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Environmental dimorphism of the frequency of significant correlations of the torso features with the feet features among 7-13-year-old youth

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Summary
Introduction. Studies on the correlation of selected torso and feet features among 7-13-year-old children and adolescents have shown that the most frequent and strongest correlations with feet features occur among girls at the age of 11 and 12 years and among boys at 11, 12 and 13 years old.
Material and method. The research was carried out in the group of adolescents aged 7 to 13 and registered 16,462 observations, including 5,552 from the urban area and 10,910 from rural environment, together with 87 features describing torso and feet. The work stand for measuring selected features using the photogrammetric method consists of a computer and a card, programme, monitor, printer and a projection-receiving device with a camera.
Conclusions

1. The frequency of significant correlations of torso features with feet features that differentiate the rural environment from urban is greater, however, the urban area presents more frequent relationship with feet features at a different level.

Features of the frontal and transversal plane tell the rural environment apart, whereas the urban environment is only differentiated by the frontal plane.

2. The frequency of significant relationships of the feet features, which torso features correlate with and differentiate between the rural and urban environment is greater. Therefore, these are the morphological features that characterize the longitudinal arch of the feet. The features that differentiate the urban environment are those describing only the longitudinal arche.

1. Introduction

The result analysis of the correlation of the value of selected torso and feet features among 7-13-year-old children and adolescents showed that in the analyzed age groups the most common and strongest relationships and coexistence with the features of the feet occur among girls at 11 and 12 years of age, and among boys at 11, 12 and 13 years of age. There were no accuracy and logical relationships between the parameters of the pelvic-spine syndrome and feet in all age groups and each sex. The features of the sagittal and frontal plane are more dominant among the features describing the pelvic-spine syndrome and most often correlating with feet features, whereas transversal plane dominates less. On the other hand, features describing the 5th hallux valgus and varus and hallux varus of the right foot are the most dominant among the feet features in correlation with the parameters of the pelvic-spine syndrome [1].

The analysis also showed that the number of torso features significantly related to feet features and differentiating between male and female sex is greater, and the relationship is more frequent among boys. The number of features of the transversal plane differentiating the male sex is the same, whereas there is more of the frontal plane. The number of feet features related to torso features is bigger among girls than boys, and the relationship with feet features is also more frequent among girls [2].

Pilot studies by Drzał-Grabiec and Snela [3] in the population of girls and boys aged 7 to 9 years allowed to establish a statistically significant correlation between the Clarke's angle and the parameters describing the length of individual spine curvatures, i.e., the length (RLL) and the height of lordosis (DLL) and the height of thoracic kyphosis (DKP). There is a statistically significant correlation between the length of thoracic kyphosis (DKP) for the left and right foot, the length of lumbar lordosis (DLL) for the right and left foot, and the height of lumbar lordosis (RLL) for the right and left foot. In terms of gender, there is a statistically significant correlation among boys between the length of thoracic kyphosis (DKP), the height of thoracic kyphosis (RKP), the height of lumbar lordosis (RLL) and the length of lumbar lordosis (DLL) and the right and left foot. In the group of girls, there is a correlation between the Clarke's angle of the right and left foot and the length of lumbar lordosis (DLL). Considering the age of the studied groups, the relationships that occur simultaneously for the right and left foot were found in the case of 9-year-olds for the DLL and RLL parameters. In the study group, there were not found statistically significant correlations between the longitudinal arch of the feet and the parameters describing the spine in the frontal plane, i.e. KNT (torso bent angle in the frontal plane), UK (deviation of the spinous processes from the C7-S1 line), UL (difference in the height of the lower angles of shoulder blades - inclination) and UB (difference of the depth of the lower angles of shoulder blades – twist), OL (difference in distance of the lower angles of shoulder blades from the spine). The authors conclude that the longitudinal arch of the feet is related to the length parameters describing the body posture. The strength of the correlation of the parameters can be average or weak, but the presence of dependency between most of the length parameters indicates a specific tendency. Other features of the body posture do not present such a relationship. Moreover, single correlations with a small strength of correlation should be treated as random.

The aim of the research is to demonstrate the environmental dimorphism of the frequency of significant relationships of selected torso features with feet features in the group of 7-13-year-old children. The result analysis of the research was going in two directions. The first was the answer to the question: which torso features do most often show a significant relationship with feet features in the context of environmental dimorphism? The second was the answer to the question: which feet features do the torso features most often show a significant relationship with also in the context of environmental dimorphism?

