation),

Table 5. Statistically significant correlations observed between the values of indexes which determined fighting methods and the indexes which determined physical capacity.

Correlated indexes	Rs	t(N-2)	Level of significance
WA1 & TW	0.711	2.476	0.048
WA1 & RPP	0.738	2.680	0.037
WA1 & ΔLA3 min after WAnT	0.719	2.531	0.045
WS1 & TW	–0.721	–2.550	0.043
WS2 & RPP	0.874	4.411	0.005
RWS & RPP	–0.881	–4.560	0.004
WA1 & ΔLA	0.723	2.563	0.043
WS & HRmax	0.771	2.967	0.025

- efficiency index in first phase of match (WS1, negative correlation).

A correlation was also observed between relative peak power (RPP) and:
- activity index in first phase of match (WA1, positive correlation),
- efficiency index in first phase of match (WS2, positive correlation),
- difference in efficiency index (RWS, negative correlation).

Moreover, a positive correlation occurred between increment of lactic acid concentration after test exercise (ΔLA3 min after WAnT) and the value of activity index in first phase of match (WA1).

In the group of indexes which determined aerobic capacity, statistically significant correlations were observed between (Table 5):
- increase in lactic acid level after test exercise (ΔLA) and activity index in first phase of match,
- maximal heart rate (HRmax) and effectiveness (WS).

Discussion

Efficiency of exercise-related mechanisms of oxygen supply in senior judokas during tournament matches, expressed in relative $\dot{V}O_2$max values, determined their ability to maintain high level of activity [1]. In junior judokas, anaerobic capacity significantly affected the technical and tactical level. Among anaerobic capacity indexes, time to obtain maximal power showed the strongest relationship with the effectiveness of activities during attack and level of achievement [2].

Based on the results from the present study, one can assume that anaerobic capacity reveals a dominant importance, also in the group of cadets. However, peak power output (PP) seems to be of particular significance. Rise in RPP (relative peak power) was accompanied by an increase in activity of contestants in first phase of match (WA1) and effectiveness of actions in second phase (WS2). Furthermore, higher values of RPP also determined efficiency of actions taken in the second phase of match. This is demonstrated by significant negative correlation between RPP and RWS (difference in efficiency index).

A good index of cadet body adaptation to physical exercise typical of judokas is also provided by total work (TW). Its level positively correlated to activity and effectiveness of actions in first phase of match.

A positive correlation of activity index in first phase of match with the increase in lactic acid concentration after anaerobic test (30s) WA1 & ΔLA3 min after WAnT and graded exercise test WA1 & ΔLA show that the persons with higher capacity and power of glycolytic anaerobic source are predisposed to take attack actions in first phase of match more frequently.

The observed relationships of WS & HR_{max} might point to the fact that stronger stimulation of sympathetic part of nervous system is conducive to higher effectiveness of actions in attack.

No relationship between physical capacity indexes and level of achievements was observed within this study. This is caused by the fact that the level of achievement of the contestants is a resultant of a higher number of factors, among which technical and tactical level seems to be of dominant importance.

In the light of the collected scientific data, one can see typical regularities in the course of match, which depend on the stage in sport development of judo contestants.

Among senior contestants who demonstrate high level of $\dot{V}O_2$max, it was possible to maintain high activity

almost throughout the whole fight. Junior judokas who are reported to show short time to obtain peak power during fight should focus on high effectiveness of actions during attack. High values of anaerobic capacity (RPP and TW) observed in the group of cadets allow them to use a wider range of variants of tactical actions. Depending on situation, they can focus on higher activity in first phase of match or on high effectiveness of technical and tactical actions during the whole match.

The authors of the present study agree with the view presented by Esteves et al. [9], who argued that 'research results in sport sciences must be oriented to the training process, and transmitted more efficiently to the coaches'.

Conclusions

1. Level of anaerobic capacity plays a specific role to the course of matches for judo cadets.

2. Individual functional abilities of judo contestant body should be taken into consideration during development of routines for technical and tactical coaching.

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