DIMORPHIC DIFFERENTIATION OF SELECTED SOMATIC FEATURES IN SCHOOL-AGE CHILDREN

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- Sexual dimorphism,
- Morphologic,
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- Feet curvature.

Abstract:

Background: Sexual dimorphism as the exponent of development changes in the body was the purpose of the research, which was also the assessment of morphological body building in school-age children.

Material and methods: The studies covered 181 students from primary school. Students were divided into two groups: 11-12 years old, and 13-15 years old. Height and weight of the body and linear feet measurements were conducted to indicate the somatic body construction of students, the calculation of Wejsflog indicator and Clarke angle.

Results: Dimorphism index of characteristics in somatic and body types in the younger age group allows to establish a competitive advantage of the dimorphic indicator's value in favour of girls. In the older age group, received positive values of the indicator in the body height, slenderness and the mesomorph and ectomorph structure indicate the prevalence of the values of these characteristics in a group of boys.

Conclusions: Gender and age of students do not differ the body type significantly. In the younger age group the sexual dimorphism in the length and width of the foot as opposed to older children is not noticed. Curvature of oblong feet in boys is higher than in girls with similar values of transverse curvature.

INTRODUCTION

Dimorphism of the body's features indicates the morphological, physiological, mental gender diversity and is defined "dimorphism" as issue of numerous scientific studies [Bukszyński, Malinowski 2002; Tatarczuk, Solan 2015, Wandycz 2014; Malinowski 2009]. Bukszyński W. and Malinowski A. [2002] point out that sexual dimorphism is growing with age, not just the calendar one, but also and mainly with the age of the development. It manifests itself in the foetal life and constantly increases with development, especially in puberty. According to the dynamic socio-economic changes, the problem of evaluation in studies concerning differences in morphological body building school in the process of progressive development is the issue of continuous update. Wolański N. [2012] emphasises that in the ontogenetic development, the body in accordance with its genetic-constitutional characteristics actively respond to environmental stimuli. Especially high sensitivity to exogenous factors are characterized by children and young people. Therefore, it is necessary to monitor the status and dynamics of biological development of this group population with the objective to gain knowledge and analysis of existing social contrasts.

THE PURPOSE OF THE RESEARCH:

The purpose of the research was to show the diversity of dimorphic characteristics of the body and longitudinal and transverse feet arch in children during the development phase - pre pubertal and pubertal one.

The research questions:

1. Whether the type of body structure substantially differentiate gender and age of students?
2. How the age and gender distinct average arithmetic measurements of the foot?
3. Whether the feet curvature of students is a factor of dimorphic varies?

The research hypothesis:

1. Body structure in children points out the sexual dimorphism in both age groups.
2. Gender in adolescence differentiate linear feet dimensions. In the older age group linear feet measurements have dimorphic differences.
3. Gender differentiate feet curvature.

MATERIAL AND METHODS:

The studies covered 181 students aged from 11 to 15 years, from Primary School in Zarzecze, Przeworsk District, including 79 boys and 102 girls (Table 1). Development phase and sex served as a criterion for the division of the group. Age ratings were created according to the auxology indicators, children who had more than 11,6 months were attributed to the group of 12-years-old. Children were divided into two groups, the first were boys and girls aged 11 to 12 years, who were in the pre pubertal phase, while the second group consisted of students aged 13 to 15 years, in the proper maturation – pubertal one [Malinowski 2009]. The research project has been approved by the bioethical commission at the University of Rzeszów.

1. Anthropometric method
   - measurement of somatic characteristics: height, body weight, in accordance with the rules adopted in anthropometrics [Malinowski, Bożiłow 1997; Carter, Heath 1990]. The results were used to calculate slenderness, BMI and to demonstrate the types of body building [Jopkiewicz, Suliga 2011, Drozdowski 1998];
   - linear feet measurements of length and width of the right and left foot both in relief and in the workload, the results of which were used to calculate Wejsflog indicator and Clarke angle. To determine the dimorphic differences in terms of analysed morphological body structure, the pointer of dimorphism was used [Drozdowski 1998; Malinowski, Bożiłow 1997]. Therefore, to the assessment of the above parameters, the Podoskan 2 D Foot Cad was used, which allowed also to analysis of curvature of the foot.
2. Statistical method
   - a descriptive statistics measures: mean average
   - assessment of significance of differences in the average level of each characteristics between the two sexes-including to have applied the analysis of variance test, F Fisher – Snedecor. Evaluation of the results was carried out with the selected significance level $\alpha = 0.05$.

