

THE LEVEL OF THE COORDINATION MOTOR SKILLS OF CHILDREN AGED 7–10 YEARS

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Abstract

The modern human being is characterised by lower and lower level of keep-fit skills and higher level of coordination skills. A greater role of coordination skills results from technological progress, which does not force people to hard physical work, but at the same time it forces to acquire complex skills of how to use new tools and devices. Coordination skills develop the most dynamically in the early stages of the ontogenesis.

The article presents the level of the coordination motor skills (CMS) of town children aged 7–10 years (515 girls and 484 boys). The research was done in the 2005–2006 period of time. The authors considered simple population exercises, which were possible to be applied in school conditions. The following elements were assessed: static balance, dynamic balance, sense of direction, frequency of arm movements, frequency of leg movements and simple reaction time. The analysis of variances indicated that the age was the factor, which differentiated significantly the kinetics of the development of the coordination motor skills of girls and boys aged 7–10 years. The increase of tested skills was noticed, regarding to boys and girls as well. The authors have not observed significant sexual dimorphism. The presented results show that the start of school education and the existence in its environment stimulate the CMS development of children. In regards to children aged 7–10 years, the authors perceived the improvement of the frequency of arm movements (ca. 33%), whereas the other skills increased between 20% and 30%. The exception was the simple reaction time, which is genetically determined and increased only ca. 6%.

Key words: motor abilities, motor development, coordination motor skills, sexual dimorphism, children

Introduction

In the modern world, due to technological and civilisation changes, the role of the physical work and the physical efforts decreases – the lifestyle changes. There are unfavourable body changes (Gába & Přidalová 2013), which lead to overweight and obesity. The level of the keep-fit skills decreases (strength, endurance). At the same time, the significance of such skills as: sense of direction, reaction rate, keeping balance in static and dynamic conditions, adjustment of movements to different conditions and situations etc., increases. Therefore, those skills become more and more essential in many areas of a human activity. High level of the development of the coordination motor skills guarantees that the undertaken activities are safe and the movement behaviour is correct. Moreover, high level of the coordination motor skills efficiently protects against different accidents, especially in difficult life situations.

The high CMS level can increase the efficiency of the physical education process at school as well as the efficiency of training

of children and youth. These skills, consisting the complex of potential properties of a human organism, indicate the speed and the quality of motor learning, its precision and sustainability. They guarantee adequate behaviours, depending on existing and changeable conditions. Therefore, the topic of the CMS control and its development should take a special place in the physical and health education of children and youth. In many countries, more and more often this aspect is appreciated in new curricula for physical education as well as in the concepts of sport training sessions.

Aim

The objective of the study is the assessment of the coordination motor skills (CMS) of children aged between 7–10 years with the age and the sex aspects taken into consideration.

Methodology

The research spanned 999 children from Kielce, including 515 girls and 484 boys, participating to 1st–3rd classes in 2004–2005 and 2008–2009 school years (Table 1).

Table 1. Age-class distribution

Years	7	8	9	10	Total
Girls	126	128	135	126	515
Boys	120	122	126	116	484
Total	246	250	261	242	999

Note: source – authors

In order to assess the coordination motor skills of children, the authors considered simple exercises, which were possible to be applied in school conditions, and which enabled to assess the following elements (Raczek et al., 2003):

1. static balance,
2. dynamic balance,
3. sense of direction,
4. frequency of arm movements,
5. frequency of leg movements,
6. simple reaction time.

In regards to *the static balance*, the authors assessed the possibility of standing on the Fleischman's beam (1964), whereas in the assessment of *the dynamic balance*, the march on the rosette of Měkota (1988) was evaluated. The *sense of direction* was assessed by trying "to jump up to reach the target" (Raczek et al., 2003). *The frequency of arm movements* was measured through "plate tapping" (Grabowski & Szopa, 1988), whereas *the frequency of leg movements* – by carrying a leg above a prop (Pilicz & Demel, 1978). The *simple reaction time* was measured with the use of the Dietrich sample (Raczek et al., 2003).

