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Associations between Morphological Characteristics, Motor Abilities and Preparedness for School in Preschool Girls

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Abstract

Links between morphological characteristics (MC), motor abilities (MA) and psychological preparedness (PP) for school of preschool girls could help improve the quality of educational work for their teachers. The main goal of the study was to determine the correlation between three sets of data: MA, MC and PP. The randomized sample of preschool girls (N=127), aged 6-7, was examined. Fourteen MCs were measured. To measure MAs of the participants, 18 composite motor tests were adjusted for preschool children, three for each motor dimension: coordination, flexibility, strength, agility, accuracy and balance. Test for School Preparedness (TSS) with five subtests was used in estimating PP. The correlations between MC, MA and PP of preschool girls were determined by the use of both univariate and canonical correlations. The results revealed that all canonical correlations were statistically significant: between MC and MA, MA and PP, as well as MC and PP. However, in spite of its significance, canonical correlation was lowest between MC and PP. One of the hypotheses in explaining this relationship could be the speed of maturity, which is different for preschool girls and boys.

Key words*: anthropometry; correlation; development; growth; preschool children; psychological tests.*

Introduction

During the processes of growth and development, the associations between children's motor abilities, morphological characteristics and their preparedness for school offer a wider perspective for developing preschool educational programs. Therefore, the

purpose of this study was to investigate the correlations between these three sets of data for preschool-age girls.

Kinanthropology is an interdisciplinary (biological, psychological, cultural and social aspects) investigation of physical activities. It is focused on the research of the variability of human characteristics and abilities, when these are related to physical activity, physical exercise and sports, during the life span (Mišigoj-Duraković, 2008). Various kinesiological programs lead to the quantitative and qualitative changes in kinanthropological dimensions, affecting these dimensions, as well as their relationships (Ismail, 1976; Mišigoj-Duraković, 2008). During growth, the structure of certain dimension is changing, within the dimension itself and in relation to other dimensions (Bala, 2003a), and these changes are specific for certain developmental periods (Bilić, 2007), and for children's individuality (Bala, 2003b). Sexual dimorphism in certain kinanthropological dimensions is obvious at the end of the second developmental period (Bala, Popović, & Jakšić, 2009; Horvat, Breslauer, & Miščančuk, 2010). The interaction between individual characteristics and abilities during a child's development includes physical, cognitive, emotional and social development (Horvat, Babić, & Jenko Miholić, 2013).

In the field of **morphological characteristics (MCs)**, hypokinesis has a strong influence on raising the average values in children's body volume and body mass and corresponding measurements (e.g. measures of subcutaneous fat tissue, body parts circumferences) (Abalkhail, 2002; Datar & Sturm, 2004; Horvat, Mišigoj-Duraković, & Prskalo, 2009). Therefore, the results of several studies suggest that regular growth and development of MCs have an influence on the development of the child's general motor ability (MA), and vice versa (Bala, Jakšić, & Katić, 2009). The three-dimensional model of MCs explains that longitudinal and transverse skeleton dimensionality are very often comprised into a single dimension named skeleton dimensionality (i.e. occasionally longitudinal skeleton dimensionality) (Malacko, Bala, & Patarić, 1981). The three-dimensional MCs model in adolescents includes body mass, skeleton dimensionality and volume, and subcutaneous adipose tissue (Viskić-Štalec, 1974; Kurelić et al., 1975). In very young children, a two-dimensional model of MCs is usually found. This model consists only of skeleton dimensionality and voluminosity, as well as subcutaneous adipose tissue (Bala, 1981).

Motor abilities (MAs) could be described as the latent motor structure which is responsible for an infinite number of manifest motor reactions, which could be measured and described (Mraković, 1992). However, the studies on MAs of preschool children have a relatively long history. The study on throwing a ball at the moving and stationary target was conducted in the first half of the 20th century (Hicks, 1930). In another study, jumping over an obstacle was used as an indicator of motor development (Cowan & Pratt, 1934). It is important to notice that a lack of motor activities during children's growth cannot be recovered in later periods of their growth and maturation. This deficient motor activity can slow down a child's overall

psychosomatic development (Humphrey, 1991; Kelly & Kelly, 1985). Determining the structure of MAs in preschool girls is one of the priorities for improving the quality of educational programs for children, bearing in mind sexual dimorphism. The structure of latent MAs in girls was defined in earlier studies (Horvat et al., 2010; Horvat, 2011; Hraski, V. Horvat, & I. Horvat, 2011; Horvat et al., 2013). These authors found that this structure is four-dimensional, consisting of the following factors: general factor of motor abilities, coordination, balance and flexibility. From these studies it could be concluded that the defining of the latent structure, just as in the case of adults, could be expected only in the later periods of life.

An important task for children's educators, parents and teachers in kindergartens is the systematic stimulation of the characteristics, which are the base of **psychological preparedness (PP)** for starting elementary school. Readiness for school is a complex set of characteristics. One classification describes physical, speech, intellectual, emotional and social maturity for school (Furlan, 1984), while the other lists physical, personal and functional maturity (Toličič, 1970, as cited in Šimunec-Muhek, 1995). Physical development (i.e. MCs) is the criterion that describes the importance of regular physical growth, which allows a child to cope more easily with various physical and mental efforts that await him/her at school (Vasta, Haith, & Miller, 1997). Mental readiness (PP) unifies the dimensions of psychomotor, cognitive, emotional and social readiness as well as a child's motivation to learn (Vasta et al., 1997). Among these aspects, cognitive readiness (adequate speech development, perception, thinking and memory, closely linked with the extent and stability of attention) is the most important aspect of the PP because it is related with the most important academic functions. Hence, it is particularly important to evaluate cognitive readiness most carefully. Motivation for learning is a very important determinant of school success. Mental reluctance, which could be a consequence of low motivation, is a major cause of school failure. Therefore, it is necessary to combine the legal-administrative and psychophysical criteria of a child's maturity for starting elementary school.

In order to design properly the kinesiology programs for preschool children, educators must have in mind the sexual dimorphism among preschool children in their MCs, MAs and PP for starting school. Making associations between these three sets of characteristics, separately for boys and girls, should provide an insight into potential gender differences in these associations. It would facilitate the insights, which are the prerequisites for adequate designs of age- and gender-adjusted programs of preschool physical education. Moreover, the findings of the research could point to certain gender differences, which would certainly be a starting point for further research.

The main **goal** of this research is to determine the correlations between three sets of data in preschool aged girls: MCs, MAs and PP for starting elementary school. The main hypothesis was that there are statistically significant correlations between all studied sets of characteristics: between MCs and MAs, between MAs and PP, as well as between MCs and PP.

Methods

Subjects

From the Croatian population of kindergarten children from urban environment (cities of Zagreb and Varaždin), a randomized sample of 121 girls was measured (chosen from the alphabetically ordered list of all girls enrolled in two kindergartens with similar capacities, in the oldest age group). At the moment of data collection, the average age of girls was 6.5 years ± 6 months (M±SD). For each participant included in the sample a parental written consent had been obtained, by which parents allowed their children to participate in the research, which is in compliance with the Code of Ethics prepared by the Children's Council, the counseling body of the Government of the Republic of Croatia.

Motor Abilities

Motor abilities of the subject sample were measured with a set of eighteen composite motor tests, usually used to assess motor and energy supply abilities of schoolchildren. For this study, the tests had been modified to comply with the capabilities of preschool children (Horvat, 2010). The tests assessed latent dimensions of coordination, flexibility, strength, agility, accuracy and balance in preschool girls, 6-7 years old. For each of the latent dimensions three composite tests were used, which were performed three times. Horvat, Babić, and Jenko Miholić (2013) give details about the characteristics and application of these tests in their article. All measurement courses and measurement periods were shortened and the number of stands was reduced. Moreover, at least one tryout was introduced before each test performance, to ensure approximately equal level of motor skill and familiarization with the tasks of all participants.

Cognitive Preparedness for School

The psychological measuring instrument constructed by Vlahović-Štetić, Vizek-Vidović, Arambašić, and Miharija (1995) was used for testing preparedness for school. "Test of preparedness for school" consists of five subtests: Perceptual test (TSS-P), Test of the knowledge of the facts (TSS-CC), Numerical test (TSS-N), Test connecting points (TSS-T) and Test strikethrough (TSS-C).

The first three subtests (Perceptive test, Test connecting points and Test strikethrough) are designed to assess the specific abilities of children while the other two subtests (Test knowledge of the facts and Numerical test) are designed to assess children's knowledge.

Testing was conducted in small groups (up to seven children) and it lasted for about an hour. After the first three subtests, fifteen minutes breaks were made, so that the limited concentration of children would not have a negative effect on the measurement results. Psychologists employed in these children's kindergartens performed the assessment of each child's preparedness for school.

Perceptual Test (TSS-P)

This test aims to examine the visual perception and differentiation of complex characters. Visual perception is important for the initial teaching of reading and

writing. The task was designed in such way that it requires a child to recognize two identical characters among five available characters, and to mark them. Characters can be realistic or abstract, as well as a combination of letters or numbers. The test consists of 15 questions and each correct answer scores one point. Predicted time duration for this test is 7 minutes.