Table 1. The multiplicity of tested group with regard to age

Age group	Gender		Total
	Boys	Girls	
11-12	35	46	81
13-15	44	56	100
Total	79	102	181

RESEARCH RESULTS

Table 2. Characteristics of somatic and body types

Characteristics of somatic	11-12				13-15			
	Sex		p	Dimorphism index	Sex		p	Dimorphism index
	male	female			male	female		
	$\bar{x}$				$\bar{x}$			
Body height	143,2	147,0	0,098	-266	162,4	159,2	0,158	198
Body weight	40,5	42,5	0,125	-494	51,9	53,5	0,214	-295
BMI	19,6	19,6	0,986	7	19,5	21,0	0,053	-748
Slenderness indicator	42,1	42,5	0,487	-90	43,9	42,6	0,012*	290
Endomorph structure	4,4	4,8	0,331	-792	3,3	4,3	0,001*	-2543
Mesomorph structure	4,2	3,7	0,075	1238	3,5	3,1	0,135	1322
Ectomorph structure	2,4	2,6	0,601	-760	3,5	2,8	0,041*	2229

The symbol * means the rejection of the null hypothesis at $\alpha = 0.05$

Analysing the basic characteristics of somatic such as height and weight of body, it is noted that with age increase these parameters, but there are big differences between gender. If the height of the body in the younger age group is concerned, the difference is 4 cm in favour of girls, while in the older group of 3 cm difference occurs in a group of boys in relation to the average body height measurement in girls. The observed differences in the case of average body weight was as follows: in the younger group girls were heavier by 2 kg, the same as in the earlier about 1.5 kg in comparison to boys. In the case of slenderness ratio analysis clearly states that in a group of younger age dominates the average body type, regardless of gender. While in the older one, calculated indicator distinguishes the type of construction, the slim applies to boys, while the average one to girls.

Body building typology used by Sheldon on the tendency for body fat, his musculature and the tendency to excessive weight loss – allows to declare that in the younger age group regardless of gender occurs endomorph and mesomorph structure. In the older age group of girls, in most cases there is endomorph structure, while in boys it was observed in similar average values of all three types of structure (3.3; 3.5; 3.5). Analysis of the p value when measuring somatic and body building concludes no significant dependency property. In the case of slenderness ratio and body types, there were significant differences, but only close to the level of $\alpha = 0.05$. The calculated dimorphism indicator in case of the characteristics of somatic and body types in the younger age group allows to establish a competitive advantage of the dimorphism in favour of girls. Only in case of the mesomorph structure, the dimorphism in boys in the younger age group (dimorphism = 1238) is clearly noted. In the older age group received positive values of the indicator on the body height, slenderness and the mesomorph and ectomorph structure indicate the prevalence of these characteristics in a group of boys (Table 2).

Table 3. Measuring linear feet

The length and width of the foot	11-12				13-15			
	Sex		p	Dimorphism index	Sex		p	Dimorphism index
	male	female			male	female		

	$\bar{x}$				$\bar{x}$			
Left foot lenght [mm] (in the workload)	227,0	229,1	0,452	-89	250,4	239,5	0,000*	443
Right foot lenght [mm] (in the workload)	226,7	228,9	0,426	-95	250,5	239,8	0,000*	436
Left foot width [mm] (in the workload)	85,2	85,8	0,548	-81	94,4	90,4	0,002*	435
Right foot width [mm] (in the workload)	85,5	86,4	0,494	-94	95,0	90,7	0,001*	455
Left foot lenght [mm] (in relief)	226,2	229,3	0,242	-136	249,7	238,4	0,000*	463
Right foot lenght [mm] (in relief)	226,2	228,9	0,320	-118	249,2	238,4	0,000*	445
Left foot width [mm] (in relief)	84,9	85,9	0,394	-118	93,7	89,8	0,002*	419
Right foot width [mm] (in relief)	85,4	86,1	0,580	-79	94,9	90,0	0,000*	524

