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Effect of motor abilities on the course of fight and achievement level in judokas at different age

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B Data Collection
C Statistical Analysis
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Abstract

Background & Study Aim: Previous studies taking judo contestants into consideration have demonstrated that some motor abilities indices correlated with technical and tactical excellence indices and sport skill level. However, it remains unclear what is the synthetic effect of motor abilities on the fights course and contestants' sport skill level. The aim of the study was knowledge about relationships between the motor abilities level and the fighting method and between the motor abilities level and the achievement level among judokas.

Material & Methods: Twenty five judo contestants participated in the study. The evaluation of activity, effectiveness of judoists' actions and achievement level was based on the tournament matches analysis. Other measurements included coordination motor abilities, speed, strength and endurance. The objects' ordering, according to the individual indices level, was achieved using a synthetic index.

Results: In the senior group, high coordination abilities level was connected with contestants high activity in the second phase of the fight. The elevated activity was determined by coordination, speed and endurance abilities. High speed abilities level in juniors was directly connected with their sports achievements.

Conclusions: Speed abilities affected athletes activity stronger when combined with strength abilities and less when combined with strength and endurance abilities. These indications should be considered during selection procedure, coaching and technical and tactical training regimes modelling in judoists with particular motor abilities profiles.

Key words: activity index • combat sport • effectiveness index • synthetic index

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Motor abilities – complexes of individual psychophysical traits (predispositions) enveloped on the basis of genes which decide the quality of process and effect of movement actions.

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

INTRODUCTION

The correlations between motor abilities and functional fitness of human body have been widely researched by scientists. They largely depend on muscular force and movement speed at which peak power is reached [1, 2]. It has also been demonstrated that 'limited gait speed, balance, ability to climb stairs and standing up from sitting position are connected with reduced strength in lower limbs' [3]. Development of motor abilities is particularly essential for professional athletes. This is caused by the fact that the level of individual abilities and their combinations directly affect sport performance. These views, however, appear to be justified only with respect to the sports characterized by simple movement patterns, such as cycling, running or weightlifting. Level of particular motor abilities in these sports seems to be a determining factor in sport performance. Different situation can be observed in sports dominated by open movement structures, with motor stimuli that come from the external environment [4-6].

The phenomenon of striving for achievement of indices of individual motor abilities that characterize best athletes in a particular sport is observed in the practice of judo training. Several studies have discussed selected aspects of motor preparation of elite athletes in response to the needs of training practice [7-9]. In judo, however, athletes can utilize a number of methods of performing movements (technique) and the whole fight (tactics). Therefore, it seems that individual aspects of motor preparation of the best athletes should not be a dominant criterion used in the process of selection, planning and implementation of training schedules. More importance should be given to the development of natural aptitudes and technical and tactical training of individual contestants depending on their profile of motor abilities and somatic build. The concept of the profile of motor abilities depending on technical and tactical training is not new to professional sport. It is already present in team games [10-13], where, depending on "nominal position on the field", the players must meet a variety of requirements in terms of physical fitness. Its level in individual players determines the scope of tactical actions of the whole team.

Previous studies of judo contestants have demonstrated that some motor abilities indices correlated with the indices of technical and tactical excellence and sport skill level [14-16]. However, the observation of coaching practice shows that individual aspects of motor preparation rarely determine activity and effectiveness of actions taken by athletes under conditions of judo fight.

Therefore, the present study aims to verify the following hypothesis:

The synthetic approach to different aspects of motor preparation of judo athletes allows for explanation of the relationships between the state of preparation and technical/tactical excellence and sport skill level. This relationship is specific for individual age groups.

Determination of the relationships between synthetically viewed motor abilities and athletes' sport skill level allowed for precise determination of the specific character of this sport in individual age groups, which might improve optimization, recruitment, selection and qualification for consecutive stages in training. Correlation analysis between combinations of motor abilities and the course of the fight should become a starting point in development of technical and tactical excellence of judo contestants with particular motor abilities profile. Assuming the current state of knowledge, we find this direction of the investigations to be original and necessary for trainers and practitioners.