Test Connecting Points (TSS-T)

This test checks the graphomotor ability of children, i.e. the level of fine coordination of hand movement. This ability is important for the acquisition of writing skills. The tasks consist of connecting multiple points in an attempt to draw a default figure that is presented in the network on the left side. The test consists of 10 tasks that should be done within the expected period of 8 minutes. The first two tasks require connecting a network of nine points while in the remaining tasks other characters are obtained by connecting sixteen points.

Test Knowledge of the Facts (TSS-CC)

This test assesses the understanding and handling of everyday facts and concepts, and the knowledge of their relationships. The goal is to determine the child's experience in the areas of nature, technology, people and society. It checks understanding of the facts and functional relations. A higher level of acquisition of information makes it easier for the child to find his/her way around the school and to adopt systematic information required by the school. The test consists of 14 tasks whereby each consists of 4 drawings of which only one is the correct answer to the interviewer's question. The expected duration is 10 minutes.

Test Strikethrough (TSS-C)

This test aims to check the ability of fine motor skills and oculomotor coordination, which is important for the acquisition of writing skills. The child should cross out between two parallel horizontal lines the character which is drawn at the beginning of the line. Some characters are numbers or letters, while others are made by drawing straight and curved lines. Most characters are similar in shape. The test consists of nine tasks and the time during which children should complete it is 9 minutes.

Numerical Test (TSS-N)

This test aims to check the child's knowledge of ordinal numbers and the ability to solve different problem tasks, as well as the willingness to learn mathematics. In one of the tasks, the knowledge of the term "small part of the whole number", i.e. the term "half" are checked. In every task, there are five drawings, and the child should mark the correct answer. This test consists of 10 tasks and takes about 10 minutes to complete.

Morphological Characteristics

The variables for the assessment of morphological characteristics of children are: body height (AVIS), body mass (ATTE), sitting height of the body (AVSJ), arm length

(ADRU), upper arm skinfold (ANNA), abdominal skinfold (ANTR), back skinfold (ANLE), lower leg skinfold (ANPK), upper arm circumference (AONO), forearm circumference (AOPD), upper leg circumference (AONK), lower leg circumference (AOPK), hip width (ASKU) and shoulder width (ASRA).

All measurements were performed using the standard methods and instruments, as described in the instructions of the International Biological Program (IBP - Weiner & Lourie, 1968). Measurements of height, width, weight and circumference were taken once. Every skinfold measurement was taken three times using the John Bull Caliper.

Measurements of morphological characteristics were taken in the morning, immediately upon children's arrival to the kindergarten. Students who were attending the elective course "Kinesiological transformations" were taking the measurements. During a course of mandatory exercises, they were adopting methods and techniques of measurement in the field of kinesiology. Particular attention was given to the acquisition of knowledge regarding the implementation of measurements just for those variables that were used in this study. In this way, the measurers were specially prepared for this research.

The reliabilities between all repeated measurements of MCs and MAs were above 0.80, and could be estimated as very reliable.

Measurement Protocol

Three times a week, in 30-minute sessions, children had an opportunity to become familiar with the motion and moving patterns they were going to perform as the future test tasks. This was done to even, as much as possible, the level of motor knowledge and skill in the future examinees and to reduce its probable impact on the results when testing motor abilities.

Motor abilities were measured during three consecutive days. At the beginning of each measurement day, children were specially prepared. The preparations commenced each day with 3-minute cyclic gross movements with various tasks. Various tasks included walking (on toes, on heels, step-shuffle step-step-shuffle step), various rate running, and jumps (two-legged and one-legged). Afterwards, a set of general preparatory exercises (10 to 12) for the whole body was applied. The drills were selected to address those big muscle groups that were going to be under special load in the forthcoming testing for that day.

The tests were scheduled across three days with the aim to prevent, as much as possible, the negative impact of previous tests on performance of the subjects in the later ones. In addition, fatigue was avoided as much as possible, as well as loss of motivation in the participants. Therefore, the test assessing dynamic muscular endurance or repetitive strength of the trunk (sit-ups) was performed at the end of the measurement of each day (three measurements altogether).

Statistical Analysis

The need for complete data for all variables on all cases (missing values) reduced the number of motor tests to 18, while in the set of MCs, the data of 14 anthropological

measures were taken. Canonical analysis was used to provide the correlations between each two sets of such variables: MC and MA, MA and PP, PP and MC. The values of Wilks lambda and corresponding Chi-squares are used to indicate the level of statistical significance of canonical correlation. The other and potentially useful indicators of the associations (Malacko, Bala, & Patarić, 1981) between these three sets of data were the univariate (Pearson) correlations. The statistical program SPSS (Statistical Package for the Social Sciences 20.0) was used.

Results

In Table 1, univariate correlations between MCs and MAs for the sample of girls in kindergartens are shown. Among 252 correlations between all the variables in those two sets, 27 correlations were statistically significant. All significant correlations are in fact very low. The highest number of statistically significant correlations was found for ADRU and AVSJ in the space of MCs, while most significant correlations were found for MSSDY, MRJOY and MAKSY in the space of MAs.

Table 1

Cross-correlations between morphological measures and motor tests

	ATTE	AVIS	AVSJ	ADRU	ANNAX	ANTRXS	ANLEX	ANPKX	AONO	AOPD	AONK	AOPK	ASKU	ASRA
MKGRY	**-0.222***	-0.087	-0.160	**-0.251****	0.067	-0.017	0.089	0.059	-0.032	0.004	-0.073	-0.133	0.003	0.002
MKGNY	-0.075	0.033	-0.012	-0.080	0.132	0.058	0.108	0.085	0.045	0.061	0.035	0.023	0.041	-0.021
MKHNY	0.004	0.001	-0.050	0.018	0.029	0.080	0.032	0.039	0.046	0.094	0.106	0.033	-0.226*	-0.263*
MFIPY	**0.217***	0.175	0.182	**0.220***	0.028	0.137	0.127	0.133	0.018	-0.073	0.167	0.076	0.030	0.131
MFSRY	-0.109	-0.124	0.010	-0.048	0.023	0.000	0.093	-0.083	-0.103	-0.062	-0.098	-0.111	-0.019	0.042
MFPKY	-0.085	-0.061	0.028	-0.100	0.032	0.090	0.117	0.098	-0.007	-0.023	-0.120	-0.063	0.099	0.106
MS10Y	-0.100	-0.185	0.005	-0.128	-0.051	-0.078	-0.102	-0.040	-0.124	-0.010	-0.176	**-0.217***	-0.042	-0.006
MSSDY	0.191	0.060	**0.211***	**0.242***	**-0.211***	-0.107	-0.154	**-0.234***	-0.025	-0.035	0.015	-0.006	-0.052	-0.010
MSPTY	0.140	0.007	0.040	**0.257****	-0.024	-0.033	-0.067	-0.095	0.056	0.154	-0.017	0.099	-0.049	-0.037
MAKSY	-0.166	**-0.236***	**-0.338****	-0.070	-0.091	**-0.216***	-0.124	-0.094	-0.120	-0.122	-0.176	-0.178	-0.134	-0.223*
MAOOY	-0.162	-0.128	**-0.248***	-0.011	-0.006	-0.049	-0.020	-0.109	0.013	-0.047	-0.092	-0.080	-0.106	-0.067
MAOSY	-0.066	-0.118	**-0.196***	-0.002	0.008	-0.062	-0.014	0.060	-0.064	-0.072	-0.130	-0.046	-0.089	-0.102
MPGCY	0.114	0.110	0.148	0.154	-0.002	0.049	0.071	0.126	0.037	0.083	-0.048	-0.025	0.188	0.232*
MPGOY	**0.203***	**0.211***	0.150	0.178	0.049	0.130	0.099	0.052	0.130	0.175	0.185	**0.240***	0.089	0.086
MPCSY	**0.192***	0.144	0.133	0.182	0.082	0.016	-0.091	0.112	0.158	0.130	0.065	0.207*	0.102	0.060
MRJUY	0.027	-0.009	0.033	0.011	0.067	-0.023	-0.041	0.005	-0.026	-0.020	-0.130	-0.112	-0.028	0.040
MROPY	-0.020	-0.012	0.089	-0.041	0.008	0.103	0.046	0.055	-0.028	0.025	-0.028	0.034	0.103	0.177
MRJOY	-0.025	-0.096	-0.006	-0.113	-0.150	**-0.191***	-0.099	-0.076	**-0.192***	**-0.192***	-0.144	-0.125	-0.087	-0.084

** Correlation is significant at the 0.01 level (2-tailed);
* Correlation is significant at the 0.05 level (2-tailed).

Morphology: *body height (AVIS), body mass (ATTE), sitting height of the body (AVSJ), arm length (ADRU), upper arm skinfold (ANNA), abdominal skinfold (ANTR), back skinfold (ANLE), lower leg skinfold (ANPK), upper arm circumference (AONO), forearm circumference (AOPD), upper leg circumference (AONK), lower leg circumference (AOPK), hip width (ASKU), shoulder width (ASRA).*

Motor tests: *MKGRY, MKGNY, MKHNY (coordination), MFIPY, MFSRY, MFPKY (flexibility), MS10Y, MSSDY, MSPTY (strength), MAKSY, MAOOY, MAOSY (agility), MPGCY, MPGOY, MPCSY (accuracy), MRJUY, MROPY, MRJOY (balance)*

Canonical analysis of MCs and MAs is guided by the hypothesis discussed in the introduction. Most of the findings discussed above reappear in the canonical results in Table 2. Of all the canonical correlations obtained in the analysis, only the first one, $R_{can}1 = 0.690$ was significant at the 0.01 level.