2. Material and method

The research was carried out in the group of children and adolescents aged 7 to 13 and registered 16,462 observations, including 5,552 from the urban (M) and 10,910 rural (W) environments. Due to the limited volume of the work, a detailed description of the somatic features of the research material and the obtained research results can be found in the author's monograph [4]. Empirical data were based on quantitative and qualitative features (gender, place of residence, etc.). The values of positional statistics were calculated (arithmetic mean, quartiles), as well as dispersion parameter (standard deviation) and symmetry indicators (asymmetry coefficient, cluster coefficient), which give a full overview of the distribution of the researched features considering age groups, gender, and environment. Relationships and significance were determined using p as a value, and frequency as percentage.

The basic assumption in the research was to always assess habitual attitude as a relatively permanent individual characteristic of a human being. This attitude reflects the individual emotional, mental, and social state of the respondent. It is the most accurate in describing his silhouette in time and place. The obtained diagnostics does not determine whether the individual's posture is correct, but it only affirms the state of its ontogenetic realization. Objectivized and comparable test results will make it possible to register the parameters adopted for the analysis with possible to define compensations. The combination of a torso and feet examination makes it possible to objectively determine the quality of the posture pattern realized in each environment, gender, and age category. The usage of the measuring device determines several dozen parameters describing the body posture. For statistical analysis, 87 angular and linear parameters of the spine, pelvis, torso, and feet were selected in the sagittal, frontal, and transversal planes, in individual age categories and environment, tab. 1. A spatial image is possible to obtain thanks to lines displayed with strictly defined parameters on the child's back and feet. The lines falling on the skin are distorted depending on the configuration of the surface. Thanks to the use of a lens, the image of the examined person can be received by a special optical system with a camera, and then transferred to a computer monitor. Line image distortions recorded in the computer memory are processed by a numerical algorithm into a contour map of the tested surface. While the examination, one should be aware that the taken picture records the image of the silhouette visible on the child's skin [4].

Tab. 1. The list of registered torso and feet features
Within torso area

No.	Symbol	Parametres		
		Label	Name	Description
Sagittal plane				
1	Alfa	degrees	Inclination of the lumbosacral segment	
2	Beta	degrees	Inclination of the thoracolumbar segment	
3	Gamma	degrees	Inclination of the upper thoracic segment	
4	DCK	mm	Total length of the spine	Vertical distance between C_7 and S_1 points
5	KPT	degrees	Torso extension angle	It is determined by the deviation of C_7-S_1 points from the vertical line (backwards)
6	KPT -	degrees	Torso bent angle	It is determined by the deviation of C_7-S_1 points from the vertical line (forwards)
7	DKP	mm	Length of thoracic kyphosis	Distance between LL a C_7 points
8	KKP	degrees	The angle of thoracic kyphosis	KKP = 180 – (Beta+Gamma)
9	RKP	mm	Height of thoracic kyphosis	Distance between C_7 a PL points
10	GKP	mm	Depth of thoracic kyphosis	The distance measured horizontally between vertical lines passing through PL and KP points
11	DLL	mm	Length of lumbar lordosis	The distance between S_1 and KP points
12	KLL	degrees	Lumbar lordosis angle	KLL = 180 – (Alfa + Beta)

13	RLL	mm	Height of lumbar lordosis	Distance between S_1 and PL points
14	GLL -	mm	Depth of lumbar lordosis	The distance measured horizontally between vertical lines passing through PL and LL points
Frontal plane				
15	KNT -	degrees	The angle of the torso bend to the side	It is determined by the deviation of the C_7-S_1 line from the vertical to the left.
16	KNT	degrees		It is determined by the deviation of the C_7-S_1 line from the vertical to the right.
17	LBW -	mm	The right shoulder higher	The distance measured vertically between the horizontal lines going through the B_2 and B_4 points.
18	LBW	mm	The left shoulder higher	
19	KLB	degrees	The angle of shoulders line, where the right one is higher	The angle between the horizontal and the straight line going through the B_2 and B_4 points.
20	KLB –	degrees	The angle of shoulders line, where the left one is higher	
21	LŁW	mm	Left shoulder blade higher	The distance measured vertically between horizontal lines going through Ł1 I and Łp points.
22	LŁW –	mm	Right shoulder blade higher	
23	UL	degrees	The angle of shoulder blades line, where the right one is higher	The angle between the horizontal and the straight line going through the Ł1 and Łp points.
24	UL -	degrees	The angle of shoulder blades line, where the left one is higher	
25	OL	mm	The lower, more distant angle of the left shoulder blade	The difference in the distance of the lower angles of the shoulder blades from the line of the spinous processes of the spine, measured horizontally at the straight lines going through the Łl and Łp points.
26	OL -	mm	The lower, more distant angle of the right shoulder blade	
27	TT	mm	The left waist	The difference in the distance measured