MATERIAL AND METHODS

Participants

The study evaluated 25 judo contestants at different age from different age categories from the best Polish sport clubs (CZARNI Bytom, WISŁA Kraków, MOSiR Bochnia, SOKÓŁ Myślenice, JORDAN Kraków and UKS JUDO Wolbrom). The participants selection for the study was carried out based on the chronological age, training experience, weight category (the two lightest and the heaviest categories were not included) and sport skill level (each of the subjects had scored at least fifth place in national tournaments). Table 1 compares characteristics of chronological age, training experience and basic indicators of somatic build of the participants.

Examinations in individual age groups were scheduled so that their competitive activity could be measured throughout the main competitions in the season and that the level of motor abilities could be measured in the nearest possible time after the tournaments. The examinations were carried out in the morning in two-day cycles. The first day was spent on determining coordination motor abilities and then the Wingate test was carried out. On the second day, muscle torques were measured and the graded test was carried out.

Table 1. Characteristics of chronological age and training experience and basic indices of somatic build of study participants

Variables	Seniors			Juniors			Cadets		
	N	$\bar{x} \pm SD$	min-max	N	$\bar{x} \pm SD$	min-max	N	$\bar{x} \pm SD$	min-max
Age (years)	9	21.9 ± 0.99	20-24	10	17.4 ±0.73	16-18	8	15.4 ±0.55	15-16
Experience (years)	9	12.6 ±1.76	10-14	10	8.5 ±1.18	8-11	8	6.0 ±0.81	4-7
Body Height (cm)	9	180.2 ±5.39	171-188	10	180.5 ±3.70	172-185	8	177.1 ±6.25	170-186
Body Mass (kg)	9	82.9 ±6.62	71.0-92,1	10	85.4 ±10.45	72.1-101.1	8	71.6 ±7.50	56.4-82.0
Lean Body Mass (kg)	9	74.1 ±6.20	65.6-82.5	10	72.3 ±5.49	64.6-78.9	8	65.3 ±6.25	52.2-73.0

The experiment was approved by the Bioethics Committee at the Regional Medical Chamber in Cracow, Poland and given no 42/KBL/OIL/2006.

Protocol

The videos from tournament fights fought by study participants were recorded for the following age groups:

- seniors: 3rd and 4th stage of the Individual and Team Senior League (Opole: 16 September 2006, Wrocław: 21 October 2006),
- juniors: elimination in the lead up to the Junior Poland Cup (Bytom: 29 September 2007) and the Junior Poland Cup (Warsaw: 20 October 2007),
- cadets: elimination in the lead up to the Poland Youth Olympic Games (Bytom, 5 April and 12 April 2008) and during the Poland Youth Olympic Games (Głogów: 26–27 April 2008).

The analysis of elimination judo matches included only the fights between the contestants who had been qualified for central competitions. In total, 175 fights were recorded (51 for seniors, 58 for juniors and 66 for cadets).

Technical actions of individual contestants were registered. The analysis focused on the actions that scored points and the part of the fight where these actions were performed. This also concerned the inefficient actions which were not given points by the judges, where a contestant threw his opponent out of balance as an attempt of performing a throw ("flying phase" was observed). These actions were also assigned a 0 note. In total, 373 technical actions were recorded.

Competition analysis (activity and effectiveness of the athletes) was divided into two parts. In the senior group, phase I was represented by first three minutes of the fight, phase II was represented by the third, fourth and fifth minutes (effective fighting time amounts to 5 minutes). In juniors and cadets, phase I was represented by the first two minutes of the fight, whereas phase II was represented by the third and fourth minutes (effective fighting time amounts to 4 minutes). If extra time was used (golden score), it was included in the second phase of the fight. Based on the collected data, indexes that determine the activity and effectiveness of actions among the study participants were calculated. The activity index (**AI**) was calculated from the following formula:

$$AI=\Sigma A/NF \qquad (1)$$

where **ΣA** is a total of the attacks, ***NF*** is the number of fights the contestant fought. The activity index calculated for phase 1 was ***AIFP***, with ***AISP*** for phase 2. Another index, ***DAI*** (difference in the activity index), was also calculated to reflect the variability of activity during competition. It was calculated as follows:

$$DAI = AIFP - AISP \qquad (2)$$

The effectiveness index (***EI***) is an arithmetic mean of the notes for attacks calculated for phases I and II of the match). The difference in the effectiveness index was calculated from the following formula:

$$DEI = EIFP - EISP \qquad (3)$$

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

- preliminary fights: 1st place 3 points, 2nd place 2 points, 3rd place 1 point, 5th place 0.5 points;
- central competition: 1st place 7 points, 2nd 5 points, 3rd 3.5 points, 5th 1.5 points, 7th 0.5 points.