The first canonical solution (first pairs of canonical roots) was found between the set of MCs (high values for ATTE, ADRU, AVSJ, AONK, AOPK) and the set of MAs (high values for MKGRY, MSSDY, MSPTY, MPGOY) (Table 2). The univariate correlations in the space of MCs show that ADRU and ATTE correlated with the composite score (0.56 and 0.51), while ANLEX and ANPKX barely had any correlation (-0.09). The univariate correlations in the space of MAs show that MKGRY and MSSDY correlated with the composite score (0.57 and 0.52), while MAOOY barely had any correlation (0.03). The canonical correlation squared reveals that 48% of the variance in the composite performance can be linked to the composite score of both morphological and motor variables.

Table 2

Canonical correlations between morphological measures and motor tests – first canonical root

Correlations with Composite Scores[a]	Morphological measures	Canonical Variate Coefficients[b]		Canonical Variate Coefficients	Motor tests	Correlations with Composite Scores
0.507	ATTE	0.460	R_{can1}=0.690	-0.554	MKGRY	**-0.565**
0.280	AVIS	-1.325	R^2_{can1}=0.476	-0.005	MKGNY	-0.316
0.444	AVSJ	0.325	c^2= 343.673	0.549	MKHNY	0.135
0.564	ADRU	0.310	df=252	0.295	MFIPY	0.319
-0.122	ANNAX	-0.872	Wilks l=0.036	-0.172	MFSRY	-0.114
0.183	ANTRXS	0.605	p<0.01	0.227	MFPKY	-0.142
-0.086	ANLEX	-0.171		0.090	MS10Y	-0.213
-0.086	ANPKX	-0.152		0.530	MSSDY	**0.521**
0.177	AONO	0.832		0.193	MSPTY	**0.399**
0.150	AOPD	-0.391		-0.281	MAKSY	-0.294
0.326	AONK	0.239		0.044	MAOOY	-0.028
0.339	AOPK	1.007		0.044	MAOSY	-0.112
-0.160	ASKU	-0.798		-0.234	MPGCY	-0.081
-0.109	ASRA	0.561		0.049	MPGOY	**0.336**
				0.127	MPCSY	0.277
				-0.129	MRJUY	-0.205
				0.060	MROPY	0.107
				-0.110	MRJOY	-0.145
Redundancy	22.086 %			Redundancy	16.140 %	

[a]*The simple product-moment correlations between the variable and the composite scores computed in the canonical analysis.*

[b]*The standardized coefficient of the variable used in computing the canonical variate that generated the composite scores.*

Morphology: *body height (AVIS), body mass (ATTE), sitting height of the body (AVSJ), arm length (ADRU), upper arm skinfold (ANNA), abdominal skinfold (ANTR), back skinfold (ANLE), lower leg skinfold (ANPK), upper arm circumference (AONO), forearm circumference (AOPD), upper leg circumference (AONK), lower leg circumference (AOPK), hip width (ASKU), shoulder width (ASRA).*

Motor tests: *MKGRY, MKGNY, MKHNY (coordination), MFIPY, MFSRY, MFPKY (flexibility), MS10Y, MSSDY, MSPTY (strength), MAKSY, MAOOY, MAOSY (agility), MPGCY, MPGOY, MPCSY (accuracy), MRJUY, MROPY, MRJOY (balance)*

In Table 3, the cross-correlations between MCs and PPs for the sample of girls in kindergartens were shown. Among 60 cross-correlations between all the variables in those two sets, only 5 were statistically significant. All significant correlations are in fact very low. Most of the significant correlations were found for ATTE and ADRU in the space of MCs, while most of the significant correlations were found for TSST and TSSP in the space of PPs.

Table 3

Cross-correlations between morphological measures and psychological tests

	TSSP	TSSCC	TSSN	TSST	TSSC
ATTE	**0.200***	-0.009	0.044	**0.191***	0.045
AVIS	0.108	-0.115	0.028	0.013	-0.028
AVSJ	0.120	0.024	0.135	0.123	-0.060
ADRU	**0.267****	0.068	0.000	**0.293****	0.162
ANNAX	0.026	-0.030	0.024	-0.064	0.053
ANTRXS	-0.042	-0.119	0.047	-0.139	-0.002
ANLEX	-0.101	**-0.293****	-0.080	-0.183	-0.022
ANPKX	0.129	-0.041	0.174	-0.009	0.043
AONO	0.050	-0.101	-0.055	-0.052	0.070
AOPD	0.159	-0.069	-0.048	-0.056	0.110
AONK	0.080	-0.126	-0.020	-0.067	-0.003
AOPK	0.133	-0.064	0.046	-0.016	0.048
ASKU	0.023	-0.096	-0.052	0.045	-0.039
ASRA	-0.013	-0.044	0.058	0.062	-0.080

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Morphology: *body height (AVIS), body mass (ATTE), sitting height of the body (AVSJ), arm length (ADRU), upper arm skinfold (ANNA), abdominal skinfold (ANTR), back skinfold (ANLE), lower leg skinfold (ANPK), upper arm circumference (AONO), forearm circumference (AOPD), upper leg circumference (AONK), lower leg circumference (AOPK), hip width (ASKU), shoulder width (ASRA).*

Cognitive tests*: perceptual (TSSP), knowledge of the facts (TSSCC), numerical (TSSN), connecting points (TSST), strikethrough (TSSC).*

Canonical analysis between MCs and PPs is guided by the hypothesis discussed in the introduction. Of all the canonical correlations obtained in the analysis, only the first one, $R^2_{can}1=0.634$, was significant at the 0.01 level (Table 4).

The first canonical solution (first pairs of canonical roots) is found between the set of morphological variables (high values for AVSJ, ANLEX, AONO, AOPD) and the set of psychological variables (high values for TSST, TSSCC and TSSN) (Table 4). The univariate correlations in the field of morphological measures show that ANLEX and AOPD correlated -0.44 and -0.38 with the composite score, while ANPKX barely had any correlation (0.01). The univariate correlations in the field of psychological variables show that TSSCC and TSST correlated both - 0.48 with the composite score, while TSSP barely had any correlation (0.16). The canonical correlation squared

reveals that 40% of the variance in the composite performance can be linked to the composite score of both morphological and psychological variables.

Table 4

Canonical correlations between morphological measures and psychological tests – first canonical root

Correlations with Composite Scores[a]	Morphological measures	Canonical Variate Coefficients[b]		Canonical Variate Coefficients	Cognitive tests	Correlations with Composite Scores
0.164	ATTE	-0.441	R_{can1}=0.634	-0.206	TSSP	0.163
-0.024	AVIS	0.863	R^2_{can1}=0.402	0.400	TSSCC	**0.481**
0.347	AVSJ	0.583	c^2= 122.240	0.494		
				0.895	TSSN	**0.450**
0.120	ADRU	0.203	df=70		TSST	**0.479**
-0.181	ANNAX	0.634	Wilks l=0.329	-0.981	TSSC	-0.193
-0.218	ANTRXS	-0.340				
-0.440	ANLEX	-0.793	p<0.01			
-0.011	ANPKX	-0.075				
-0.304	AONO	-0.338				
-0.382	AOPD	-0.614				
-0.211	AONK	-0.272				
-0.143	AOPK	0.266				
-0.352	ASKU	-0.653				
0.311	ASRA	0.911				
	Redundancy	6-270 %			Redundancy	18.897 %

[a]*The simple product-moment correlations between the variable and the composite scores computed in the canonical analysis.*

[b]*The standardized coefficient of the variable used in computing the canonical variate that generated the composite scores.*

Morphology: *body height (AVIS), body mass (ATTE), sitting height of the body (AVSJ), arm length (ADRU), upper arm skinfold (ANNA), abdominal skinfold (ANTR), back skinfold (ANLE), lower leg skinfold (ANPK), upper arm circumference (AONO), forearm circumference (AOPD), upper leg circumference (AONK), lower leg circumference (AOPK), hip width (ASKU), shoulder width (ASRA).*

Cognitive tests*: perceptual (TSSP), knowledge of the facts (TSSCC), numerical (TSSN), connecting points (TSST), strikethrough (TSSC).*

In Table 5, the cross-correlations between motor tests and psychological tests for the sample of girls in kindergartens are shown. Among 90 cross-correlations between all the variables in those two sets, 13 correlations are statistically significant. All significant correlations are in fact low or very low. Most of the significant correlations were found for MPCSY and MRJUY, in the field of motor tests, while most of significant correlations were found for TSSCC, TSSN and TSST in the field of psychological tests.

