ORIGINAL ARTICLE

Dynamics of the development of coordination motor abilities in freestyle wrestlers aged 16-20

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A Study Design
B Data Collection
C Statistical Analysis
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Abstract

Background & Study Aim: The aim of the study was changes in the levels of selected indices of coordination motor abilities (CMA) in freestyle wrestlers during a 4-year training process.

Material & Methods: The tests were carried out fivefold with one-year interval periods between each of them. They included the same group of wrestlers (n=15) from the sports club "Radomka". Twelve selected indices describing 7 CMA were subjected to analysis during the four-year continuous research.

Results: It was observed that changes in the levels of CMA in freestyle wrestlers aged 16-20 occurred at different times, in different directions, with different intensity levels and had their own distinctive character. The greatest changes in the levels of CMA were discerned at the age of 16-17, where the bulk of CMA under investigation, kinesthetic differentiation and balance in particular, developed considerably. Moreover, it was noted that at the age of 19 and above a quick reaction ability still evolved.

Conclusions: Oriented individualised development of CMA in competitors at every stage of training may positively affect the process of learning and improving sports technique and the selection of effective strategies in performance.

Key words: combat sport · monitoring CMA · sports-motor tests

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INTRODUCTION

Contemporary sport requires new approaches to technical and tactical training in order to improve performance [1]. The results of research carried out in recent years show that one of the effective ways is coordination training and perceptual training of CMA [2-9]. The role of coordination preparation increases in sports which are characterised by complex motor tasks and by the changeability of sports competition conditions [10, 11]. Currently coaches apply conditioning training more often, thus neglecting the development of movement coordination [11]. It is known that the greatest adaptability of CMA occurs between 7 and 12 as well as between 14 and 18 years of age [12] and even though sensitive periods do not overlap in the findings of various authors [2, 7, 12-15], everybody is unanimous that developing CMA in a period other than the sensitive one will be more laborious and less effective. It is significant in sports training as it may disturb its course and hinder the realisation of short- and long-term training objectives [16].

One way of optimising sports training in wrestling is to get to know movement coordination thoroughly and to identify dominant CMA as well as defining the dynamics of changes in the course of the long-term training process [17]. To the best of our knowledge, there is a scarcity of data on the issues of CMA in wrestling, particularly on the dynamics of their development in long-term training.

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Freestyle wrestling – Olympic sport which consists in a direct combat between two competitors.

Coordination motor abilities – psychomotor properties that define the readiness to control and regulate motor activities in an optimal way.

The aim of the study was changes of selected indices of CMA in freestyle wrestlers during a 4-year training process.

MATERIAL AND METHODS

The research included 15 freestyle wrestlers from the sports club "Radomka" in Radom. At the beginning of the research they were 16.60.35 years old, while at the end they were 20.60.35 years old. Their training experience was 3.50.67 and 7.50.67 years long, respectively. The subjects were of a similar biological age established on the basis of their morphological age. All the wrestlers volunteered to serve as subjects for the study as they were motivated by future result analysis and an assessment of their levels of coordination abilities.

It was continuous research that lasted 4 years. The tests were carried out fivefold with one-year interval periods between each of them. They included the same group of wrestlers and they were performed at the beginning of a one-year training cycle and after a detraining period (summer holidays). The research was carried out in standard conditions by the same research group. Wrestlers underwent tests twice in their free time, i.e. in the morning just after a full rest period. Prior to commencing the tests each subject was familiarised with procedures and then participated in an introductory test. The subjects performed the tests with 5-10-minute intervals. The testing procedure was always identical.

Seven CMA were assessed based on 12 indices. Sports-motor tests created by various authors [12] and by the authors of this study [18] were applied. The tests were tried beforehand in terms of accuracy and diagnostic informativeness [18].