Examinations of the coordination abilities were carried out using a set of computer tests developed by Jaworski [17] based on the most recent classifications of coordinated motor abilities [18]. The present study covered the following indicators: kinaesthetic differentiation of movements; movement frequency; simple reaction time (to visual and auditory stimuli); selective reaction time; spatial orientation; visual-motor coordination; rhythmization; speed; accuracy and precision of movements and ability to adapt movements. A detailed description of this method is contained in the study by Lech et al. [16].

Exercise tests were carried out in the Department of Physiology and Biochemistry at the University School of Physical Education in Cracow, Poland. Biometrical measurements: body height (BH) and body mass (BM) and structural determinationsa: fat percentage (PF); fat mass (FM) and lean body mass (LBM) were also carried out. Speed abilities were evaluated by means of the 30-second Wingate test for lower limbs [7].

The level of endurance abilities was evaluated based on the results obtained from graded exercise test. A detailed description of this method is contained in a study by Lech et al. [14, 15].

The muscle torque measurements were taken in the Department of Anthropometrics at the University School of Physical Education in Cracow, Poland. They included measurements of maximum muscle torques in flexors and extensors of the trunk and shoulder, elbow, hip and knee joints. A detailed description of this method is contained in a study by Sterkowicz et al. [19].

Statistical Analysis

The analysis of the correlations between the motor abilities level and the indices that characterize the course of the fight and contestants sport skill level was based on the Pearson's r linear correlation coefficient. Its use necessitates a linear arrangement of objects according to the level of the diagnostic variables (the results obtained from testing individual motor abilities). A synthetic index (***Wi***) was employed for this purpose, calculated based on the following formula [20, 21]:

$$Wi = \frac{100}{m} \sum_{j=1}^{m} a_j x_{ij} \qquad (4)$$

Where: ***m*** is the number of characteristics being considered, a_j weight of ***j*** variable.

The index was calculated from diagnostic variables made comparable through unitarization, where: the distance of a particular data from the observed 'worst' value is divided by the range. This operation was performed according to the following formula [20, 21]:

$$Stimulants: \rightarrow x_{ij} = \frac{x_{ij} - \min_i (x_{ij})}{\max_i (x_{ij}) - \min_i (x_{ij})} \qquad (5)$$

$$Destimulants: \rightarrow x_{ij} = \frac{\max_i (x_{ij}) - x_{ij}}{\max_i (x_{ij}) - \min_i (x_{ij})} \qquad (6)$$

where: subscript ***i*** denotes the object ***No.*** whereas subscript ***j*** is the number or the characteristic.

The character of variables (stimulant, destimulant) was determined through content-related analysis of these variables, whereas the points of reference were adopted as minimal and maximal values of the indices in the analysed age groups (Table 2).

The first stage involved determination of the value of ***Wi*** for coordination, speed, strength and endurance abilities. The arithmetical mean was then calculated from the synthetic indices for each combination, which is its synthetic index (***Wi***) where the effect of the number of variables that determined individual abilities on its value was eliminated (identical values of correlation coefficients were obtained by multiplying the indexes of individual motor abilities times the inverse of their number; therefore, both methods of elimination of the effect of variables which determined individual abilities on their levels seem to be correct).

This yielded 15 cases in total (4 synthetic indices of individual abilities and 11 ***Wi*** combinations) for each athlete (Table 3).

