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SEX DIFFERENTIATION OF MORPHOLOGICAL CHARACTERISTICS AND MOTOR SKILLS IN PRESCHOOL-AGED CHILDREN

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Aim. The research was conducted with the aim of determining preschool-aged children's sex differentiation using the multivariate and univariate variance analyses (MANOVA/ANOVA). **Material and methods.** A battery of measuring instruments comprising 17 variables (8 morphological characteristics variables and 9 motor skills variables) was carried out on a sample of 69 children (49 boys and 20 girls), aged 5 and 6, from the Primorje-Gorski Kotar County in the Republic of Croatia. **Results.** The results showed that, between boys and girls of this age, there are multivariate statistically significant differences in arithmetic meanings at the level of p = .022 in the entire system of morphological and motor variables, whereas univariate values did not show a statistical significance. **Conclusion.** The conclusion is drawn that in the morphologic space in children between the ages of five and six years, there are quite equal developmental processes based on sex differentiation and genetic determinations (4:4); however, this is more pronounced in the motor space in favor of the girls (2:7) at this age.

Keywords: *differences, boys and girls, ages 5 and 6, morphology, motor skills.*

Introduction.

Within the group of problems of the overall anthropological status, children in the period of childhood and adolescence need to meet their biological needs for movement, and preschool and school institutions should enable them with sustainable development in all anthropological dimensions (morphological, motor, functional, cognitive, conative, social, and health). With regards to this, significant scientific and life-related problems also include those in the field of sex differentiation, whereby genetic development cannot be disregarded, given that it unambiguously suggests that human abilities and characteristics can be most successfully developed individually over a period of time when this is objectively the most possible.

It is very important that the most significant developmental pace of development of a person's certain anthropological characteristics and abilities takes place as a natural progression under the influence of applied kinesiological contents, the adaptive possibilities increase in relation to the factors of the environment, and particularly favorable assumptions are thereby created for the formation of certain skills and habits and the adoption of kinesiological contents of a particular type. This is based on the premise that the child's organism is more vulnerable to external influences (transformation) during this period than others, if in their orientation they show basic age and sex tendencies in the natural course of changes in anthropological characteristics.

Generally speaking, this means that we have to consider, on the one hand, the so-called internal (endogenous) factors, which are primarily determined by the genetic potential of the child and, on the other, external (exogenous) factors, which primarily include the organization, but also purposeful, correct, and optimal kinesiological content [7]. In the case of internal factors, the variable nature (genetic constraints) of anthropological characteristics and abilities should be taken into consideration, the so-called "critical periods," especially during the ontogenetic development period when an impact is possible since precisely the development of these characteristics determines later adaptation to modern work and living conditions. As far as the external factors are concerned, it is necessary to point out that, in addition to the available training time and material conditions for work, special attention should be given to age and sex [3].

Knowledge of the rules of development is necessary if meaningful actions are to be implemented, which will serve as quality support for the development of a child's bio-psycho-social characteristics. Specifically programmed kine-

siologic education, compared to the one that is realized in the standard way, has significantly greater effects on the development of virtually all relevant motor skills, especially aerobic endurance, all strength factors, and flexibility [1, 5].

In [4], the researchers analyzed sex differences in the motor abilities of preschool-aged boys (n = 106) and girls (n = 121) between the ages of 6 and 7. In the research, a battery of eighteen modified tests for preschool-aged children was used. Three tests (coordination, flexibility, strength, agility, precision, balance) were envisioned for each latent dimension of motor skills. Significant sex differences were found between boys and girls in the measured variables of motor skills. In most variables, boys achieved better results, except in the variables in the group of flexibility estimates – seated straddle stretch – in which the girls showed better results. The results of the discriminant analysis confirm that this set of manifest variables for the assessment of motor skills creates a good differentiation between boys and girls. Those variables influenced by the motion control mechanism have shown to play the most significant role in the possible differentiation of children with regards to their sex. The results suggest that there is a rise in sexual dimorphism in motor abilities as early as in children of 6.5 years of age.

By applying the standard battery of 11 anthropometric and motor variables, [9] researched the ontogenetic development of applied variables within the sexes in the first four grades of elementary school on the sample of 4,429 pupils (2,202 boys and 2,227 girls) between the ages of 7 and 11 years from the Primorje-Gorski Kotar County in the Republic of Croatia. The results showed that anthropometric and motor variables develop continually and evenly in the observed age groups. This progress is in line with the standard genetic potential (endogenous factors) and under the influence of applied teaching content (exogenous factors), which is more intense in boys. In girls, higher values were obtained only in the anthropometric subtype of subcutaneous fat variables and the motor variable of flexibility.