Kinesthetic differentiation was assessed by means of "long jump at 50% of maximal capabilities", the result being error percentage in strength differentiation (%). Rhythmization was evaluated by imitating and differentiating the rhythm of "rhythmic jumps on the Johnson-Matheny mat", where the difference between an optimal attempt and an average time of attempts imposed on the subjects constituted the result (s). Time-space orientation was measured by "aimed jumps", in which accuracy percentage (the closer to the target, the better) was calculated (%) and "the run towards colourful balls" tests, the result being the performance time (s). Movement combining was determined by means of "the movement of a gymnastic baton" test, in which the performance time was taken into account and "standing long jump with and without a swing", where the difference between a jump with a swing and a jump without a swing was calculated. As for a quick reaction ability, "grabbing Ditrich's stick" test was applied. In this test the length of a dropped gymnastic stick constituted the result (cm). In the case of motor adjustment, "standing long jump forwards and backwards" and "run forwards and backwards 3x10 m" tests were used. As for the former test, the proportion of the length of a jump forwards and a jump backwards was calculated (%), whereas in the latter one the proportion of the time of a run forwards and a run backwards was taken into consideration (%). Static balance was evaluated with the help of "standing with calves raised" test, where the performance time was measured (s), while dynamic balance was assessed with the use of "turns on an inverted gymnastic bench", the result being the number of turns.

The assessment of CMA development was carried out on the basis of an increase (%) in indices characterising CMA in the following age groups: 16-17, 17-18, 18-19, 19-20 and 16-20. The dynamics of changes was defined by comparing current results with the results from the previous year. ANOVA Friedman's test was used in the research, while Wilcoxon's test was implemented to calculate statistical significance of differences between the results from successive age categories.

RESULTS

Both an increase and regression of CMA under investigation occurred in particular groups. It was noted that significant progress in the bulk of CMA was made between 16 and 17 years of age. In turn, stagnation and regression of CMA occurred mostly between 18 and 20 years of age (Table 1).

Between the age of 16 and 17 the greatest growth was observed in rhythmization (by 18.6%; index 5) and kinesthetic differentiation (15.0%; index 1) ($p < 0.01$). Furthermore, significant changes also occurred in motor adjustment (9.5%; index 3), time-space orientation (6.5% in index 6 and 3.2% in index 7), movement combining (5.5%; index 9) and dynamic balance (5.2%, index 10) as well as quick reaction (3.7%, index 12). Gains in motor adjustment (3.8%; index 2) and movement combining (4.7%; index 8) were statistically insignificant ($p > 0.05$). As far as rhythmization is concerned (index 4), statistically insignificant regression was noted.

While analysing the age category of 17-18, discernible development of CMA was observed. On average, indices of balance increased by 10.6% ($p < 0.01$), while those of quick reaction grew by 5.7% ($p < 0.05$). Moreover, significant changes were found in motor adjustment (by 6.6%; index 2) and time-space orientation (3.4%; index 7). As for the remaining cases, changes turned out to be statistically insignificant ($p > 0.05$).

In the case of the age category of 18-19, there occurred some development stabilisation or even a slight decrease in the levels of several CMA. A significant improvement was found only in quick reaction (6.1%) and partly in rhythmization (14.7%; index 5) and dynamic balance (3.8%).

As for the age category of 19-20, a considerable growth was still observed in quick reaction (3.0%).

On the basis of the obtained research results it was revealed that between 16 and 20 years of age freestyle wrestlers demonstrated an increase in the tested CMA (table 1). The greatest mean growth occurred in the following abilities: balance (31.3%), rhythmization (21.5%), kinesthetic differentiation (18.1%), quick reaction (17.3%), motor adjustment (14.4%), time-space orientation (10.4%) and movement combining (9.9%).

For better visualisation of changes in CMA levels the results achieved are presented in a graphic form in Figure 1. Along with mean values of the group the graphs show individual pace of the development of particular CMA in wrestlers demonstrating high and low levels of a tested index.

The findings regarding wrestlers with low and high CMA levels indicate that the changes that came

Table 1. Selected indices of CMA in freestyle wrestlers aged 16-20 ($\bar{x} \pm SD$)