The authors assessed the normality of the distribution for the variables of the continuous character with the use of the Kolmogorov-Smirnov test. In the case, when the distribution did not have a normal character, the authors chose medians to conduct analysis. The differences between the medians achieved were verified with the use of the median test and the Kruskal-Wallis one-way analysis of variance by ranks and the dependences between continuing variables with the use of the analysis of variance method (ANOVA). The significance of the differences of variances was verified with the use of the Fisher-Snedecor test (Oktaba, 1980). The test was extended with "post-hoc" tests, which enabled to make repeated comparative analysis of the smallest, but significant differences – SSD. In order to assess the dependences between single categorised variables, the chi-squared and the Spearman's non parametric correlation tests were used. The authors accepted the probability at the level 0.05.

Results

The analysis of variances indicated that the age was the factor which differentiated significantly the kinetics of the development of the coordination motor skills in girls and boys aged

between 7–10 years. Such statement concerns the following aspects: the simple reaction time of left and right arms, the static and the dynamic balance, the sense of direction and the frequency of arm and leg movements (Table 2, Table 3).

Table 2. Analysis of variances of the coordination motor skills in girls aged 7–10 years with the age factor taken into consideration

	CMS	ss	df	MS	ss	MS	F	p
Simple reaction time – right arm		1.8	3	0.6	345	0.07	7.857	0.0000
Simple reaction time – left arm		1.7	3	0.6	345	0.08	6.986	0.0001
Static balance		41.7	3	13.9	323	3.04	4.584	0.0037
Dynamic balance		1220.0	3	406.7	323	13.83	29.396	0.0000
Sense of direction		73114.2	3	24371.4	323	7049.15	3.457	0.0167
Frequency of arm movements		2503.3	3	834.4	323	10.89	76.599	0.0000
Frequency of leg movements		1056.2	3	352.1	323	4.60	76.559	0.0000

Note: values statistically significant marked in bold, source – authors, ss – sum of squares, df – degrees of freedom, MS – mean square

Table 3. Analysis of variances of the coordination motor skills in boys aged 7–10 years with the age factor taken into consideration

	CMS	ss	df	MS	ss	MS	F	p
Simple reaction time – right arm		2.7	3	0.9	33	0.10	9.363	0.0000
Simple reaction time – left arm		1.3	3	0.4	33	0.10	4.428	0.0045
Static balance		73.0	3	24.3	1630	5.09	4.779	0.0028
Dynamic balance		1355.0	3	451.7	4386	13.71	32.950	0.0000
Sense of direction		86678.9	3	28893.0	2123206	6635.02	4.355	0.0050
Frequency of arm movements		2097.0	3	699.0	3921	12.25	57.048	0.0000
Frequency of leg movements		870.9	3	290.3	1966	6.14	47.246	0.0000

Note: values statistically significant marked in bold, source – authors, ss – sum of squares, df – degrees of freedom, MS – mean square

While participating in the initial school education (between 7 and 10 years old), the frequency of the arm movements increases significantly (ca. 33%) (Table 7). It is probably related to the educational process and the improvement of writing skills. The dynamic balance increases more seldom

(ca. 30%) (Table 5), similarly as the sense of direction and the static balance (ca. 25%) (Table 6, Table 4) and frequency of leg movements (ca. 21%). The simple reaction time achieves a very low level (ca. 6%) (Table 9, Table 10). It can be caused by strong genetic conditions.

Table 4. Characteristic of the static balance in girls and boys aged 7–10 years

Years	Standing time in the position “one foot in front of the other”, on the Fleischman’s beam (s)						d	t
	Girls			Boys				
	M	SD	V	M	SD	V		
7	2.64	2.00	75.67	2.76	2.09	75.53	0.12	0.452
8	3.10	1.50	48.20	3.04	1.40	45.90	−0.06	0.320
9	3.57	1.73	48.59	3.79	2.51	66.20	0.22	0.613
10	3.35	1.58	47.11	3.99	3.63	91.03	0.64	0.962