Table 2. Variables and their character (S – stimulant, D – destimulant) used when development of synthetic indices

Motor Ability	Test	No.	Variable/Index	Unit	Character of Variable
Coordination	Balance	1	Number of attempts to stand on the beam	n	D
	Ability to differentiate movements	2	Kinaesthetic differentiation – anticipation	pixel	D
	Frequency of movements	3	Hand movements frequency (tapping)	n	S
	Reaction time	4	Minimum reaction time (visual stimulus)	ms	D
		5	Mean reaction time (visual stimulus)	ms	D
		6	Maximum reaction time (visual stimulus)	ms	D
		7	Minimum reaction time (auditory stimulus)	ms	D
		8	Mean reaction time (auditory stimulus)	ms	D
		9	Maximum reaction time (auditory stimulus)	ms	D
		10	Minimum complex reaction time	ms	D
		11	Mean complex reaction time	ms	D
		12	Maximum complex reaction time	ms	D
	Rhythmization ability	13	Movement rhythmization	ms	D
	Speed, accuracy and precision of movements	14	Labyrinth to the left	s	D
		15	Labyrinth to the right	s	D
		16	Labyrinth to the left / mistakes	n	D
		17	Labyrinth to the right / mistakes	n	D
	Motor adjustment	18	Difference between the direction to the right and to the left	s	D
		19	Difference between the direction to the right and to the left / mistakes	n	D
	Visual-motor coordination	20	Optional	s	D
		21	Forced / errors	n	D
		22	Forced / correct	n	S
		23	Eye-hand coordination	s	D
		24	Eye-hand coordination / mistakes	n	D
	Spatial orientation	25	Optional	s	D
		26	Optional /errors	n	D
	Reaction to moving objects	27	Forced / correct	n	S
		28	Forced / errors	n	D
Speed	Wingate test (anaerobic capacity)	29	Total work	$J \cdot kg^{-1}$	S
		30	RPP (relative peak power)	$W \cdot kg^{-1}$	S
		31	FI (fatigue index)	%	D
		32	toPP (time to obtain peak power)	s	D
		33	tuPP (time of maintaining peak power)	s	S
		34	LA level after Wingate test	$mmoL \cdot l^{-1}$	S

Motor Ability	Test	No.	Variable/Index	Unit	Character of Variable
Strength	Muscle torques	35	EF (elbow flexors)	$Nm \cdot kg^{-1}$	S
		36	EE (elbow extensors)	$Nm \cdot kg^{-1}$	S
		37	AF (arm flexors)	$Nm \cdot kg^{-1}$	S
		38	AE (arm extensors)	$Nm \cdot kg^{-1}$	S
		39	KF (knee flexors)	$Nm \cdot kg^{-1}$	S
		40	KE (knee extensors)	$Nm \cdot kg^{-1}$	S
		41	HF (hip flexors)	$Nm \cdot kg^{-1}$	S
		42	HE (hip extensors)	$Nm \cdot kg^{-1}$	S
		43	TF (trunk flexors)	$Nm \cdot kg^{-1}$	S
		44	TE (trunk extensors)	$Nm \cdot kg^{-1}$	S
Endurance	Graded test	45	VO_2max	$ml \cdot kg^{-1} \cdot min^{-1}$	
		46	HRmax	$sk. \cdot min^{-1}$	S
		47	HR_{TDMA}	$sk. \cdot min^{-1}$	S
		48	%HRmax	%	S
		49	$\%VO_2max$	%	S
		50	LA after graded exercise test	$mmoL \cdot l^{-1}$	S

Table 3. Possible combinations of motor abilities

No	Motor Ability				Synthetic Index
1	Coordination				Wi_{Co}
2		Speed			Wi_{Sp}
3			Strength		Wi_{St}
4				Endurance	Wi_{Ed}
5	Coordination	+ Speed	+ Strength	+ Endurance	$Wi_{CoSpStEd}$
6	Coordination		+ Strength	+ Endurance	Wi_{CoStEd}
7	Coordination	+ Speed		+ Endurance	Wi_{CoSpEd}
8	Coordination	+ Speed	+ Strength		Wi_{CoSpSt}
9	Coordination	+ Speed			Wi_{CoSp}
10	Coordination		+ Strength		Wi_{CoSt}
11	Coordination			+ Endurance	Wi_{CoEd}
12		Speed	+ Strength	+ Endurance	Wi_{SpStEd}
13		Speed	+ Strength		Wi_{SpSt}
14		Speed		+ Endurance	Wi_{SpEd}
15			Strength	+ Endurance	Wi_{StEd}

RESULTS

Statistically significant relationships were found only in two cases (Table 4). These were favourable correlations (higher values of *Wi* correlated with favourable values of the course of the fight). Wi_{Co} (synthetic index of coordination abilities) was positively correlated with *AISP* (activity index in the second phase of the fight). This relationship exhibited very high correlation power (r = 0.84). These variable shared 70.6% of the variance.