Table 5

Cross-correlations between motor tests and psychological tests

	TSSP	TSSCC	TSSN	TSST	TSSC
MKGRY	-0.174	-0.129	-0.071	-0.097	-0.074
MKGNY	-0.124	**-0.192***	-0.075	-0.017	0.003
MKHNY	-0.025	-0.141	-0.100	-0.144	-0.003
MFIPY	-0.031	0.138	0.128	0.088	-0.077
MFSRY	-0.042	0.032	0.014	-0.070	-0.050
MFPKY	-0.027	-0.137	0.013	0.007	-0.006
MS10Y	0.127	0.020	-0.043	0.099	0.036
MSSDY	-0.015	0.011	0.171	0.123	-0.059
MSPTY	0.157	0.071	0.132	0.148	0.178
MAKSY	0.015	-0.089	-0.121	-0.083	0.084
MAOOY	0.052	0.099	0.019	0.058	**0.194***
MAOSY	0.095	-0.016	0.034	-0.007	0.128
MPGCY	**0.239***	0.126	0.119	**0.287****	0.128
MPGOY	0.159	-0.047	0.023	0.094	-0.008
MPCSY	0.270**	0.234*	0.202*	0.284**	0.239*
MRJUY	0.156	**0.201***	**0.220***	**0.277****	0.169
MROPY	-0.036	0.044	**0.206***	0.125	-0.016
MRJOY	-0.012	0.171	0.086	0.123	0.129

*** Correlation is significant at the 0.01 level (2-tailed).*

** Correlation is significant at the 0.05 level (2-tailed).*

***Cognitive tests**: perceptual (TSSP), knowledge of the facts (TSSCC), numerical (TSSN), connecting points (TSST), strikethrough (TSSC).*

***Motor tests:** MKGRY, MKGNY, MKHNY (coordination), MFIPY, MFSRY, MFPKY (flexibility), MS10Y, MSSDY, MSPTY (strength), MAKSY, MAOOY, MAOSY (agility), MPGCY, MPGOY, MPCSY (accuracy), MRJUY, MROPY, MRJOY (balance)*

Canonical analysis of motor and psychological tests is guided by the hypothesis discussed in the introduction. Of all the canonical correlations obtained in the analysis, only the first one, $R^2_{can}1 = 0.606$, was significant at the 0.05 level (Table 6).

The first canonical solution (first pairs of canonical roots) is found between the set of motor variables (high values for MFIPY, MSSDY, MAKSY, MPGSY, MPCSY, MRJUY and MROPY) and set of psychological variables (high values for TSST, TSSN, TSSCC) (Table 6). The univariate correlations in the field of motor measures show that MRJUY and MROPY correlated (0.48 and 0.47) with the composite score, while MFSRY barely had any correlation (-0.03). The univariate correlations in the field of psychological variables show that TSST and TSSN correlated (0.69 and 0.67) with the composite score, while TSSP barely had any correlation (-0.22). The canonical correlation squared reveals that 48% of the variance in the performance composite can be linked to the composite score of both motor and psychological variables.

Table 6

Canonical correlations between motor tests and psychological tests – first canonical root

Correlations with Composite Scores[a]	Cognitive tests	Canonical Variate Coefficients[b]		Canonical Variate Coefficients	Motor tests	Correlations with Composite Scores
0.270	TSSP	-0.217	R can1=0.606	0.195	MKGRY	-0.109
0.357	TSSCC	0.047	R^2can1=0.476	0.040	MKGNY	-0.088
0.674	TSSN	0.690	c^2= 117.056	-0.086	MKHNY	-0.345
0.686	TSST	0.977	df=90	0.451	MFIPY	**0.389**
0.150	TSSC	-0.625	Wilks l=0.338	-0.013	MFSRY	-0.028
			p<0.05	0.322	MFPKY	0.031
				0.291	MS10Y	0.030
				0.575	MSSDY	**0.460**
				-0.056	MSPTY	0.155
				-0.286	MAKSY	**-0.370**
				-0.110	MAOOY	-0.096
				0.331	MAOSY	-0.140
				-0.042	MPGCY	**0.391**
				-0.002	MPGOY	0.125
				0.434	MPCSY	**0.363**
				0.518	MRJUY	**0.482**
				0.195	MROPY	**0.470**
				-0.040	MRJOY	0.181
	Redundancy	20.883 %			Redundancy	6.231 %

[a]*The simple product-moment correlations between the variable and the composite scores computed in the canonical analysis.*

[b]*The standardized coefficient of the variable used in computing the canonical variate that generated the composite scores.*

***Cognitive tests**: perceptual (TSSP), knowledge of the facts (TSSCC), numerical (TSSN), connecting points (TSST), strikethrough (TSSC).*

***Motor tests:** MKGRY, MKGNY, MKHNY (coordination), MFIPY, MFSRY, MFPKY (flexibility), MS10Y, MSSDY, MSPTY (strength), MAKSY, MAOOY, MAOSY (agility), MPGCY, MPGOY, MPCSY (accuracy), MRJUY, MROPY, MRJOY (balance)*

Discussion

The main finding of this research is a consideration that correlations (in spite of their statistical significance) between psychological (cognitive) and motor tests are lowest (significant at p<0.05), while the correlations between morphological measures and cognitive tests are higher, as well as the correlations between motor and cognitive tests, in preschool-age girls (both at p<0.01). In fact, a more exact claim could be that all three canonical correlations in girls have a similar value. It could be also considered that among univariate correlations between MC and MA, MA and PP, as well as between PP and MC, all (even statistically significant) univariate correlations are in fact zero-ordered, very low or low-sized.

In previous research, in which the participants were boys of the same preschool age (Horvat, Sindik, & Mraković, 2015), the correlations between morphological measures

and motor tests were higher, as well as the correlations between motor and cognitive tests. This sexual (gender) dimorphism could be explained also by the finding that boys of the same age (6-7 years) score better than girls in most tests which assess motor abilities (Horvat et al., 2013). The results revealed are contradictory to the findings of the study conducted by Bala and Katić (2009), in which cognitive aspects showed higher correlations with motor abilities in female than in male children. However, the findings obtained in this study, similarly as in the study where the participants were boys of the same preschool age (Horvat, Sindik, & Mraković, 2015), replicated the finding that cognitive characteristics (PP) relatively weakly correlate with MCs and/or MAs, while MAs and MCs are higher related in male children (Bala et al., 2009). It could be generally considered that these results are, more or less, in accordance with the theory of integral development of children (Bala & Katić, 2009), having in mind that the pace of the development and growth is different in boys and girls (always having in mind individual variations), especially in some stages. From the kinesiological aspect, it is important to emphasize that better functioning of the nervous system and the child's conductive motor performance are both preconditions and consequences of harmonious functioning of the mechanisms of movement regulation and energy regulation (Bala & Katić, 2009).

There was quite a high association of MCs and MAs structures in the group of girls (in this study) and boys (in the study conducted by Horvat et al., 2015), aged 6 to 7. This relation explained about 62% of common variability for the first pairs of canonical roots for boys and only 48% for the first pairs of canonical roots in girls. In the area of the relationships between MCs and PPs, the first pairs of canonical roots for boys explained 32% of common variability (Horvat et al., 2015), while the association for the first pairs of canonical roots in girls is higher (explained common variability of 40%). In the field of the relationships between MAs and PPs, the first pairs of canonical roots for boys explained 42% of common variability (Horvat et al., 2015), while the association for the first pairs of canonical roots in girls is higher (explained common variability of 48%). These findings suggest that both motor development and motor behavior in boys was, to a larger extent, defined by morphological growth and development, compared to preschool girls aged 6-7. On the other hand, girls of the same age have a better balanced integral psychosomatic development than preschool boys. The explanations could be given in terms of the trend and level of growth and development of morphological structure, motor structure and central nervous system, as well as in terms of physical activity that is more emphasized in boys than in girls (Bala et al., 2009).

The findings from previous studies show that girls aged 6-7 achieved better results in assessing flexibility, which is primarily under the influence of the synergy and tonus regulation mechanisms (Brodie & Royce, 1998; De Privitellio, Caput-Jogunica, Gulan, & Bosch, 2007). On the other hand, boys are very often more successful in the motor dimensions under the primary influence of the movement regulatory mechanism

(coordination, agility and balance) and energy-supply regulation mechanism (strength/power). In previous research (Horvat et al., 2013), where the same motor tests were used, it was revealed that among flexibility tests, only the variable *straddle seated forward bend,* statistically significantly differentiated boys from girls, while other tests did not show statistically significant gender differences. In this study, the researchers explained these results in terms of intrinsic motivation of children to fulfill all the measurement tasks. On the other hand, boys had better performance in motor abilities that are under the influence of the excitation-intensity regulation mechanism (Horvat et al., 2013). In another study (Bala & Katić, 2009), where the participants belonged to different age groups of children, the results showed statistically significant gender differences in MCs and MAs (with higher average values for boys, compared with girls in the same age groups). However, no statistically significant differences were found in the aspect of cognitive abilities. Gender differences found in MC and MA spaces contributed to the defining of adequate general factors according to space and gender (Bala & Katić, 2009). It seems that these correlations between the MC and PP structures, as well as between MA structures and PP structures in the group of preschool girls (as well as in the group of boys of the same age), for this group of children aged 6-7, could be a guidance for future studies.