Note: source – authors, M – mean, SD – standard deviation

Table 5. Characteristic of the dynamic balance in girls and boys aged 7–10 years

Years	March on the rosette of Měkota (number of steps)						d	t
	Girls			Boys				
	M	SD	V	M	SD	V		
7	2.14	1.37	64.14	2.58	1.75	67.83	0.44	2.081*
8	3.64	2.95	81.16	4.02	2.42	60.23	0.38	1.026
9	5.84	5.65	96.90	6.70	5.58	83.25	0.87	0.911
10	8.06	5.51	68.44	8.29	5.90	71.20	0.24	0.179

Note: source – authors, M – mean, SD – standard deviation, * – $p < 0.05$

The authors stated that the sense of direction, the static and the dynamic balance significantly increase, however between 9 and 10 years old the sexual dimorphism increase to the boys' advantage. The frequency of arm and leg movements and the simple reaction time of left and right arm improve at the same level regarding girls as well as boys. It is related to the fact that in the early education stage such processes take place – it is the improvement of manual movements due to the maturity of the motor cortex in the nerve centre and the improvement of

the functions of the nerve centre and muscle and joint systems.

High values from the standard deviations (SD), especially from variables (V) indicate the particular differentiation between humans regarding the static and the dynamic balance (Table 4, Table 5), the sense of direction (Table 6) and the frequency of arm movements (Table 7). On the other hand, the significant lower individual differentiation of the coordination motor skills is observed regarding the frequency of leg movements (Table 8) and the simple reaction time (Table 9, Table 10).

Table 6. Characteristics of sense of direction in girls and boys aged 7–10 years

Years	Difference in the achievement of the target when jumping up with blindfolding – 5 m distance (cm)						d	t
	Girls			Boys				
	M	SD	V	M	SD	V		
7	138.38	93.91	22.56	132.82	95.73	21.86	5.57	0.441
8	132.84	91.21	18.62	123.29	76.71	18.78	9.55	0.817
9	102.92	61.03	16.40	98.10	69.47	16.28	4.81	0.436
10	107.34	65.98	14.95	89.85	66.09	14.95	17.49	1.151

Note: source – authors, M – mean, SD – standard deviation

Table 7. Characteristics of the frequency of arm movements in girls and boys aged 7–10 years

Years	Time of touching circles with the use of fitter arm – 50 times (s) (Eurofit sample – “plate tapping”)						d	t
	Girls			Boys				
	M	SD	V	M	SD	V		
7	22.56	4.26	18.88	21.86	4.08	18.66	0.71	1.271
8	18.62	3.06	16.43	18.78	3.54	18.85	−0.17	0.364
9	16.40	2.39	14.60	16.28	3.05	18.71	0.12	0.253
10	14.95	1.71	11.44	14.95	2.02	13.49	0.00	0.003

Note: source – authors, M – mean, SD – standard deviation

Table 8. Characteristics of the simple reaction time of the right arm in girls and boys aged 7–10 years

Years	Sitting position on a chair – carrying a fitter leg above a prop of 20 cm height in 20 s time (number of cycles)						d	t
	Girls			Boys				
	M	SD	V	X	SD	V		
7	19.46	1.85	9.53	19.98	2.25	11.24	0.53	1.922
8	21.68	2.27	10.48	21.18	2.55	12.06	−0.51	1.514
9	23.15	2.23	9.65	22.87	2.55	11.16	−0.29	0.704
10	24.83	2.41	9.69	24.90	2.77	11.14	0.07	0.123

Note: source – authors, M – mean, SD – standard deviation

Table 9. Characteristics of the simple reaction time of the right arm in girls and boys aged 7–10 years

Years	Reaction time when catching the Dietrich baton with the use of the right arm (s)						d	t
	Girls			Boys				
	M	SD	V	M	SD	V		
7	2.74	0.24	8.85	2.70	0.26	9.67	0.04	1.214
8	2.62	0.28	10.49	2.59	0.28	10.74	0.03	0.817
9	2.56	0.32	12.55	2.50	0.38	15.06	0.06	1.080
10	2.59	0.25	9.77	2.49	0.35	14.08	0.11	1.852