CMA (test, index)	16	17	Changes 16-17 years old (%)	18	Changes 17-18 years old (%)	19	Changes 18-19 years old (%)	20	Changes 19-20 years old (%)	Changes 16-20 years old (%)
Kinesthetic differentiation										
1. Long jump at 50% of maximal capabilities (%)	80.5 6.74	92.6 3.76	15.0**	91.8 3.57	–0.9	94.9 5.68	3.4*	95.1 3.67	0.2	18.1**
Motor adjustment										
2. Standing long jump forwards and backwards (%)	62.8 9.29	65.2 7.78	3.8	69.5 10.25	6.6*	68.8 7.43	–1.0	71.3 7.58	3.6*	13.5**
3. Run forwards and backwards 3x10 m (%)	63.3 8.28	69.3 10.75	9.5**	71.1 12.06	2.3	72.5 12.59	2.0	72.9 9.41	0.6	15.2**
Rhythmization										
4. Rhythmic jumps – rhythm imitation (s)	0.29 0.13	0.33 0.09	- 13.8	0.29 0.09	12.1	0.31 0.12	–6.9	0.26 0.09	16.1	10.4
5. Rhythmic jumps – rhythm differentiation (s)	0.43 0.15	0.35 0.15	18.6**	0.34 0.11	2.9	0.29 0.10	14.7*	0.29 0.12	0.0	32.6**
Time-space orientation										
6. Aimed jumps (%)	76.7 6.36	81.7 7.46	6.5*	83.6 9.49	2.3	86.9 5.80	4.0	87.2 5.80	0.4	13.7**
7. Run towards colourful balls (s)	13.07 0.43	12.65 0.47	3.2**	12.22 0.80	3.4*	12.17 0.79	0.4	12.14 0.58	0.3	7.1**
Movement combining										
8. Movement of a gymnastic baton (s)	14.05 1.11	13.39 0.72	4.7	13.41 0.57	–0.2	12.83 1.03	4.3	12.82 0.91	0.1	8.8**
9. Standing long jump with and without a swing (%)	79.7 5.04	84.1 8.11	5.5*	85.5 7.45	1.7	87.9 7.95	2.8	88.5 8.05	0.7	11.0**
Balance										
10. Turns on an inverted gymnastic bench (n)	5.83 0.56	6.13 0.77	5.2**	6.87 0.58	12.1*	7.13 0.67	3.8*	7.20 0.75	1.0	23.5**
11. Standing with calves raised (s)	9.44 2.22	11.19 2.65	18.5	12.21 2.38	9.1**	12.91 2.33	5.7	13.13 2.35	5.6	39.1**
Quick reaction										
12. Grabbing Ditrich's stick (cm)	18.51 3.02	17.82 2.71	3.7*	16.81 2.18	5.7*	15.79 2.16	6.1*	15.31 1.88	3.0*	17.3**

