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SELECTED COORDINATION MOTOR ABILITIES IN ELITE WRESTLERS AND TAEKWON-DO COMPETITORS

Coordination in combat sports

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Abstract

Introduction. The aim of the study was to compare CMAs in elite wrestlers and taekwon-do competitors. ***Material and methods***. Forty-nine Greco-Roman wrestlers and ITF taekwon-do competitors were included in the study. The wrestlers were 21.9±2.74 years old, while the taekwon-do competitors were 22.7±5.78 years old. The former group had between 7 and 14 years' training experience and the latter group had from 6 to 16 years' experience. All subjects were elite sportspeople (between first class and international master class levels). Five CMAs were assessed using 14 indices. Computer tests from the Vienna Test System were employed in the study. ***Results***. It was shown that there were no significant differences in CMA levels between wrestlers and taekwon-do competitors. Wrestlers from higher sports classes outperformed competitors who possessed lower sports classes in the majority of CMA indices. Statistically significant differences were observed for simple reaction, movement coupling and high frequency of movements. Taekwon-do competitors at the international master sports class (IM) level scored better than athletes who were at national master class (NM) and first class (I) levels in spatial orientation, reaction time, movement coupling and high frequency of movements. Regardless of the type of combat sport, competitors demonstrated high individual differences in CMAs, which may indicate that a focus on coordination improvement could increase training effectiveness. ***Conclusions***. Further research on identifying predominant CMAs in sportspeople at different levels of competition, particularly in those achieving significant sports successes may be conducted. Tests to thoroughly diagnose coordination should be employed in such investigations.

Key words: coordination, Vienna Test System, elite competitors

Introduction

Combat effectiveness in wrestling and taekwon-do requires proper levels of coordination motor abilities (CMAs) at every stage of training [1, 2, 3]. Well-developed CMAs facilitate accurate technical and tactical activities, increasing the effectiveness of advanced athletes in competitions [1, 4, 5, 6].

The control of coordination preparation based on assessment of predominant CMAs plays an important role in the supervision of the training process. Wrestling and taekwon-do coaches implement diverse methods to control CMAs. The coaches apply different motor tests, making it difficult to compare and generalise research results [4, 7, 8]. Tests used to define predominant CMAs in combat sports may serve as an example [1]. It is significant that most motor tests to evaluate CMAs are "burdened" by the need to condition, thus reducing their informative value. As a consequence, the reliability and validity of the findings may be affected.

Computer tests, e.g. VTS (Vienna Test System), may prove to be an alternative to commonly used motor tests. They eliminate the influence of the conditioning factor on research results, ensuring an increase in the precision and reliability of measurements [9, 10, 11, 12]. There is little evidence of prior research on CMAs among wrestlers and ITF (International Taekwon-do Federation) taekwon-do competitors in particular [1, 13].

The majority of research has focused on the observation of individual abilities such as quick reaction [2, 14, 15, 16]. There is also a lack of data regarding CMAs of competitors in different combat sports. When analysing beginners' and advanced athletes' perceptual abilities, Kioumourtzoglou et al. [17] showed that the disparate nature of competitors in sport determined differences between novices and elite competitors. It was revealed that elite basketball, volleyball and water polo players differed from beginners in several perceptual abilities that conditioned the course of movement coordination. Starosta et al. [18] also proved the existence of statistically significant differ-

Table 1. Characteristics of the investigated groups

Group	Number of subjects	Sports class	Age (years)	Training experience (years)	Body mass (kg)	Body height (cm)
Group I wrestlers	25	MM; M; I	21.9 ± 2.74	9.28 ± 2.19	72.5 ± 15.8	174.0 ± 7.41
group IA	11	MM	23.0 ± 2.86	9.91 ± 2.07	76.5 ± 21.4	176.0 ± 7.56
group IB	14	M; I	21.1 ± 2.40	9.01 ± 1.84	69.4 ± 9.30	172.4 ± 7.14
Group II taekwon-do competitors	24	MM; M; I	22.7 ± 5.78	10.9 ± 4.26	73.8 ± 12.3	179.9 ± 7.46
group IIA	11	MM	25.6 ± 5.80	13.8 ± 4.49	76.1 ± 10.8	180.0 ± 8.14
group IIB	13	M; I	20.3 ± 4.73	8.46 ± 1.94	71.9 ± 13.6	179.8 ± 7.17

ences in the levels of overall movement coordination in hockey players, judo practitioners and track and field athletes. The best scores for "quick coordination" were obtained by judokas in a task that was most similar to the specificity of their sport.