A very high negative correlation was observed for the relationship between Wi_{CoSpEd} (synthetic index of coordination, speed and endurance coordination) and *DAI* (difference in activity index, $r_c = 0.6$). In this group of contestants no relationships were found between the level of achievement (*LOA*) and synthetic indices of motor abilities (Table 4).

Three favourable correlations were found in juniors (Table 5). The synthetic index of speed abilities correlated positively with the level of achievement (r = 0.64; $r_c = 0.41$). A positive correlation was found between Wi_{SpStEd} and *AI* (r = 0.65; $r_c = 0.40$). Another positive correlation with *AI* was observed for Wi_{SpSt} (r = 0.68; $r_c = 0.46$). It should be emphasized that all the correlations above involved speed abilities (Wi_{Sp}).

Unfavourable relationships (negative correlations) were demonstrated in the case of *LOA* and: Wi_{Ed} (r = 0.84; $r_c = 0.71$), Wi_{CoEd} (r = 0.71; $r_c = 0.51$) and Wi_{StEd} (r = 0.66; $r_c = 0.44$). It should be emphasized that all the correlations contained endurance abilities (Table 5).

Seventeen statistically significant correlations were found in cadets between synthetic indices with the indices of the course of the fights (Table 6). *AIFP* correlated positively (favourable correlations) with: Wi_{Sp} (r = 0.81; $r_c = 0.65$), Wi_{CoSpEd} (r = 0.76; $r_c = 0.57$), Wi_{SpStEd} (r = 0.74; $r_c = 0.54$), Wi_{SpEd} (r = 0.82; $r_c = 0.67$). Positive (unfavourable) correlations were observed between DAI and: Wi_{SpStEd} (r = 0.71; $r_c = 0.51$) and Wi_{SpEd} (r = 0.77; $r_c = 0.59$). Positive correlations were observed between EISP and: $Wi_{CoSpStEd}$ (r = 0.79; $r_c = 0.63$), Wi_{CoSpEd} (r = 0.79; $r_c = 0.62$), Wi_{SpStEd} (r = 0.82; $r_c = 0.65$), Wi_{SpEd} (r = 0.79; $r_c = 0.62$).

EIFP correlated negatively (unfavourably) with: $Wi_{CoSpStEd}$ (r = –0.74; $r_c = 0.55$), Wi_{CoSpSt} (r = –0.73; $r_c = 0.54$), Wi_{SpStEd} (r = –0.74; $r_c = 0.55$), Wi_{SpSt} (r = –0.89; $r_c = 0.77$). Negative (favorable correlations) were found also between DEI and: $Wi_{CoSpStEd}$ (r = –0.82; $r_c = 0.68$), Wi_{SpStEd} (r = –0.84; $r_c = 0.71$), Wi_{SpSt} (r = –0.82; $r_c = 0.67$).

No relationships were found in this age group between the level of achievement and synthetic indices of motor abilities.

DISCUSSION

Theorists of professional sport are facing the necessity to generalize findings based on a small number of events. Therefore, the attempts have been constantly made to find and develop new methods, since statistical tools used for multidimensional analyses (e.g. multiple regression, factor analysis) are very rigorous when determining the minimal sample size.