The shortcoming of the research is a relatively small number of participants for the requirements of stable canonical solutions. On the other hand, it is hard to measure and test children in preschool age (especially in the short time), because of their unstable attention, distractibility and motivation. Thus, when conducting research with samples of preschoolers, a researcher has to be very careful. Many factors have to be taken into account: how the tests are performed, the way of presenting the tasks to the children, the order of the application of these tasks, as well as the duration of the measurement sessions (Horvat et al., 2013). Each disturbance and deviation from the standardized procedure could have as its consequence misleading results. Moreover, this study included only one age group of children (6-7), but the results obtained can also be taken as the indicators of the changes during the respective age span, using the same tests and measures (in longitudinal or at least follow-up study). In such studies, it could also be recommended that children should be equalized (and measured) over a larger number of time points, such as according to half-year age groups or shorter time intervals (e.g. two months) (Bala et al., 2009), to partially control the fact of irregularity of children's development, on the inter-individual level. On the other hand, larger samples of participants could be examined, from different regions of Croatia or/and outside Croatia, comparing rural and urban population, etc.

The relationships between these three types of data (MAs, MCs and PPs) in children that were studied in this research are simultaneously a point of interest for kinesiologists, biologists, physicians and teachers. The results obtained in this study could help the kinesiologists to design appropriate plans and control of training processes for using various motor activities, convenient for the development of motor

behavior or in "child-adjusted" sports activities. However, it is recommended that, while planning kinesiological activities, teachers have to be informed on the development of the abilities which are sensitive to the environmental influence (Horvat et al., 2013). Finally, in addition to kinesiological imperatives to stimulate the development of general motor abilities and behaviors in preschool children (Bala & Katić, 2009), it is important to have in mind the need for stimulating integral child's development, as the interaction of biological, psychological and social development as well.

Conclusions

Correlations between MC, MA and PP of preschool girls were determined by the use of both univariate and canonical correlations. The results revealed that all canonical correlations were statistically significant: those between MC and MA, between MA and PP, as well as those between MC and PP. The canonical correlation between PP and MC was lowest (significant at $p<0.05$), while the canonical correlations between MC and PP were higher, as well as the canonical correlations between MA and PP, in preschool-age girls (both at $p<0.01$). The most exact consideration about the values of canonical correlations could be that all three canonical correlations are similarly high. It could also be considered that, among univariate correlations between MC and MA, MA and PP, as well as between PP and MC, all (even statistically significant) univariate correlations are in fact very low. According to the findings of this study, girls at this age have a better balanced integral psychosomatic development than preschool boys.

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Povezanosti morfoloških karakteristika, motoričkih sposobnosti i spremnosti za školu kod djevojčica predškolske dobi

Sažetak

Povezanost morfoloških karakteristika (MC), motoričkih sposobnosti (MA) i psihološke pripremljenosti (PP) za školu kod djevojčica predškolske dobi može pomoći u poboljšanju kvalitete odgojno-obrazovnog rada njihovih odgojitelja. Osnovni cilj istraživanja bio je utvrditi povezanost između tri skupine podataka: MA, MC i PP. Ispitan je slučajni uzorak djevojčica predškolske dobi (N=127), u dobi od 6 do 7 godina. Mjereno je 14 MC. Za mjerenje MA sudionica 18 je kompozitnih motoričkih testova prilagođeno za djecu predškolske dobi, po tri za svaku motoričku dimenziju: koordinacija, fleksibilnost, snaga, agilnost, preciznost i ravnoteža. Test pripremljenosti za školu (TSS) s pet subtestova koristio se u procjeni PP. Korelacije između MC, MA i PP kod djevojčica predškolske dobi određene su i s pomoću univarijatnih i s pomoću kanoničkih korelacija. Rezultati su pokazali da su sve kanoničke korelacije statistički značajne: između MC i MA, MA i PP, kao i MC i PP. Međutim, unatoč svojoj statističkoj značajnosti, kanoničke su korelacije najniže između MC i PP. Jedna od hipoteza u objašnjavanju tog odnosa može biti brzina sazrijevanja, koja je različita kod predškolskih djevojčica i dječaka.

Ključne riječi: *antropometrija, korelacija, razvoj, rast, predškolska djeca, psihološki testovi*

Uvod

Tijekom procesa rasta i razvoja utvrđivanje povezanosti između dječjih motoričkih sposobnosti, morfoloških karakteristika i spremnosti za školu nudi veću mogućnost za razvoj predškolskih obrazovnih programa. Svrha je ovog rada utvrditi korelacije između tri skupa podataka kod djevojčica predškolske dobi.

Kinantropologija je interdisciplinarno (s biološkog, psihološkog, kulturalnog i socijalnog aspekta) istraživanje tjelesnih aktivnosti. Usmjerena je na istraživanje varijabilnosti ljudskih osobina i sposobnosti, kad se odnose na fizičke aktivnosti,

tjelovježbu i sport, tijekom životnog vijeka (Mišigoj-Duraković, 2008). Razni kineziološki programi dovode do kvantitativnih i kvalitativnih promjena u kinantropološkim dimenzijama, utječući na te dimenzije, kao i na njihove odnose (Ismail, 1976; Mišigoj-Duraković, 2008). Tijekom rasta struktura se određene dimenzije mijenja, unutar sebe i u odnosu na druge dimenzije (Bala, 2003a), a te su promjene specifične za neka razvojna razdoblja (Bilić, 2007), kao i ovisne o dječjoj individualnosti (Bala 2003b). Spolni dimorfizam u određenim kinantropološkim dimenzijama očit je na kraju drugog razvojnog razdoblja (Bala, Popović i Jakšić, 2009; Horvat, Breslauer, i Miščančuk, 2010). Interakcija između pojedinih osobina i sposobnosti tijekom djetetova razvoja uključuje fizički, kognitivni, emocionalni i socijalni razvoj (Horvat, Babić, i Jenko Miholić, 2013).

U prostoru **morfoloških karakteristika (MC)** hipokineza ima snažan utjecaj na povišenje prosječne vrijednosti u dječjem volumenu tijela i tjelesne mase, kao i pripadajućih mjera (npr. mjera potkožnog masnog tkiva, tjelesni opsezi) (Abalkhail, 2002; Datar i Sturm, 2004; Horvat, Mišigoj-Duraković, i Prskalo, 2009). Rezultati nekoliko studija pokazuju kako rast i razvoj MC ima utjecaj na razvoj djetetovih općih motoričkih sposobnosti (MA) i obrnuto (Bala, Jakšić, i Katić, 2009). Trodimenzionalni model MC opisuje kako se uzdužna i poprečna dimenzionalnost skeleta vrlo često objedinjuje u jednu dimenziju pod nazivom dimenzionalnost skeleta (tj. povremeno uzdužna dimenzionalnost skeleta) (Malacko, Bala, i Patarić, 1981). Trodimenzionalni model MC u adolescenata uključuje tjelesnu masu, dimenzionalnost skeleta i volumen te potkožno masno tkivo (Viskić-Štalec, 1974; Kurelić i sur., 1975). Kod vrlo male djece obično se pronalazi dvodimenzionalni model MC. Taj se model sastoji samo od skeletne dimenzionalnosti i voluminoznosti, kao i potkožnog masnog tkiva (Bala, 1981).

Motoričke sposobnosti (MA) može se prikazati kao latentne motoričke strukture, koje su odgovorne za beskonačan broj manifestnih motoričkih radnji, koje se mogu mjeriti i opisati (Mraković, 1992). Međutim, studije o MA predškolske djece imaju relativno dugu povijest. Studije o bacanje lopte u pokretne i stacionarne mete provođene su u prvoj polovini 20. stoljeća (Hicks, 1930). U drugoj studiji koristilo se skakanje preko prepreka kao pokazatelj motoričkog razvoja (Cowan i Pratt, 1934). Važno je primijetiti kako se nedostatak motoričkih aktivnosti tijekom dječjeg rasta ne može nadoknaditi u kasnijim razvojnim razdobljima. Taj nedostatak motoričke aktivnost usporava cjelokupni psihosomatski razvoj djeteta (Kelly i Kelly, 1985; Humphrey, 1991). Utvrđivanje strukture MA u predškolskih djevojčica jedan je od prioriteta za poboljšanje kvalitete obrazovnih programa s djecom, imajući u vidu spolni dimorfizam. Struktura latentnih MA u djevojčica definirana je u prethodnim studijama (Horvat i sur., 2010; Horvat, 2011; Hraski, V. Horvat, i I. Horvat, 2011; Horvat i sur., 2013). Navedeni su autori otkrili da je MA struktura četverodimenzionalna, s faktorima: opći faktor motoričkih sposobnosti, koordinacija, ravnoteža i fleksibilnost. Na temelju tih istraživanja može se zaključiti kako definiranje latentne strukture nije jednako kao u odraslih te se može očekivati tek u kasnijim razvojnim razdobljima.