To date, research has not provided any explanation that may specify to what extent the type of sport and the level of sports advancement differentiate the coordinational profile of a competitor.

It was decided that research results regarding athletes at similar levels of sports competition who practised sports that required similar coordination abilities might be of interest.

This study sought to compare CMAs in elite wrestlers and taekwon-do competitors.

Material and methods

Two groups of competitors were included in the analysis. The first group (group I) consisted of elite Greco-Roman wrestlers (n=25) who were members of the Polish senior national team. The second group (group II) was made up of elite taekwon-do competitors from the Polish national team of ITF taekwon-do (n=24). The wrestlers were 21.9 ± 2.74 years old, while the taekwon-do competitors were 22.7±5.78 years old. The former group had between 7 and 14 years' training experience and the latter group had between 6 and 16 years' experience (Tab. 1). The subjects were also divided according to their level of sports class. Group IA consisted of wrestlers (n=11) and group IIA was comprised taekwon-do competitors (n=11) who were at an international master (IM) sports class level. The remaining athletes were at the national master (NM) level and the first (I) sports class and belonged to group IB (n=14) and IIB (n=13), respectively.

CMAs were assessed in standard conditions. Prior to commencing the tests each subject was familiarised with procedures and then participated in an introductory test. The measurements were made before a training session.

Five CMAs were assessed on the basis of 14 indices. The study included computer tests of VTS [11, 12] which had been checked in terms of reliability and validity beforehand [10]. In total the subjects performed 4 tests with 2-minute intervals in the following order: RT (reaction test – S1 version) assessing simple reaction, DT (decision test – S1 version) measuring complex reaction, SIGNAL (signal detection test – S2 version) examining spatial orientation and MLS (motor performance test – S1 version) evaluating movement coupling and the frequency of movements.

The non-parametric Mann-Whitney U test for independent variables and STATISTICA 5.0 programme were used in the statistical analysis of the results.

Results

It was observed that both wrestlers and taekwon-do competitors demonstrated considerable individual differences in most CMAs (Tab. 2, Tab. 3). Variation coefficients ranged from 8% to 46% (Tab. 2). The biggest individual differences were noted in complex reaction (from 8% to 46%), simple reaction (between 10% and 24%) and movement coupling (from 10% to 30%). The smallest differences, however, were observed in the indices of spatial orientation (between 8% and 17%) and the frequency of movements (from 9% to 12%).

The comparison of CMA results of wrestlers and taekwon-do competitors did not reveal any statistically significant differences ($p>0.05$). It was only in the B2 index (the number of incorrect and missed reactions), which measured complex reaction, that the 29% difference to the wrestlers' advantage turned out to be statistically significant at the level of $p<0.05$ (Tab. 2).

The results of wrestlers from different sports classes (Tab. 3) show that competitors from group IA differed significantly from group IB athletes in simple reaction times (the difference in A1:19.1 ms, $p<0.05$; in A2:19.9 ms, $p<0.05$; in A3:38.9 ms, $p<0.01$) and complex reaction times (difference in B3:0.02 ms, $p<0.05$) as well as in movement coupling indices (differences in D1:3 ms, $p<0.01$ and in D3:11.2 ms, $p<0.01$) and in the indices regarding the frequency of movements (difference in E3:11, $p<0.01$).

Taekwon-do competitors from group IIA differed from their counterparts from group IIB in simple reaction times (differences in A1:12% and in A3:9%), complex reaction times (difference in B1:8%), test results concerning spatial orientation (differences in C1:8% and C2:4%), movement coupling (differences in D1:8%, D2:11% and in D3:6%) and the frequency of movements (difference in E3:6%).

Discussion

The aim of this study was to compare CMAs in elite wrestlers and taekwon-do competitors. Considerable differences in the indices of selected CMAs were observed in both groups. The biggest differentiation was found between the indices of simple and complex reaction and movement coupling. The differences within each group may indicate that there is some potential in coordination preparation of the subjects that ought to be utilised in further training. The differentiation of individual profiles is greater among elite competitors, which results in noticeable implications for training practice. According to some research [7, 13, 19], specific development of CMAs positively influences technical improvement and effectiveness in sport. Our findings confirm previous assumptions that athletes practising sports with similar competition requirements demonstrate similar levels of CMAs. According to Kioumourtzoglou et al. [17], basketball, volleyball and water