The symbol * means the rejection of the null hypothesis at $\alpha = 0.05$

The length and width of the foot in the younger age group (for both the left and right foot in the workload and in relief) were similar. While in the older age group observed a clearer differentiation of the value of the arithmetic mean of the measurements of the linear foot for their growth in boys. In both age groups there were significant relationships between the investigated parameters. Negative sexual dimorphism indicator in the younger age group indicates a small advantage of these values in girls as opposed to an older age group where there is a positive indicator value in all the test parameters (Table 3).

Table 4. Feet curvature

Transverse and longitudinal curvature	11-12				13-15			
	Sex		p	Dimor-phism index	Sex		p	Dimor-phism index
	male	female			male	female		
	$\bar{x}$				$\bar{x}$			
Wejsflog indicator of left foot (in the workload)	2,67	2,67	0,820	-21	2,66	2,65	0,808	19
Wejsflog indicator of right foot (in the workload)	2,65	2,66	0,846	-17	2,64	2,65	0,813	-19
Clarke angle of left foot (in the workload)	50,9	50,9	0,936	14	52,7	50,6	0,002*	404
Clarke angle of right foot (in the workload)	51,2	50,8	0,562	89	52,4	50,5	0,003*	372
Wejsflog indicator of left foot (in relief)	2,67	2,67	0,889	-13	2,67	2,66	0,550	44

Wejsflog indicator of right foot (in relief)	2,65	2,66	0,655	-42	2,63	2,65	0,331	-76
Clarke angle of left foot (in relief)	51,7	49,6	0,028*	410	52,1	50,7	0,030*	268
Clarke angle of right foot (in relief)	51,6	50,1	0,099	301	52,0	51,2	0,228	160

Analysis of medium sized Wejsflog indicator showed similar values both in the workload and in relief. In the case of analysis of curvature in the younger age group, there was no difference in the size of the Clarke angle and Wejsflog indicator, with little variation for the Clarke angle in relief, which could not statistically show significant difference ($p = 0.028$). In a group of older age there was observed the increase in the arc dynamic foot with correct its values but in the upper normal limits (Table 4). There are noted the positive values of the indicator (dimorphism indicator: 404; 372; 268) in case of Clarke angle for the left and right feet (Table 4).

DISCUSSION

In research on differentiation of dimorphic characteristics of body building attended 181 students aged from 11 to 15 years old, living in the area of Zarzecze, Przeworsk District in Podkarpackie Province. According to many authors, morphological parameters such as height and weight, the level of biological maturity in children and adolescents, are the sensitive indicators of changes to socio-economic conditions, the degree of urbanisation of residence, habits and customs of nutrition, climate, etc., that affect the physical development of children and youth [Bukszyński, Malinowski 2002; Jopkiewicz, Suliga 2011; Wolański 2012; Wandycz 2014; Mrozkowiak, Jazdończyk 2015]. Observations of many authors indicate that differences in dimorphic of the main somatic characteristics, such as height, weight, are mostly manifested during puberty and after puberty period, and the least in a group of children before the period of puberty [Bukszyński, Malinowski 2002; Wandycz 2014]. Mrozkowiak, Jazdończyk [2015] pointed out that from 7.5 to 11.5 year of living the individuals of both sexes receive very similar increases in somatic characteristics of height, body weight), and in the next age there is gradual systematic "propagate" to size, that document also distinct advantage body height of men over women. In the test groups, there were no statistically significant differences in the values of the dimorphic indicators, for both younger and older age group.

In the case of slenderness ratio analysis in the younger age group, there was noted the average body type, with the same in the older age group of girls to slight slenderness of boys. According to the typology of Sheldon a younger age group, regardless of the sex was characterised by the endomorph and mesomorph structure. In the older age group of girls, have been observed in the majority of cases, the endomorph structure, while in boys in similar average values of all three types of the structure. Analysing the value of p when measuring somatic and body building concludes no significant dependency property. In the case of slenderness ratio and body types, there were significant differences, but only close to the level of $\alpha = 0.05$ (Table 2).