* significance at the level of $p<0.05$; ** $p<0.01$

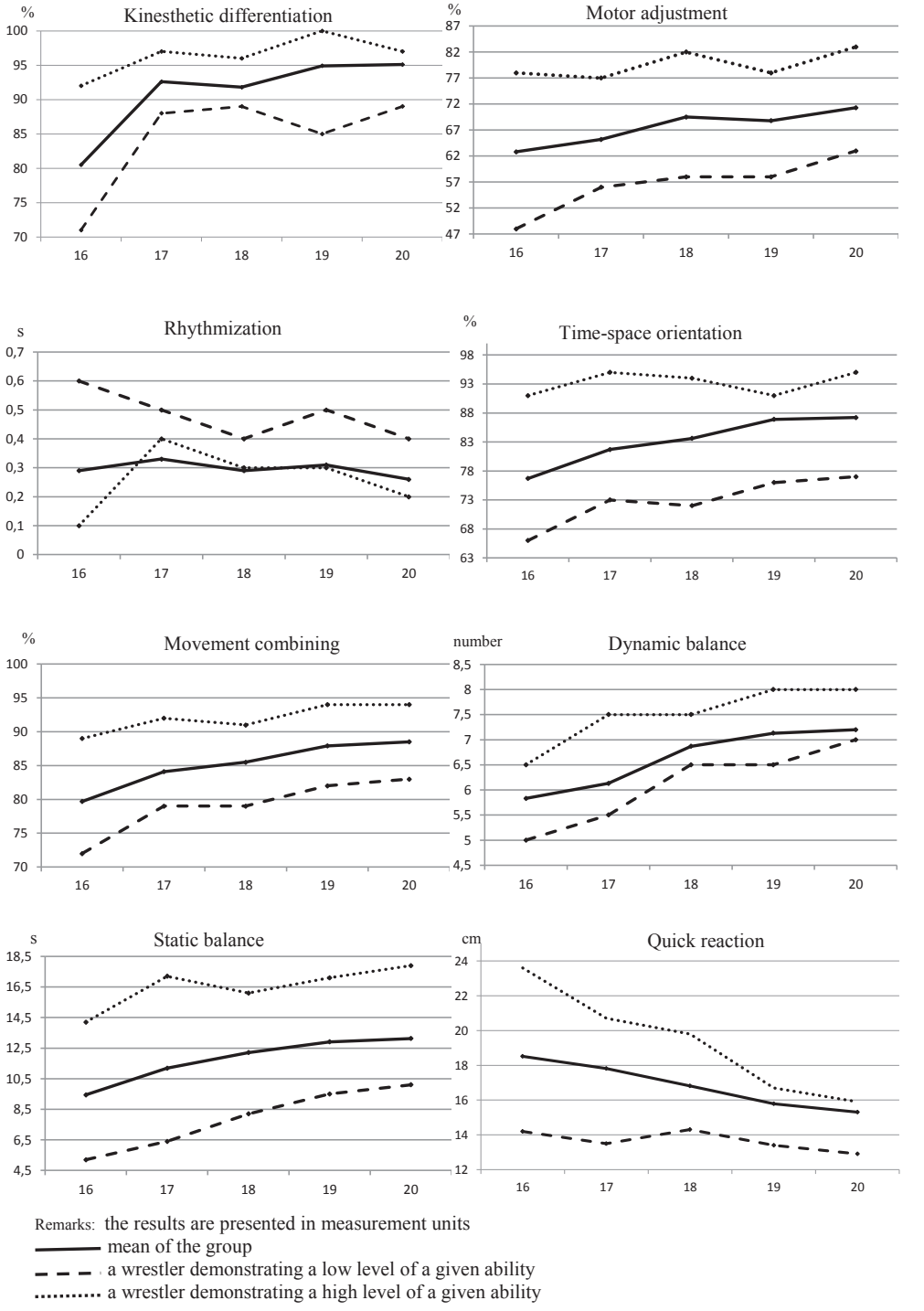

Figure 1. Changes in the levels of selected CMA in freestyle wrestlers aged 16-20 compared with the mean value of the group (the x-axis: years)

about had their own distinctive character. Large individual differences were noticeable in the majority of the groups of subjects under examination (Figure 1).

Taking the aforementioned results into account, it may be stated that the most considerable mean growth in CMA levels in wrestlers occurred between 16 and 17 (7.1%) as well as 17 and 18 (4.4%) years of age. As for the age category of 18-19, the growth was lower (3.4%). The lowest mean improvement in CMA (2.5%) was observed in wrestlers aged 19-20 (Figure 2).

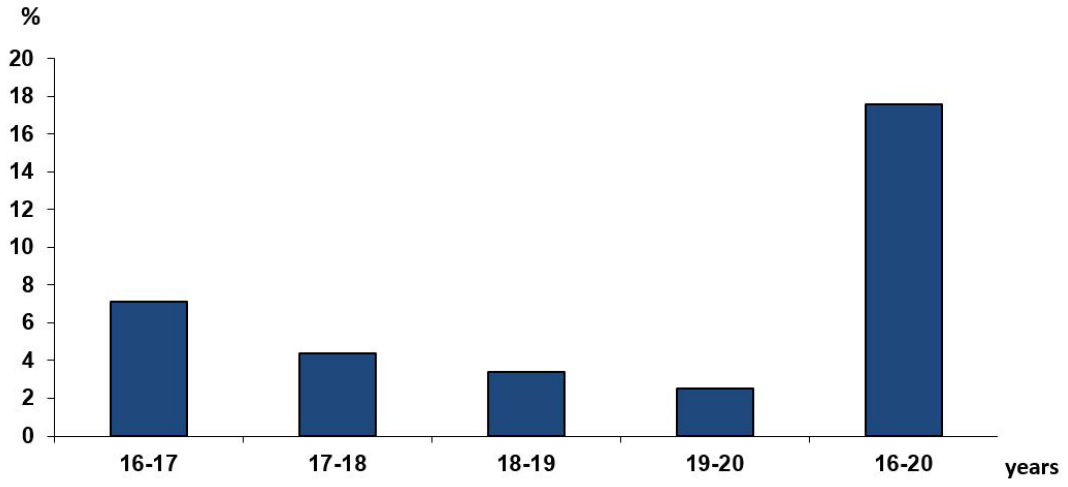

Figure 2. Changes [%] in CMA (mean growth) taking into consideration the age of the subjects

DISCUSSION

The aim of the study was to define changes of selected CMA indices in freestyle wrestlers during a 4-year training process.

It was observed that the pace of the development of particular coordination motor abilities was diverse and most changes had their own distinctive character.

The manifestation of individual variability of CMA development, as suggested by authors [11, 15] might, on the one hand, have stemmed from the age difference but, on the other hand, it may have resulted from diversified exposure to training stimuli during a training process.