Table 2. Selected indices of CMAs in wrestlers and taekwon-do competitors ($\bar{x}$± SD;V)

COORDINATION ABILITY test (indices)	wrestlers (n=25)		taekwon-do competitors (n=21)		differences
	$\bar{x}$ ± SD	V	$\bar{x}$ ± SD	V	
Simple reaction					
A1. A median of reaction time (ms)	232.4 ± 23.3	10.0	**232.0** ± 24.2	10.4	0.40
A2. A median of single movement time (ms)	96.8 ± 23.6	24.4	**90.7** ± 13.8	15.2	6.10
A3. A median of quick reaction (ms)	329.2 ± 35.8	10.9	**322.7** ± 26.7	8.27	6.50
Complex reaction					
B1. Number of correct reactions (number)	249.1 ± 35.8	14.4	**250.8** ± 24.0	9.57	1.70
B2. Number of incorrect and missed reactions (number)	**31.2** ± 14.2	45.5	40.3 ± 13.7	34.0	9.10*
B3. A median of reaction time (s)	0.74 ± 0.06	8.11	**0.73** ± 0.06	8.22	0.01
Spatial orientation					
C1. Number of proper and delayed reactions (s)	52.2 ± 3.99	7.65	52.2 ± 4.30	8.24	-
C2. A median of detection time (s)	**0.76** ± 0.09	**11.8**	0.79 ± 0.13	16.5	0.03
Movement coupling					
D1. Inserting long pegs with the right hand (s)	**41.1** ± 4.18	10.2	42.7 ± 4.40	10.3	1.60
D2. Inserting long pegs with the left hand (s)	**65.9** ± 8.52	12.9	68.2 ± 9.74	14.3	2.3
D3. Inserting long pegs with both hands (s)	**58.2** ± 14.1	24.2	58.3 ± 17.7	30.4	0.10
Frequency of movements					
E1. Right-hand tapping (number)	**220.8** ± 23.6	10.7	217.0 ± 18.4	8.48	3.80
E2. Left-hand tapping (number)	197.6 ± 22.9	11.6	**199.9** ± 21.3	10.7	2.30
E3. Tapping with both hands (number)	199.7 ± 18.4	9.21	**201.5** ± 17.2	8.54	1.80

Note: values in bold show a higher level of a given group;
* statistically significant difference $p<0.05$;

Table 3. CMAs of wrestlers and taekwon-do competitors in the context of which sports class they are in ($\bar{x}$±SD)

COORDINATION ABILITY test (parameter)	wrestlers		differences %	taekwon-do competitors		differences %
	group IA (n=11)	group IB (n=14)		group IIA (n=11)	group IIB (n=13)	
Simple reaction						
A1. A median of reaction time (ms)	221.7 ± 22.6	240.8 ± 20.9	**8.6***	218.4 ± 21.5	243.5 ± 21.7	**11.5****
A2. A median of single movement time (ms)	85.6 ± 13.2	105.5 ± 26.6	**23.3***	89.5 ± 14.0	91.6 ± 14.6	2.4
A3. A median of quick reaction (ms)	307.4 ± 17.9	346.3 ± 37.4	**12.7****	307.9 ± 30.0	335.2 ± 17.5	**8.9****
Complex reaction						
B1. Number of correct reactions (number)	254.5 ± 38.7	244.9 ± 34.1	3.8	262.1 ± 18.8	241.3 ± 25.3	**7.9***
B2. Number of incorrect and missed reactions (number)	29.0 ± 14.3	33.0 ± 14.4	13.8	40.3 ± 17.8	40.4± 10.4	0.3
B3. A median of reaction time (s)	0.73 ± 0.06	0.75 ± 0.07	**2.7***	0.70 ± 0.04	0.76 ± 0.06	8.6
Spatial orientation						
C1. Number of proper and delayed reactions (s)	51.8 ± 3.34	52.5 ± 4.54	1.4	54.5 ± 2.4	50.2 ± 4.82	**7.9****
C2. A median of detection time (s)	0.78 ± 0.09	0.75 ± 0.08	3.9	0.78 ± 0.10	0.81 ± 0.16	**3.9****
Movement coupling						
D1. Inserting long pegs with the right hand (s)	39.3 ± 3.87	42.3 ± 4.11	**7.6****	41.1 ± 4.9	44.4 ± 3.40	**8.0****
D2. Inserting long pegs with the left hand (s)	66.3 ± 70.3	65.7 ± 9.79	3.5	64.9 ± 7.2	71.7 ± 11.7	**10.5****
D3. Inserting long pegs with both hands (s)	52.0 ± 5.58	63.2 ± 16.8	**21.5****	56.6 ± 16.5	59.8 ± 19.8	**5.7****
Frequency of movements						
E1. Right-hand tapping (number)	226.4 ± 23.9	216.4 ± 23.2	4.4	218.6 ± 18.8	215.6 ± 19.4	1.4
E2. Left-hand tapping (number)	206.6 ± 24.6	190.5 ± 19.4	7.8	205.5 ± 18.2	195.2 ± 24.0	5.0
E3. Tapping with both hands (number)	205.9 ± 18.9	194.9 ± 17.0	**5.3****	207.7 ± 19.2	196.3 ± 14.9	**5.5****