In [2], the authors analyzed the conditions and differences between boys and girls on a large sample of 1,170 preschool-aged children (565 boys and 605 girls), between the ages of 4 and 7.5 years. Generally, significant differences were found in anthropometric characteristics related to bone growth in length in favor of the boys and those related to the circumference and the subcutaneous fat in favor of the girls. With regards to the motor variables, there are significant differences in the functioning of the mechanism for the structure of movement, the mechanism for synergistic regulation, and the mechanism for regulating the duration of excitation in favor of the boys, and in the functioning of the mechanism for regulating the tonus in favor of the girls.

In [8], the researchers applied a system of 43 variables (14 morphological and 29 motor) on a sample of 393 preschool-aged children (169 girls and 224 boys) between the ages of 2 and 6. The results showed that there is a multivariate statistical significance of differences of p =.00 between the sexes in the systems of applied variables. Based on the obtained univariate values, it can be concluded that boys with statistically significant differences in the arithmetic mean of morphologic variables with reduced subcutaneous fat content and increased skeletal transversal dimensionality, as well as higher values in body height and weight, achieve better results in motor variables of the explosive leg force, partial body coordination, flexibility while lying down, and endurance flexibility (running for three minutes expressed in meters) as well as better pulse rates before and after the activity. Girls with increased morphological values of soft tissue volume achieve better values in the static arm and shoulder belt strength, repetitive trunk strength, rear leg flexibility, hip flexibility, and 3-minute polygon activity.

In [7], researchers applied a system of 10 variables (4 morphologic and 6 motoric) on a sample of 655 children (348 boys and 307 girls), between the ages of 7 and 11, with the aim of determining the significance of differences in the arithmetic environment between sexes in morphological characteristics of motor skills using the multivariate variance analysis and the canonical discriminant analysis. The obtained results show that, in the system of applied variables, there is a statistically significant difference between the sexes at the level of p = .00. Boys achieved better results in the motor abilities of explosive power, body coordination, repetitive force, and static strength, while girls showed better values only in flexibility. Using canonical discriminant analysis, one discriminant function was isolated whose structure consisted of seven variables, six of which referred to the boys, and only one (seated straddle stretch) to the girls. The authors concluded that in PE education at this age for both sexes it is equally important to keep in mind the development (with significant changes) of morphological characteristics and

motor abilities, which are not genetically restrictive, i.e., changes are possible. The obtained indicators are an important factor for the optimal planning, programming, and operationalization of PE education in primary education as well as the control of the ontogenetic development of these anthropological features influenced by programmed contents by the sex of the students of this age.

The aim of this research was to determine the statistically significant gender differentiation in the arithmetic environments of the applied morphological and motor variables system to optimize the modeling, diagnosis, planning, programming, and controlling of the process of physical exercise of preschool children.

Methods of research

Sample of participants

According to the set research aim, the sample of participants comprised 69 children (49 boys and 20 girls), ages 5 and 6 years, from the Primorje-Gorski Kotar County in the Republic of Croatia. All participants were clinically healthy and without aberrant phenomena.

Pattern of variables

The variable pattern consisted of 17 variables (8 variables of morphological characteristics and nine variables of motor skills).

Morphological variables

• Longitudinal dimensionality of the skeleton: **VIT** – body height (mm);

• Volume and body mass: **TEŽ** – body weight (kg); **OND** – upper arm circumference (mm); **OTR** – abdominal circumference (mm); **OKU** – hip circumference (mm);

• Transversal dimensionality of the skeleton: **DIK** – knee diameter (mm); **KND** – upper arm fold (mm); **KNL** – back skinfold (mm).

Motor variables

• Agility: **KOC** – transfer of dice (sec);

• Coordination: **HOD** – polygon backward (sec);

• Rhythm coordination: **SCO** – hopscotch (sec);

• Explosive power: **SKU** – standing long jump (cm);

• Repetitive power: **ZGI** – pull-ups (fr); **P15** – sit-ups in 15 seconds (fr);

• Flexibility: **RZL** – seated straddle stretch – left (cm); **RZD** – seated straddle stretch – right (cm);

• Aerobic endurance: **P3M** – Polygon in 3 minutes expressed in meters (m).