There is much controversy about the choice of tests for speed and endurance abilities evaluation. Speed abilities, determined by the level of indices of anaerobic capacity, are usually tested using the Wingate test. However, it should be emphasized that the concept of speed abilities belongs to different organizational level of the processes and phenomena than the

Table 4. Statistically significant correlations between the level of *Wi* (synthetic indices) for motor abilities and the course of the fights indices and sport skill level in the group of seniors (n = 7)

Correlated indices	Mean	Standard Deviation	r(X,Y)	r_c	t	p
Wi_{Co}	0.019	0.005	**0.840**	**0.705**	**3.463**	**0.018**
AISP	1.371	0.281				
Wi_{CoSpEd}	0.039	0.006	–0.774	0.599	2.736	0.041
DAI	0.428	0.672				

Note: Favourable correlations are written in bold /better result of the test was connected with the demanded value of the index

Table 5. Statistically significant correlations between the levels of synthetic indices (Wi) for motor abilities and the indices of the course of the fight and sport skill level in the group of juniors (n = 10)

Correlated indices	Mean	Standard Deviation	r(X,Y)	r_s	t	p
Wi_{Sp}	0.079	0.015	**0.640**	**0.410**	**2.359**	**0.046**
LOA	3.300	1.513				
Wi_{Ed}	0.088	0.023	−0.842	0.709	4.421	0.002
LOA	3.300	1.513				
Wi_{CoEd}	0.032	0.006	−0.714	0.510	2.884	0.020
LOA	3.300	1.513				
Wi_{SpStEd}	0.069	0.008	**0.635**	**0.403**	**2.327**	**0.048**
AI	2.131	0.633				
Wi_{SpSt}	0.062	0.011	**0.680**	**0.462**	**2.622**	**0.030**
AI	2.131	0.633				
Wi_{StEd}	0.066	0.012	−0.662	0.439	2.501	0.036
LOA	3.300	1.513				

Note: Favourable correlations are written in bold /better result of the test was connected with the demanded value of the index

concept of anaerobic exercise. Although the former (speed abilities) are connected with the characteristics of motor abilities and a particular and specific scope of possibility of performing a movement activity, the latter (anaerobic exercise) relates directly to the type of energy transformation.

In practice, athletes' endurance is typically determined by the indices of aerobic capacity [22-25]. However, judo fight is characterized by interval physical exercise with maximum intensity and fatigue. Therefore, understanding endurance as limited only to aerobic capacity indices is insufficient for this sport. The ability of fighting under conditions of substantial disturbances in internal homeostasis in the body, which is reflected by e.g. high post-exercise lactate levels, seems to be insufficient. This type of endurance is considered as aerobic-anaerobic endurance. Therefore, the lactate levels observed in the present study after the Wingate test were used as an index of speed abilities, whereas these levels measured after graded exercise test (performed until fatigue) were considered to represent endurance abilities.

The obtained results lead to the conclusion that the effect of motor abilities on the activity and effectiveness of actions declines with age (as the contestants are qualified to older age groups). 15 statistically significant correlations (of which 4 were unfavourable) were found in the group of cadets. In the groups of juniors and seniors, two correlations were found in either of the groups.

Analysis of the relationships between the variables analysed in individual age groups revealed that the particularly important factor in the group of seniors was motor coordination, which correlated with high activity in the second phase of the fight and extra time. Combined with speed and endurance abilities, motor coordination determined an increase in activeness in this part of the fight. These results are important, because in a study of seniors carried out by Sterkowicz et al. [4] the authors found that contestants' activity had direct effect on the level of achievement during the national championships in Poland. Level of motor abilities in this age group was not directly connected with the results obtained by the judokas in the analysed fights. This is likely to have been caused by higher effect of other factors, such as psychical aptitudes, technical and tactical excellence or the above mentioned training experience.

In the group of juniors, activity correlated more with speed abilities combined with strength abilities and less when combined with strength and endurance abilities. A particular importance of speed abilities in

Table 6. Statistically significant correlations between the levels of synthetic indices (*Wi*) for motor abilities and the indices of the course of the fight and sport skill level in the group of cadets (n = 8)