Važan zadatak za odgajatelje, roditelje i nastavnike jest sustavno poticanje karakteristika koje su temelj **psihološke pripremljenosti** (PP) za odlazak u osnovnu školu. Spremnost za odlazak u školu složen je skup karakteristika. Jedna klasifikacija opisuje fizičku, govornu, intelektualnu, emocionalnu i socijalnu zrelost za školu (Furlan, 1984), a drugi navode fizičku zrelost, osobnu i funkcionalnu zrelost (Toličič, 1970, prema Šimunec-Muhek, 1995). Tjelesni razvoj (MC) je kriterij koji opisuje važnost redovitog tjelesnog rasta koji djetetu omogućuje lakše nošenje s raznim fizičkim i mentalnim naporima koji ga očekuju u školi (Vasta, Haith, i Miller, 1997). Psihološka pripremljenost (PP) ujedinjuje dimenzije psihomotorne, kognitivne, emocionalne i socijalne spremnosti, kao i motivaciju djeteta za učenje (Vasta i sur., 1997). Među tim aspektima kognitivna je spremnost (adekvatan razvoj govora, percepcije, mišljenja i pamćenja tijesno povezan s opsegom i stabilnosti pažnje) najvažniji aspekt PP, jer je ona povezana s najvažnijim akademskim funkcijama. Dakle, te su funkcije posebno važne za pažljivu procjenu kognitivne spremnosti. Motivacija za učenje vrlo je važna odrednica školskog uspjeha. Mentalna nevoljkost, kojoj bi uzrok mogla biti niska motivacija, jedna je od glavnih odrednica školskog neuspjeha. Dakle, potrebno je kombinirati pravnoadministrativne i psihofizičke kriterije zrelosti za polazak u osnovnu školu.

Kako bi kreirali primjerene kineziološke programe za djecu predškolske dobi, odgajatelji moraju imati u vidu spolni dimorfizam djece predškolske dobi u njihovim MC, MA i PP za polazak u školu. Utvrđivanje povezanosti između ta tri seta karakteristika, posebno za dječake i djevojčice, treba pružiti uvid u moguće spolne razlike u tim povezanostima. Te bi informacije bile preduvjet za osmišljavanje primjerenih programa predškolskog tjelesnog vježbanja. Osim toga, rezultati istraživanja mogli bi ukazati na određene spolne razlike, koje će sigurno biti polazište za daljnja istraživanja.

Glavni cilj ovog istraživanja jest utvrditi korelaciju između tri skupa podataka kod djevojčica predškolske dobi: MC, MA i PP prije polaska u školu. Osnovna je hipoteza kako postoje statistički značajne korelacije između sva tri istraživana seta karakteristika: između MC i MA, između MA i PP, kao i između MC i PP.

Metode

Sudionici

Iz populacije djece koja polaze vrtiće u urbanim sredinama (gradovi Zagreb i Varaždin) slučajno je odabran uzorak od 121 djevojčice (izabrane su iz abecedno poredanih popisa svih djevojčica upisanih u dva dječja vrtića sa sličnim kapacitetima, u najstarijoj dobnoj skupini). U trenutku prikupljanja podataka prosječna dob djevojčica bila je 6,5 godina ± 6 mjeseci (M ± SD). Za svaku sudionicu koja je bila uključena u ispitani uzorak dobivena je roditeljska pisana suglasnost, kojom su roditelji dopustili da njihova djeca sudjeluju u istraživanju, što je usklađeno s Etičkim kodeksom pripremljenim od Dječjeg vijeća, savjetodavnog tijela Vlade Republike Hrvatske.

Motoričke sposobnosti

Motoričke sposobnosti mjerene su s pomoću skupa od osamnaest kompozitnih motoričkih testova, koji se obično koriste za procjenu motoričkih i energetskih sposobnosti školske djece. Za ovu studiju testovi su bili izmijenjeni u skladu s mogućnostima djece predškolske dobi (Horvat, 2010). Testovima se procjenjuju latentne dimenzije koordinacije, fleksibilnosti, snage, agilnosti, preciznosti i ravnoteže kod predškolskih djevojčica. Za svaku od latentnih dimenzija koristila su se tri kompozitna testa, koji su primijenjeni po tri puta. Horvat, Babić i Jenko Miholić (2013) u svom članku daju podatke o svojstvima i primjeni tih testova. Ukratko, sve procedure mjerenja i razdoblja mjerenja bili su skraćeni, a smanjen je i broj stajanja. Osim toga, barem jedno probno testiranje uvedeno je prije svake izvedbe, kako bi se osigurala približno jednaka razina motorne vještine svih sudionica i njihovo upoznavanje sa zadacima.

Kognitivna pripremljenost za školu

Psihološki mjerni instrument autora Vlahović-Štetić, Vizek-Vidović, Arambašić i Miharija (1995) koristio se za testiranje pripremljenosti djeteta za školu. "Test spremnosti za školu" sastoji se od pet subtestova: Perceptivnog testa (TSS-P), Testa znanja činjenica (TSS-CC), Numeričkog testa (TSS-N), Testa spajanja točaka (TSS-T) i Testa precrtavanja (TSS-C).

Prva tri subtesta (perceptivni test, test spajanja točaka i test precrtavanja) dizajnirani su za procjenu specifičnih sposobnosti djece, a druga su dva subtesta (test znanja činjenica i numerički test) osmišljeni kako bi se utvrdilo dječje znanje.

Ispitivanje je provedeno u malim grupama (do sedmero djece), a trajalo je oko sat vremena. Nakon prva tri subtesta bile pauze od petnaest minuta zbog čega ograničena koncentracija djece nije imala negativan utjecaj na rezultate mjerenja. Psiholozi zaposleni u izabranim dječjim vrtićima izvršili su procjenu spremnosti svakog djeteta za školu.

Perceptivni test (TSS-P)

Ovaj test ima za cilj ispitati vizualnu percepciju i diferencijaciju složenih znakova. Vizualna percepcija je važna za početno poučavanje čitanja i pisanja. Zadatak je osmišljen tako da zahtijeva od djeteta da prepozna dva identična znaka između pet dostupnih znakova, te ih označava. Likovi mogu biti realni ili apstraktni, kao i kombinacija slova ili brojeva. Test se sastoji od 15 pitanja, a svaki točan odgovor nosi jedan bod. Predviđeno vrijeme trajanja za ovaj test je 7 minuta.

Test spajanja točaka (TSS-T)

Ovaj test provjerava grafomotornu sposobnost djece, tj. razinu fine koordinacije pokreta ruke. Ta sposobnost je važna za stjecanje vještine pisanja. Zadatci se sastoje od povezivanja više točaka u pokušaju da nacrtaju zadani lik koji se nalazi u mreži s

lijeve strane. Test se sastoji od 10 zadataka koje treba provesti u predviđenom vremenu od 8 minuta. Prve dvije zadaće zahtijevaju povezivanje mreže od devet točaka, a u drugim se zadacima drugi likovi dobivaju spajanjem šesnaest točaka.

Test poznavanja činjenica (TSS-CC)

Ovaj test ocjenjuje razumijevanje i rukovanje svakodnevnim činjenicama i konceptima, te znanje o njihovu odnosu. Cilj je utvrditi djetetovo iskustvo u području prirode, tehnologije, ljudi i društva. Test provjerava razumijevanje činjenica i funkcionalnih odnosa. Viša razina usvajanja informacija olakšava djetetu kako bi pronašlo svoj put do škole i usvajanje sustavnih informacija potrebnih za školu. Test se sastoji od 14 zadataka, a svaki zadatak od 4 crteža od kojih jedan predstavlja točan odgovor na pitanje osobe koja intervjuira. Paušalno je trajanje testa 10 minuta.

Test precrtavanja (TSS-C)

Ovaj test ima za cilj provjeriti sposobnost fine motorike i okulomotorne koordinacije, što je važno za stjecanje vještine pisanja. Dijete treba precrtati likove nacrtane na početku retka između dvije paralelne horizontalne linije. Neki likovi su brojevi ili slova, a drugi su oblikovani crtanjem ravne i zakrivljene linije. Većina je znakova sličnog oblika. Test se sastoji od devet zadataka. Vrijeme u kojem dijete treba dovršiti test je 9 minuta.

Numerički test (TSS-N)

Ovaj test ima za cilj provjeriti djetetovo znanje o rednim brojevima, sposobnost za rješavanje različitih problemskih zadataka i spremnost za učenje matematike. U jednom od zadataka provjerava se poznavanje izraza "manji dio cijelog broja", tj. pojam "polovine". U svakom zadatku postoji pet crteža, a dijete treba označiti točan odgovor. Ovaj se test sastoji od 10 zadataka i njegovo rješavanje traje oko 10 minuta.

Morfološke karakteristike

Varijable za procjenu morfoloških karakteristika djece: tjelesna visina (AVIS), tjelesna masa (ATTE), sjedeća visina tijela (AVSJ), duljina ruku (ADRU), kožni nabor nadlaktice (ANNA), kožni nabor trbuha (ANTR), kožni nabor leđa (ANLE), kožni nabor potkoljenice (APK), opseg nadlaktice (AONO), opseg podlaktice (AOPD), opseg natkoljenice (AONK), opseg potkoljenice (AOSP), širina kukova (ASKU), širina ramena (ASRA).