Burdukiewicz (1995) pointed out that the most astonishingly thin body have children of 11 years. During the period between 11 and 15, also in girls is increasing the bulkiness of the build, while in boys the ratio between height and weight do not change significantly. In turn, according to Tatarczuk, Solan, Nowacka-Chiari (2016), girls are, on average slimmer than the boys. According to the authors, later entry of boys in puberty (an average of about 18 months) manifests itself more with a super-slim profile starting from the age of 14.

The next analysed somatic parameters were linear measurements of feet and their curvature. The authors in many publications state that the growth of the foot shows changes with age progress. One can observe periods of intense increments and some inhibitions associated with the evolution of its vaults [Demczuk – Włodarczyk 2003; Łuba, Olejniczak, Woźniak 2014; Rykała, Snela, Drzał–Grabiec, Podgórska et al. 2013; Puszczałowska–Lizis, Ridan, Ogarek 2011]. Łuba, Olejniczak, Woźniak (2014) find men's feet are longer than the feet of women by more than 10 mm, as well as, on average, greater is their width of about 4 mm. Müller S, Carlsohn A, Müller J and others (2012) indicate that the majority of the static and dynamic characteristics of the foot changes continuously during growth and maturation. Also Demczuk-Włodarczyk (2003) is of the opinion that the diversity of morphological construction rate of men and women's feet, in the development of ontogenetic, not increases in the same pace, and is most noticeable after a period of sexual maturation. Ruling characteristics of morphological structure are dimorphic different [Demczuk–Włodarczyk 2003; Łuba, Olejniczak, Woźniak 2014].

On the basis of the results of personal research, analysis of the parameters of linear feet showed no differences in children 11-12 years, with little differentiation of the length and width of the foot in a group of 13-15 years. The average rate of boys in the older age group were longer from girls – about 11 mm (250,5 boys, girls 239,8 - test in the workload). It has also been indicated increased width – about 4,3 mm – this is the right foot (boys 95,0, girls 90.7) (Table 3).

The results of personal research on the State of curvature arch transverse and longitudinal feet indicate the absence of irregularities in its structure. Smmilar results were presented by: Leszczak, Drzał – Grabiec, Rykała, Podgórska – Bednarz and others (2014); Rykała, Snela, Drzał – Grabiec, Podgórska and others (2013). The value of the Wejsflog indicator was the basis for analysis of curvature of the foot of the cross as the ratio of its length to the width. The results of personal research showed no statistically differences due to age of the subjects and their gender.

The course of the longitudinal arch of the foot test, points to the diversity of the value Clarke angle with little tendency to increase in a group of older boys (Table 4). Simmilar conclusions were presented by: Demczuk – Włodarczyk (2003); Rykała, Snela, Drzał – Grabiec, Podgórska and the others (2013).

Test results of many authors differentiate subject advantage of curvature of longitudinal one foot over the other. Nadolska – Ćwikła showed that the right foot is characterized by a larger angle of curvature. Otherwise according to Drzał – Grabiec J. (2012), Puszczałowska– Lizis, Ridan, Ogarek (2011) girls had better curved at the rate of the left, and the boys right foot. Observations of many authors analyzing the differences in longitudinal curvature evaluation for Clarke angle show that girls have better arched feet than boys [Puszczałowska–Lizis, Ridan, Ogarek 2011].

The results of research and analysis and interpretation, can be the basis for further scientific studies. It is important to monitor the development of the differences in dimorphic body building characteristics in the process of the progressive development of children and young people to watch dynamic changes socio-economic.

CONCLUSIONS:

On the basis of the obtained results the following conclusions can be formulated:

1. Gender and age of tested group does not differentiate substantially the body type.
2. With the increase in the age of the students, parameters in linear feet increase. In the younger age group there is sexual dimorphism in the length and width of the foot. With age, there is an increase in the length and width of the foot of boys as opposed to girls. While in the older group it is observed the increase of these parameters in boys

compared to girls. In boys, one can find an increase in the length and width of the foot depending on the age.
3. Curvature of oblong feet boys is higher than in girls with similar values of curvature of the cross one.

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