In recent years there have appeared works [4, 7, 14, 19] in which the authors started to pay more attention to presenting individual results compared with the means of the examined group, claiming that development is a process that never takes place in an "averaged" manner. Manifestations of individual variability of motor development including CMA usually stem from biological age differences, diverse motor development pace as well as from the sports advancement and level of a competitor, which points to the necessity to individualise the process of CMA development in long-term sports training [15].

Defining the dynamics on the basis of single tests does not provide complete data on developmental changes of all CMA. The generalisation of the findings concerning the development dynamics of various coordination motor abilities made it possible to observe some distinctive tendencies. They point to the occurrence of periods most conducive to the development of particular CMA in a training process of wrestlers at oriented and special training stages.

It was noted that the age of 16-17 was a proper period for the development of the majority of the examined CMA. At the age of 17-18 the subjects demonstrated gains in balance and quick reaction and partly in rhythmization, motor adjustment and time-space orientation. At the age of 18-19 they still demonstrated an increase in quick reaction, dynamic balance, kinesthetic differentiation and partly rhythmization, while at the age of 19-20 it was quick reaction that continued to improve.

During a 4-year research period wrestlers aged 16-20 did not make any considerable progress regarding the following abilities: movement combining (index 8), rhythmization (index 4), motor adjustment (significant improvement was observed except for index 2 at the age 17-18 and index 3 at the age of 16-17), time-space orientation (apart from the age of 16-17, where index 6 revealed its major gains). Most probably the tests applied were incapable of revealing the specificity of CMA in the group under investigation or the sensitive period of those abilities had occurred before the wrestlers attained the age of 16 [10, 15, 16].

Drawing on the research results it may be assumed that the development of CMA is not confined to the age of 12. The largest gains were observed between 16 and 18 years of age.

The results are in line with the findings of other authors investigating the course of the CMA development at a similar stage of ontogenesis in competitors of other sports [11, 12, 14, 19, 20].

According to a lot of authors [2, 4, 7, 9, 11, 12, 21], pinpointing means and methods of coordination preparation and including them in a training process at every stage e.g. in the form of coordination training ought to be an absolute must in many sports, particularly in those with highly complex motor tasks.

As indicated by various authors, oriented individualised development of CMA in competitors at every stage of training may positively affect the process of learning and improving sports technique and the selection of effective strategies in performance [8-10, 22].

In this work we applied the battery of sports-motor tests recommended by Raczek et al. [12] as well as used in our own previous studies [18]. While standing with calves raised (s) in different versions (i.e. *Flamingo Test* [23] *Balance Beam Test*, *Balance Stand Test*, *Standing Stork Test* [24]) is a commonly used test of static balance, the measurement of dynamic balance is characterized by a greater variety. Witkowski et al. compared static balance (measured with the *Flamingo Test* based on EUROFIT in a modified version [23, p.154]) with dynamic balance (measured with the *Marching Test*) in 14-15-year-old boys training judo and in their non-active peers [25]. The test applied by us, i.e. turns on an inverted gymnastic bench (n), to measure dynamic balance (similarly to the *Marching Test* [25]) does not reflect the specificity of rotation of the body or wrestlers or judo athletes. `Rotational Test` used to evaluate the body balance disturbance tolerance skills [26] complies with the accuracy required and the criteria for this type of testing in relation to people practicing combat sports. Freestyle wrestlers, similarly it judokas, belong to athletes with the highest level of body balance disturbance tolerance skills [26]. It turns out that fire fighters with such skills qualify on leading ranking positions in the simulations of a rescue task [27].

Apart from the accuracy of the chosen tests, the results are an example of monitoring the CMA as an essential complement of knowledge about the complex morphological, mental, etc. possibilities of wrestlers [28, 29] at different stages of their sporting career and in each of the annual periods of training cycles.

CONCLUSIONS

Changes in the levels of CMA in freestyle wrestlers aged 16-20 occurred at different times, in different directions, with different intensity levels and had their own distinctive character. The greatest changes in the levels of CMA were discerned at the age of 16-17, where the bulk of CMA under investigation, kinesthetic differentiation and balance in particular, developed considerably. At the age of 19 and above a quick reaction ability still evolved.

The obtained research results can be utilised by wrestling coaches and instructors in a process of mapping out training loads in a long-term training process.

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