The variance analysis method was used (MANOVA/ANOVA) to determine the differences in the arithmetic mean of the applied variables between boys and girls. Multivariate null hypothesis testing, i.e., the centroid groups being equal to the common center (GENERAL MANOVA), was performed using λ – Wilks' Lambda test, Rao's R – Rao's coefficient, and p – statistical significance ($p > .05$). The univariate statistical significance of the difference between the arithmetic mean of boys and girls by variables was calculated with the F-test and p-statistical significance ($p > .05$). Data processing was performed using the IBM SPSS Statistics 20 statistical package.

Results and discussion

In Table 1, the results of morphological and motor variables are presented in basic central and dispersive statistical parameters. From these results it is clearly observable that the boys (Mm), of the total of 17 morphological and motor variables, demonstrated better values (variables are shaded and marked with *) in the skewness (Sk) in 11 variables (5 morphological and 6 motor). On the other hand, girls (Mž) achieved better values in 14 variables (7 morphological and 7 motor), indicating that, in girls, the value was measured with greater precision in variables of the subcutaneous fat tissue.

By analyzing the results in the morphological space, as shown in Table 2, it is noticeable that boys show increased values in four morphological variables (VIT – body height, TEŽ – body weight, OTR – abdominal circumference, DIK – knee diameter) and only in two motor variables (KOC – transfer of dice, SKU – standing long jump). The girls also demonstrated increased values in four morphological variables (OND – upper arm skin fold, OKU – hip circumference, KND – upper arm skin folds, KNL – back skin fold); however, they showed increased values in as many as seven variables (HOD – polygon backward, SCO – hopscotch, ZGI – pull-ups, P15 – sit-ups in 15 seconds, RZL – seated straddle stretch – left, RZD – seated straddle stretch – right, P3M – polygon in 3 minutes, expressed in meters).

By testing the univariate statistical significance of sex differences in their arithmetic environments, it is clear that there is no statistically significant difference between boys and girls in a single morphological or motor variable (univariate) but only in the entire system (multivariate) of all applied variables at the level $p = .022$. This finding indicates that sex differentiation has already been initiated between 5 and 6 years of age, which is considered to be predominantly endogenous genetic potential.

Table 1

Basic central and dispersive statistical parameters – boys (m) and girls (ž)

Variables	min		max		M		S		Sk	
	m	ž	m	ž	m	ž	m	ž	m	ž
VIT	97.00	102.00	137.00	125.20	116.39	116.29	9.14	7.16	**.09***	**–.57***
TEŽ	14.00	16.00	41.00	29.50	23.65	22.85	6.00	3.40	**.94***	**.00***
OND	14.50	17.00	27.00	22.00	18.84	19.12	2.83	1.512	1.06	**.44***
OTR	47.00	51.00	73.00	65.00	55.67	54.72	5.42	3.31	**.98***	1.61
OKU	49.00	57.00	88.00	72.00	63.52	64.35	7.74	4.08	**.63***	**.21***
DIK	5.90	6.20	10.50	8.30	7.44	7.26	.90	.540	**.99***	**–.18***
KND	4.00	4.00	19.00	12.00	7.00	7.85	2.85	1.98	2.04	**.09***
KNL	2.00	3.00	16.00	11.00	5.34	6.30	2.72	2.36	2.00	**.87***
KOC	12.30	12.90	24.90	23.00	16.47	16.88	2.84	2.80	1.20	**.80***
HOD	4.01	5.69	18.70	16.65	9.97	9.65	3.69	3.27	1.11	**.86***
ŠKO	1.32	1.46	3.78	5.76	2.34	2.25	.65	.930	**.56***	3.02
SKU	25.00	23.00	131.00	118.00	87.69	80.90	25.25	22.27	**–.55***	**–.72***
ZGI	.00	.00	22.80	22.80	3.92	5.09	4.95	5.16	1.96	2.34
P15	.00	2.00	10.00	10.00	5.10	5.40	2.70	2.186	**–.65***	**.46***
RZL	50.00	50.00	90.00	82.00	64.59	64.80	9.00	9.76	**.72***	**.38***
RZD	50.00	50.00	90.00	75.00	65.08	65.65	8.78	7.30	**.60***	**–.77***
P3M	270.00	330.00	500.00	450.00	394.08	403.50	51.83	37.45	**–.55***	**–.39***