Sva mjerenja provedena su s pomoću standardnih metoda i instrumenata kao što je opisano u uputama Međunarodnog biološkog programa (IBP - Weiner i Lourie, 1968). Mjerenje visine, širine, težine i opsega provedeno je jedanput. Svako mjerenje kožnog nabora izmjereno je tri puta uz pomoć John Bullova kalipera.

Mjerenja morfoloških karakteristika provedena su u jutarnjim satima, odmah po dolasku djece u vrtić. Mjerenja su proveli studenti koji su sudjelovali u izbornom kolegiju "Kineziološke transformacije". Tijekom trajanja obveznih vježbi studenti su

usvojili metode i tehnike mjerenja u području kineziologije. Posebna pažnja usmjerena je na stjecanje znanja u vezi s provedbom mjera samo za one varijable koje su se koristile u ovom istraživanju. Na taj su studenti bili posebno pripremljeni za ovo istraživanje.

Pouzdanosti svih ponovljenih mjerenja MC i MA bile su više od 0,80, te se mjerenja mogu procijeniti kao vrlo pouzdana.

Protokol mjerenja

Tri puta tjedno, u tridesetominutnim razdobljima, djeca su se imala prilike upoznati s gibanjima i pokretima koje su trebali obaviti, kao budućim ispitnim zadacima. To je učinjeno zato da bi se, koliko god je to moguće, ujednačila razina motoričkih znanja i vještina kod budućih ispitanica, i time smanjio njihov vjerojatni utjecaj na rezultate pri testiranju motoričkih sposobnosti.

Motoričke sposobnosti mjerene su tijekom tri uzastopna dana. Na početku svakog mjerenja djeca su bila posebno pripremljena na dan mjerenja. Pripreme su svakodnevno provođene s pomoću trominutnih cikličkih krupnih pokreta s različitim zadacima poput hodanja (na prstima, na petama, u čučnju …), različitog tempa trčanja, skakanja (na dvije noge i na jednu nogu). Nakon toga se primjenjuje niz općih pripremnih vježbi (10 do 12) za cijelo tijelo. Vježbe su odabrane za pripremu velikih mišićnih skupina koje su bile pod posebnim opterećenjem u narednom testiranju za taj dan.

Testovi su raspoređeni kroz tri dana s ciljem sprečavanja negativnog utjecaja prethodnih ispitivanja. Osim toga važno je, koliko god je to moguće, izbjegavati umor i gubitak motivacije kod ispitanika. Testovi dinamičke mišićne izdržljivosti ili repetitivne snage trupa (trbušnjaci) provodili su se na kraju mjerenja svakog dana (tri mjerenja za redom).

Statističke analize

Zbog potrebe za potpunim podacima za sve varijable kod svih sudionica (sa što manje vrijednosti koje nedostaju) smanjen je broj motoričkih testova na 18, a u skupu MC dobiveni su podatci o 14 antropoloških mjera. Kanonička analiza koristila se za pronalaženje korelacije između svaka dva skupa varijabli: MC i MA, MA i PP, PP i MC. Vrijednosti Wilksove lambde i pripadajućih Hi-kvadrat testova koristile su se za označavanje razine statističke značajnosti kanoničke korelacije. Drugi i potencijalno korisni pokazatelji povezanosti (Malacko, Bala i Patarić, 1981) između ta tri skupa podataka bile su univarijatne (Pearsonove) korelacije. U analizi se koristio statistički program SPSS (Statistical Package for Social Sciences 20.0).

Rezultati

U Tablici 1. prikazane su univarijatne korelacije između MC i MA za uzorak djevojčica u dječjim vrtićima. Od ukupno 252 korelacije između svih varijabli u ta

dva skupa statistički značajno je njih 27. Sve statistički značajne korelacije zapravo su vrlo niske. Najveći broj statistički značajnih korelacija pronađen je za ADRU i AVSJ u prostoru MC, a većina značajnih korelacija pronađena je za MSSDY, MRJOY i MAKSY u prostoru MA.

Tablica 1 i 2

Kanonička analiza između MC i MA vođena je hipotezama o kojima se raspravljalo u uvodu. Većina nalaza ponovno se pojavila u rezultatima kanoničke analize u Tablici 2. Od svih kanoničkih korelacija koje su proizašle iz analize samo prva Rcan1 = 0,690 bila je značajna na razini $p<0,01$.

Prva kanonička solucija (prvi par kanoničkih korijena) pronađena je između skupa MC (visoke vrijednosti za ATTE, ADRU, AVSJ, AONK, AOPK) i skupa MA (visoke vrijednosti za MKGRY, MSSDY, MSPTY, MPGOY) (Tablica 2.). Univarijatne korelacije u prostoru MC pokazuju da ADRU i ATTE koreliraju 0,56 i 0,51 s kompozitnim rezultatom, a ANLEX i ANPKX jedva pokazuju ikakvu povezanost (-0,09). Univarijatne korelacije u prostoru MA pokazuju da su MKGRY i MSSDY u korelacijama 0,57 i 0,52 s kompozitnim rezultatom, a MAOOY pokazuje minimalnu korelaciju (0,03). Kvadrat kanoničke korelacije otkriva da je 48 % povezano s kompozitnim rezultatom oba skupa, morfoloških i motoričkih skupova varijabli.

Tablica 3

U Tablici 3. prikazane su unakrsne korelacije između MC i PP. Od 60 unakrsnih korelacija između svih varijabli u ta dva skupa statistički je značajno samo njih 5. Sve značajne korelacije zapravo su vrlo niske. Najviše značajnih korelacija pronađeno je za ATTE i ADRU u prostoru MC, a većina je značajnih korelacija pronađena za TSST i TSSP u prostoru PP.

Kanonička analiza između MC i PP vođena je hipotezama o kojima se raspravljalo u uvodu. Od svih kanoničkih korelacija koje su proizašle iz analize samo je prva, Rcan1 = 0,634, bila značajna na razini $p<0,01$ (Tablica 4.).

Tablica 4

Prva kanonička solucija (prvi par kanoničkih korijena) pronađena je između skupova morfoloških varijabli (visoke vrijednosti za AVSJ, ANLEX, AONO, AOPD) i skupa psiholoških varijabli (visoke vrijednosti za TSST, TSSCC i TSSN) (Tablica 4.). Univarijatne korelacije u prostoru morfoloških mjera pokazuju da su ANLEX i AOPD u korelaciji -0,44 i -0,38 s kompozitnim rezultatom, dok je ANPKX jedva pokazao povezanost (0,01). Univarijatne korelacije u prostoru psiholoških varijabli pokazuju da su i TSSCC i TSST povezani 0,48 s kompozitnim rezultatom, dok je TSSP jedva bio povezan (0,16). Kvadrat kanoničke korelacije otkriva da je 40 % varijance povezano s kompozitnim rezultatom oba skupa, morfoloških i psiholoških varijabli.

Tablica 5

U Tablici 5. prikazane su unakrsne korelacije između motoričkih testova i psiholoških testova na uzorku djevojčica. Od 90 unakrsnih korelacija između svih varijabli u ta dva seta statistički je značajno njih 13. Sve značajne korelacije zapravo su niske ili vrlo niske. Najviše značajnih korelacija pronađeno je za MPCSY i MRJUY, u prostoru motoričkih testova, dok je većina značajnih korelacija pronađena za TSSCC, TSSN i TSST u prostoru psiholoških testova.

Kanonička analiza između motoričkih i psiholoških testova vođena je hipotezama o kojima se raspravljalo u uvodu. Od svih kanoničkih korelacija koje su proizašle iz analize samo je prva, Rcan1 = 0,606, bila značajna na razini p<0,05 (Tablica 6.).

Tablica 6

Prva kanonička solucija (prvi par kanoničkih korijena) pronađena je između skupa motoričkih varijabli (visoke vrijednosti za MFIPY, MSSDY, MAKSY, MPGSY, MPCSY, MRJUY i MROPY) i skupa psiholoških varijabli (visoke vrijednosti za TSST, TSSN, TSSCC) (Tablica 6.). Univarijatne korelacije u prostoru motoričkih mjera pokazuju da su MRJUY i MROPY u korelaciji 0,48 i 0,47 s kompozitnim rezultatom, a da MFSRY jedva ima ikakvu korelaciju (-0,03). Univarijatne korelacije u prostoru psiholoških varijabli pokazuju da su TSST i TSSN u korelaciji 0,69 i 0,67 s kompozitnim rezultatom, a da je TSSP jedva imao korelaciju (-0,22). Kvadrat kanoničke korelacije otkriva da 48 % varijance može biti povezano s kompozitnim rezultatom oba skupa, motoričkih i psiholoških varijabli.

Rasprava

Glavni rezultat ovog istraživanja je tvrdnja kako su korelacije (unatoč njihovoj statističkoj značajnosti) između psiholoških (kognitivnih) i motoričkih testova najniže (značajne uz p<0,05), a da su korelacije između morfoloških mjera i kognitivnih testova više, kao i korelacije između motoričkih i kognitivnih testova, kod djevojčica predškolske dobi (značajne obje uz p<0,01). Zapravo, moglo bi se utvrditi kako su sve tri kanoničke korelacije slično visoke kod djevojčica. Također se smatra kako su univarijatne korelacije između MC i MA, MA i PP, kao i PP i MC, sve (čak i statistički značajne) zapravo nulte, vrlo niskih ili niskih vrijednosti.