Correlated indices	Mean	Standard Deviation	r(X,Y)	r_c	t	p
Wi_{Sp}	0.078	0.030	**0.806**	**0.649**	**3.333**	**0.016**
AIFP	1.157	0.614				
$Wi_{CoSpStEd}$	0.042	0.005	–0.742	0.551	2.715	0.035
EIFP	5.255	1.763				
$Wi_{CoSpStEd}$	0.042	0.005	**0.791**	**0.625**	**3.163**	**0.019**
EISP	2.959	2.708				
$Wi_{CoSpStEd}$	0.042	0.005	–0.822	0.675	3.533	0.012
DEI	2.296	4.198				
Wi_{CoSpEd}	0.038	0.006	**0.757**	**0.573**	**2.836**	**0.030**
AIFP	1.157	0.614				
$Wi_{KCoSpEd}$	0.038	0.006	**0.786**	**0.618**	**3.118**	**0.021**
EISP	2.959	2.708				
Wi_{CoSpSt}	0.035	0.004	–0.733	0.538	2.641	0.038
EIFP	5.255	1.763				
Wi_{SpStEd}	0.071	0.015	**0.737**	**0.542**	**2.668**	**0.037**
AIFP	1.157	0.614				
Wi_{SpStEd}	0.071	0.015	**0.712**	**0.507**	**2.487**	**0.047**
DAI	0.220	0.847				
Wi_{SpStEd}	0.071	0.015	–0.740	0.548	2.696	0.035
EIFP	5.255	1.763				
Wi_{SpStEd}	0.071	0.015	**0.821**	**0.675**	**3.527**	**0.012**
EISP	2.960	2.708				
Wi_{SpStEd}	0.071	0.015	–0.840	0.706	3.801	0.009
DEI	2.296	4.198				
Wi_{SpSt}	0.064	0.013	–0.879	0.773	4.520	0.004
EIFP	5.255	1.763				
Wi_{SpSt}	0.064	0.013	–0.817	0.667	3.471	0.013
DEI	2.296	4.198				
Wi_{SpEd}	0.084	0.0249	**0.821**	**0.674**	**3.526**	**0.012**
AIFP	1.157	0.64				
Wi_{SpEd}	0.084	0.025	**0.767**	**0.589**	**2.932**	**0.026**
DAI	0.220	0.847				
Wi_{SpEd}	0.084	0.025	**0.789**	**0.623**	**3.150**	**0.020**
EISP	2.959	2.708				

Note: Favourable correlations are written in bold /better result of the test was connected with the demanded value of the index

this age group is confirmed by its direct correlation with level of achievement (*LOA*) during competition. It can be assumed in the case of the lack of correlation of the synthetic index of these abilities with the indices which characterize the course of the fight that the level of speed abilities was connected with *LOA* and the activity of contestants in defence, which was not the subject of the study. In the contestants with high level of achievement, the authors found negative correlation of endurance abilities with *LOA*. This is likely to be connected with high level of speed skills and low level of endurance abilities. Presumably, this concerns the combined effect of endurance and coordination abilities and endurance and strength abilities on *LOA*. Regardless of the causes, this fact should be considered for planning and implementation of coaching programs in this age group.

In the group of cadets, particular combinations of motor abilities were connected with high activity of contestants in the first phase of the fight and high effectiveness in the second one. This regularity is likely to have determined the correlations between the level of motor abilities and the decline in activity and increase in effectiveness during the second phase of the fight and extra time. The effect of speed abilities was found in all these cases. Level of motor abilities in this age group was not directly connected with the level of achievement.

The relationships demonstrated in the present study are important and should be taken into consideration by coaches when planning technical and tactical development of the contestants.

In conclusion, it is worth emphasizing that coaching in individual age groups should be focused on obtaining an optimum level of motor abilities at the age of senior. Therefore, particular stress should be put on development of coordination abilities. A great deal of motor coordination exercises should be scheduled for the early school age, before peak height velocity (PHV) period, also termed a sensitive period in development of coordination abilities. The athletes who start training during the sensitive period tend to use the actions with complex movement structures (e.g. throws with trunk rotation) more often and to use their own body inertia. Importantly, they exhibit higher sport skill level at the age of senior [26].

CONCLUSIONS

The results of the study should be taken into consideration during the process of recruitment, selection and development of technical and tactical skills of the athletes after diagnosis of their profile of motor abilities.

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COMPETING INTERESTS

Authors have declared that no competing interest exists.

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