Note: (min – minimum value, max – maximum value, M – arithmetic mean, S – standard deviation, Sk – skewness, m – boys, ž – girls, * distribution normality); VIT – body height, TEŽ – body weight, OND – upper arm circumference, OTR – abdominal circumference, OKU – hip circumference, DIK – knee diameter, KND – upper arm skin fold (mm), KNL – back skin fold, KOC – transfer of dice, HOD – polygon backward, SHO – hopscotch, SKU – standing long jump, ZGI – pull-ups, P15 – sit-ups in 15 seconds, RZL – seated straddle stretch – left, RZD – seated straddle stretch – right, P3M – polygon in 3 minutes expressed in meters.

Table 2

Univariate and multivariate (ANOVA/MANOVA) significance of the differences between boys (Mm) and girls (Mž) in morphological characteristics and motor abilities

Variables	Mm	Mž	F	p
VIT (mm)	**116.39***	116,29	.002	.966
TEŽ (kg)	**23.65***	22.85	.314	.577
OND (mm)	18.84	**19.12***	.171	.680
OTR (mm)	**55.67***	54.72	.528	.470
OKU (mm)	63.52	**64.35***	.205	.652
DIK (mm)	**7.44***	7.26	.716	.401
KND (mm)	7.00	**7.85***	1.480	.228
KNL (mm)	5.34	**6.30***	1.866	.177
KOC (sec)	**16.47***	16.88	.293	.590
HOD (sec)	9.97	**9.65***	.115	.736
ŠKO (sec)	2.34	**2.25***	.176	.676
SKU (cm)	**87.69***	80.90	1.097	.299
ZGI (fr)	3.92	**5.09***	.774	.382
P15 (fr)	5.10	**5.40***	.191	.664
RZL (cm)	64.59	**64.80***	.007	.932
RZD (cm)	65.08	**65.65***	.065	.799
P3M (m)	394.08	**403.50***	.542	.464

Wilks' Lambda = .589, **p= .022***

Legend: arithmetic mean for boys (Mm) and girls (Mž); ANOVA: F – F ratio; p – statistical significance $p < .05$; MANOVA: Wilks' Lambda; p – statistical significance.

In accordance with all of the above, it is possible to state that detailed knowledge of limiting factors and critical periods [6], as well as of the dynamics of development of morphological characteristics and motor skills within and between the sexes, which mainly describe the general ontogenesis, are a prerequisite for a proper and effective management of transformation processes in education and sport. This conclusion equally applies to all other dimensions of personality.

Conclusion

It can be concluded that uniform developmental processes in the morphologic space of children aged five to six years are based on sex differentiation and genetic determinations (4:4), while sex differentiation in the motor space is significantly more pronounced in the repetitive power, flexibility, and aerobic endurance in favor of the girls (2:7).

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ЗАВИСИМЫЕ ОТ ПОЛА РАЗЛИЧИЯ МОРФОЛОГИЧЕСКИХ ПАРАМЕТРОВ И ДВИГАТЕЛЬНЫЕ НАВЫКИ У ДЕТЕЙ ДОШКОЛЬНОГО ВОЗРАСТА

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Целью данного исследования является выявление различий морфологических параметров, зависящих от пола, у детей дошкольного возраста с использованием дисперсионного анализа (MANOVA/ANOVA). **Материалы и методы.** Измерения проводились с использованием 17 переменных (8 морфологических характеристик и 9 двигательных навыков). В исследовании принимали участие 69 детей (49 мальчиков и 20 девочек) в возрасте 5–6 лет из региона Приморско-Горанска, Хорватия. **Результаты.** Полученные результаты показали, что между мальчиками и девочками данной возрастной группы существуют многофакторные статистически значимые различия в арифметических значениях на уровне $p = 0{,}022$ во всей системе морфологических и двигательных характеристик, при этом одномерные величины не имеют статистической значимости. **Заключение.** Мы пришли к выводу, что в части морфологических характеристик дети в возрасте от пяти до шести лет развиваются одинаково, исходя из половой принадлежности и генетической детерминации (4:4); однако развитие моторных навыков более выражено у девочек (2:7) данного возраста.

Ключевые слова: *различия, девочки и мальчики, 5–6 лет, морфология, двигательные навыки.*

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