Note: * statistically significant difference $p<0.05$; ** - $p<0.01$

polo players at different levels of sports competition demonstrated statistically insignificant differences in the majority of the psychomotor indices analysed. It could be argued that the nature of training and sports competition in wrestling and taekwon-do yields similar psychomotor competitor profiles. It may account for the lack of statistically significant differences in the CMAs under investigation.

However, we observed the differences in CMAs between athletes in the groups of wrestlers and competitors at high but differentiated sports levels. The subjects in the IM sports class obtained better average CMA results. Wrestlers from group IA achieved significantly better average results in reaction, movement coupling and frequency of movement tests than wrestlers from group IB. Taekwon-do competitors from group IIA obtained better average results in movement coupling, spatial orientation, quick reaction and frequency of movement tests than their peers from group IIB. Our findings are somewhat different from the data presented by Kioumourtzoglou et al. [17], who observed significant differences between beginner and elite basketball, volleyball and water polo players in only a few perceptual abilities, which may reveal some influence of the nature and duration of particular training in the groups. Nevertheless, it does not allow us to explain the strength of correlation between sports advancement and selected CMAs in competitors of various sports.

Sadowski [13], Sterkowicz et al. [20] and Starosta and Tracewski [21] claim that elite athletes (taekwon-do competitors, wrestlers, judokas, karate practitioners) demonstrate higher average values of CMAs than less advanced competitors.

Quick reaction times in elite wrestlers and taekwon-do competitors are in line with the findings of other authors [2, 5, 14, 15, 16, 22]. They claim that wrestling and taekwon-do belong to a group of sports in which reaction time is one of the predominant CMAs and is a factor that has some influence on the result of a sports competition. This is the reason why coaches apply a lot of training means that develop this ability.

Movement coupling ability was at a higher level in IM competitors than in NM and I athletes. It may prove significant in wrestling and taekwon-do training. Studies by other researchers bear it out as well [1].

The comparison of CMA results in groups IA and IB as well as IIA and IIB revealed that differentiation occurred more often in taekwon-do competitors. It could be argued that the sports result in taekwon-do is influenced by coordination factors to a larger extent, while other determinants such as motor preparation, are more important in wrestling. The differences between taekwon-do competitors and wrestlers could also be explained by the nature of sports competition. In taekwon-do the fight itself is highly dynamic, as it is confirmed by the offensive and defensive activity index, which ranges from 0.82 to 92% [23]. During a fight competitors maintain a greater distance from each other to avoid kicks and also due to the fact that rules and regulations prohibit clinching and require full control of the strength of strikes (touch contact is obligatory). An ability to accurately assess of body positioning and its changes with regard to an opponent as well as perform movements in the proper direction are connected with spatial orientation. Higher levels of this ability were noted in elite taekwon-do competitors. The fight in wrestling is characterised by a wide range of techniques and manners of their performance, while movement precision depends on making use of a competitor's own skills as well as on how involved and motivated their opponent is. However, compared with taekwon-do competitors, wrestlers are in direct contact with each other during the fight. Therefore, despite enormous significance of CMAs, conditioning factors may still be predominant.

Conclusions

Our findings made it possible to note the differences in CMAs depending on which sports classes the subjects were in. It was observed that competitors from higher sports classes obtained higher values of CMA indices. The research results have some limitations. Although the study included elite athletes, it was restricted to Polish subjects. As a consequence, the findings cannot yet be held to be universally accurate.

Further research should focus on the investigation of predominant CMAs in athletes at different levels of sports competition, particularly among those who have achieved significant sports success. This will require the employment of special tests that assess coordination accurately.

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