U prethodnim istraživanjima, u kojima su sudionici bili dječaci u istoj predškolskoj dobi (Horvat, Sindik i Mraković, 2015), korelacije između morfoloških mjera i motoričkih testova bile su više, kao i korelacije između motoričkih i kognitivnih testova. Taj spolni (rodni) dimorfizam može biti uzrokovan time što dječaci u toj dobi (6 do 7 godina) postižu bolje rezultate u većini testova motoričkih sposobnosti (Horvat i sur., 2013). Dobiveni rezultati djelomično se protive rezultatima istraživanja koje su proveli Bala i Katić (2009), a u kojima kognitivni aspekti pokazuju višu korelaciju s motoričkim sposobnostima kod djevojčica. Međutim, rezultati dobiveni u ovom istraživanju, slično kao u istraživanju u kojem su sudionici bili dječaci u istoj predškolskoj dobi (Horvat, Sindik, i Mraković, 2015), pokazuju da su kognitivne

osobine (PP) u relativno nižoj korelaciji s MC i/ili MA, a da su MA i MC više povezani kod muške djece (Bala i sur., 2009). Moglo bi se općenito reći da su dobiveni rezultati, manje ili više, u skladu s teorijom integralnog razvoja djece (Bala i Katić, 2009), imajući u vidu da se tempo rasta i razvoja razlikuje kod dječaka i kod djevojčica (uvijek imajući u vidu individualne varijacije), osobito u nekim fazama. Od kinezioloških aspekata važno je naglasiti da su bolje funkcioniranje živčanog sustava i djetetove vodljive motoričke izvedbe i preduvjeti i posljedice skladnog funkcioniranja mehanizama regulacije kretanja i reguliranja energije (Bala i Katić, 2009).

Pronađena je dosta visoka povezanost MC i MA struktura u skupini djevojčica (u ovom istraživanju) i dječaka (u istraživanju koje su proveli Horvat i sur., 2015), za dobne skupine od 6 do 7 godina. Ovaj odnos objasnio je oko 62 % zajedničke varijabilnosti prvih parova kanoničkih korijena za dječake, a samo 48 % prvih parova kanoničkih korijena za djevojčice.

U prostoru odnosa između MC i PP prvi par kanoničkih korijena za dječake objasnio je 32 % zajedničkog varijabiliteta (Horvat i sur., 2015), dok je objašnjena varijanca za prvi par kanoničkih korijena u djevojčica veća (objašnjena je kovarijabilnost od 40 %). U prostoru odnosa između MA i PP prvi par kanoničkih korijena za dječake objasnio je 42 % zajedničkog varijabiliteta (Horvat i sur., 2015), dok je objašnjena varijanca za prvi par kanoničkih korijena u djevojčica veća (objašnjena kovarijabilnost 48 %). Ti rezultati ukazuju na to da su i motorički razvoj i motoričko ponašanje dječaka bili u većoj mjeri definirani morfološkim rastom i razvojem od djevojčica predškolske dobi (6 do 7 godina). S druge strane, djevojčice u istoj dobi imaju bolje uravnotežen cjelokupni psihosomatski razvoj nego dječaci. Uzrok može biti prije svega u trendu rasta i razvoja morfološke strukture, motoričkih sposobnosti i središnjeg živčanog sustava, kao u smislu tjelesne aktivnosti koja je intenzivnija u dječaka nego u djevojčica (Bala i sur., 2009).

Nalazi iz prethodnih studija pokazuju kako su djevojčice u dobi od 6 do 7 godina postizale bolje rezultate u procjeni fleksibilnosti, koja je u prvom redu pod utjecajem mehanizama za upravljanje sinergijom i tonusom (Brodie i Royce, 1998; De Privitellio, Caput-Jogunica, Gulan, i Bosch, 2007). S druge strane, dječaci su često uspješniji u motoričkim sposobnostima koje su pod primarnim utjecajem regulatornih mehanizama kretanja (koordinacija, gibljivost i ravnoteža) i energetske opskrbe mehanizma regulacije (snaga/energija). U prethodnom istraživanju (Horvat i sur., 2013), u kojem su se koristili isti motorički testovi, otkriveno je da je među testovima fleksibilnosti samo varijabla *pretklon u sijedu* statistički značajno razlikovala dječake od djevojčica, a da ostali testovi nisu pokazali statistički značajne spolne razlike. U ovoj studiji istraživači pretpostavljaju kako je uzrok u unutarnjoj motivranosti u ispunjavanju svih mjernih zadataka. S druge strane, dječaci su pokazali bolje rezultate u onim motoričkim sposobnostima koje su pod utjecajem mehanizma regulacije pobuđenosti-intenziteta (Horvat i sur., 2013). U drugoj studiji (Bala i Katić, 2009), u kojoj su sudionici bili djeca različitih dobnih skupina, rezultati su pokazali statistički

značajne spolne razlike u MC i MA (s višim prosječnim vrijednostima za dječake u usporedbi s djevojčicama u istim dobnim skupinama). Međutim, nije bilo statistički značajnih razlika u aspektima kognitivnih sposobnosti. Spolne razlike pronađene u MC i MA prostorima pridonijele su definiranju odgovarajućih općih faktora u odnosu na prostor i spol (Bala i Katić, 2009). Čini se kako bi utvrđeni odnosi između MC i PP struktura, kao i između MA i PP struktura u skupini djevojčica predškolske dobi (kao i u skupini dječaka u istoj dobi), mogla biti predmet budućih istraživanja.

Nedostatak ovog istraživanja relativno je malen broj sudionica za postizanje zahtjeva stabilnih kanoničkih solucija. S druge strane, teško je izmjeriti i testirati djecu u predškolskoj dobi (osobito u kratkom vremenu), zbog nestabilnosti i distraktibilnosti pažnje i motivacije. Stoga, kada se provode istraživanja na uzorcima djece predškolske dobi, istraživač mora biti vrlo oprezan. Mora uzeti u obzir: kako se izvode testovi, kako prezentiranja zadaća koje djeca moraju izvesti, redoslijed primjene pojedinih zadataka (testova), kao i trajanje pojedinih odsječaka mjerenja (Horvat i sur., 2013). Svako odstupanje od standardiziranog postupka može dovesti do pogrešnih rezultata. Osim toga, ova studija uključuje samo jednu dobnu skupinu djece (6 do 7 godina), ali se dobivene rezultate može također uzeti kao pokazatelje promjena tijekom određenog dobnog razdoblja, koristeći se istim testovima i mjerama (u longitudinalnim ili barem studijama praćenja). U takvim se istraživanjima može preporučiti da se djeca izjednače (i izmjere) u većem broju vremenskih točaka, što je u skladu s polugodišnjim dobnim skupinama ili kraćim vremenskim intervalima (npr. dvomjesečnim) (Bala et al., 2009), da bi se barem djelomično kontroliralo činjenice o diskontinuitetu razvoja djece, na interindividualnoj razini. S druge strane mogli su biti ispitani veći uzorci sudionica, iz različitih krajeva Hrvatske i/ili izvan Hrvatske, uspoređujući ruralno i urbano stanovništvo itd.

Odnosi između tri vrste podataka (MA, MC i PP) kod djece, proučavani u ovom istraživanju, istodobno su predmet interesa za kineziologe, biologe, liječnike i učitelje. Rezultati dobiveni u ovom istraživanju mogu poslužiti kineziologu kako bi osmislio odgovarajuće planiranje i kontrolu procesa tjelesnog vježbanja različitim motoričkim aktivnostima koje su pogodne za razvoj motoričkog ponašanja ili "djetetu prilagođenih" sportskih aktivnosti. Autori sugeriraju kako prilikom planiranja kineziološkihaktivnosti voditelji potiču razvoj sposobnosti koje su osjetljive na okolišne utjecaje (Horvat i sur., 2013). Na kraju, osim kineziološkihimperativa za poticanje razvoja općih motoričkih sposobnosti i ponašanja djece predškolske dobi (Bala i Katić, 2009) važno je imati na umu potrebu za poticanje integralnog razvoja djeteta, kao interakcije biološkog, psihološkog i socijalnog razvoja.

Zaključak

Korelacije između MC, MA i PP kod djevojčica predškolske dobi određene su s pomoću univarijatnih i kanoničkih korelacija. Rezultati su pokazali kako su sve kanoničke korelacije bile statistički značajne: između MC i MA, MA i PP, kao i između

MC i PP. Kanonička korelacija između PP i MC bila je najniža (značajna uz $p<0,05$), a kanonička korelacija između MC i PP bila je viša, kao i kanonička korelacija između MA i PP (obje statističke značajnosti uz $p<0,01$). Sve su tri kanoničke korelacije slično visoke. Moglo bi se također utvrditi kako su univarijatne korelacije između MC i MA, MA i PP, kao i između PP i MC, (čak i statistički značajne) zapravo vrlo niske ili niske veličine. Prema rezultatima koji su objavljeni u ovoj studiji može se zaključiti kako djevojčice u ovom dobnom uzrastu imaju bolje uravnotežen psihosomatski sustav od dječaka iste dobi.