Note: source – authors, M – mean, SD – standard deviation

Table 10. Characteristics of the simple reaction time of the left arm in girls and boys aged 7–10 years

Years	Reaction time when catching the Dietrich baton with the use of the left arm (s)						d	t
	Girls			Boys				
	M	SD	V	M	SD	V		
7	2.71	0.25	9.22	2.64	0.29	11.00	0.07	2.063*
8	2.65	0.28	10.55	2.57	0.31	11.99	0.08	1.886
9	2.52	0.37	14.57	2.49	0.35	13.95	0.03	0.507
10	2.62	0.26	9.81	2.51	0.29	11.73	0.11	2.223*

Note: source – authors, M – mean, SD – standard deviation, * – $p < 0.05$

Table 11. Analysis of variances of the coordination motor skills in children aged 7–10 years with the sex factor taken into consideration

	CMS	SS	df	MS	S	MS	F	p
Simple reaction time – right arm		0.1	1	0.1	14	0.06	1.474	0.2260
Simple reaction time – left arm		0.3	1	0.3	17	0.07	4.258	0.0402
Static balance		0.9	1	0.9	934	4.17	0.205	0.6515
Dynamic balance		10.7	1	10.7	556	2.48	4.332	0.0386
Sense of orientation		1751.6	1	1751.6	201442	8992.97	0.195	0.6593
Frequency of arm movements		28.1	1	28.1	3894	17.38	1.616	0.2050
Frequency of leg movements		15.7	1	15.7	952	4.25	3.694	0.0559

Note: values statistically significant marked in bold, source – authors, ss – sum of squares, df – degrees of freedom, MS – mean square

The sexual dimorphism within the CMS in children aged 10 years was not significant. Only, regarding the children aged 7 years, the simple reaction time of the left arm and the dynamic balance were diversified depending on the sex (Table 11). In both cases, better results were achieved by boys. If there were any differences, they were not important and not statistically significant (Table 11).

Discussion

The CMS classification is still open. From the point of view of physical education practitioners in children and youth, it is very important to simplify this classification. In the last years, many authors have listed the following specific coordination skills (i.e. Raczek, 1993, 2010; Mynarski, 1995; Raczek et al., 2003):

- kinesthetic differentiation,
- balance in motion,
- rate of reaction,
- motor adaptation and movement,
- temporal and spatial orientation,
- link between movements,
- rhythmization of movements,
- frequency of movements.

In the paper the authors only diagnosed some of the skills, possible to be assessed in the research: static balance, dynamic balance, sense of direction and frequency of movements. The CMS assessment was conducted with the participation in children of initial education. The authors considered a specificity of initial education period.

Such skills mostly develop in the time of the early education stage, therefore it is often called “sensitive period” (Raczek, 2010), however the building of such terms is very controversial in the literature. The authors noticed a big differentiation between children, which can indicate that a genetic factor is responsible for such skills. This observation is coherent with the research results achieved by Szopa et al. (1985) and by Mleczko (1991) who, based on numerous studies coming from family research, developed the heritability, which considers significant genetic determinants of such skills.

The results achieved clearly indicate that the sexual dimorphism of the coordination motor skills of children aged 7–10 years is not significant, without any particular tendency that any of the sex is dominant. The similar results were presented by other authors (Jopkiewicz et al., 2011; Kopecný, 2006; Mleczko, 1991; Raczek & Mynarski, 1992), who also applied experimental measurement methods for the assessment of these skills.

Conclusion

1. The CMS level in the initial education process (children aged 7–10 years) indicates little sexual dimorphism, but without any particular tendency that any of the sex (girls or boys) is dominant.

2. The start of the initial school education and the existence in its environment stimulate the CMS development in children. Between 7 and 10 years old, the frequency of the arm move-

ments increases significantly (ca. 33%), which is probably related to the educational process and the improvement of writing skills. The other CMS development (dynamic and static balance, sense of direction and frequency of leg movements) increase between 20–30%. The exception is the simple reaction time, which is conditioned genetically (ca. 6%).

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