			triangle is higher	vertically between the T_1 and T_2 points and between T_3 and T_4 points.
28	TT –	mm	The right waist triangle is higher	
29	TS	mm	The left waist triangle is wider	The difference in the distance measured horizontally between the straight lines going through the T_1 and T_2 points and T_3 and T_4 points.
30	TS -	mm	The right waist triangle is wider	
31	KNM	degrees	The pelvic tilt angle, the right ala of ilium is higher	The angle between the horizontal and straight line going through the M1 and Mp points.
32	KNM -	degrees	The pelvic tilt angle, the left ala of ilium is higher	
33	UK	mm	The maximum deviation of the spinous process of the vertebra to the right	The greatest deviation of the spinous process from the vertical coming from S_1. The distance is measured on the horizontal axis.
34	UK -	mm	The maximum deviation of the spinous process of the vertebra to the left	
35	NK	_	The number of the vertebrae deviating as far as possible to the left or right	The number of the vertebrae most deviating to the left or right in the asymmetrical course of the spinous process, counting as 1, first cervical vertebra (C1) If the arithmetic mean is, for example, from 12.0 to 12.5 it is Th5, if from 12.6 to 12.9 it is Th6.
Transversal plane				
36	ŁB -	mm	The lower angle of the right shoulder blade more oblique	The difference in the distance (convexity) of the lower angles of the shoulder blades from the back surface.
37	ŁB	mm	The lower angle of the left shoulder blade more oblique	

38	UB –	degrees	The angle of the line of convexity of the lower angles of the blades, more convex on the left	Angle difference UB_1 - UB_2. The UB_2 angle between: the line passing through the point Łl and being simultaneously perpendicular to the camera axis and the straight line passing through Łl and Łp. The UB_1 angle included between the line passing through the point Łp and being simultaneously perpendicular to the camera axis and the straight line passing through Łp and Łl.
39	UB	degrees	The angle of the line of convexity of the lower angles of the blades, more convex on the right	
40	KSM	degrees	Pelvis twisted to the right	The angle between a line passing through Ml point and being simultaneously perpendicular to the camera axis and a straight line passing through Ml and MP points
41	KSM -	degrees	Pelvis twisted to the left	The angle between a line passing through Mp point and being simultaneously perpendicular to the camera axis and a straight line passing through Ml and MP points

Within feet area

Feature number	Symbol	Features		
		Label	Name	Description
42	DL p	mm	Length of the right foot (p), and left foot (l)	The distance between akropodion and pterion points on the platnogram
43	DL l			
44	Sz p		The width of the right foot(p), and left foot (l)	The distance betwenn metatarsale fibulare and metatarsale tibiale points on the plantogram
45	Sz l			
46	Alfa p m	degrees	The angle of the hallux valgus of the right foot: Alfa p p, and left: Alfa l p. The angle of hallux vargus of the right foot: Alfa p m, and left: Alfa l m.	The angle between the straight line passing through the metatarsale tibiale and the innermost points at the medial edge of the heel and the straight line passing through the metatarsale tibiale and the innermost points at the medial edge of the toe
47	Alfa p p			
48	Alfa l m			
49	Alfa l p			
50	Beta p m		The angle of the 5th hallux vargus of the right foot: Beta p p, and left: Beta l	The angle between the straight line passing through the metatarsale fiburale points and the outermost point on the lateral edge of the heel and the straight line passing through the metatarsale fiburale points and
51	Beta p p			
52	Beta l			

	m		p.	the outermost straight line on the lateral edge of the V toe on the plantogram
53	Beta l p		The angle of the 5th hallux valgus of the right foot: Beta p m, and left: Beta l m.	
54	Gamma P		Heel angle of the right foot (p), and left foot (l)	The angle between the straight line passing through the metatarsale tibiale and the innermost points on the medial edge of the heel and the straight line passing through the metatarsale fiburale points and the outermost line on the lateral edge of the heel in the plantogram
55	Gamma L			
56	PSP	mm^2	Surface of the right foot(p), and left foot(l)	Foot plantogram surface
57	PSL			
58	DP 1	mm	Length of longitudal arch of the right foot 1, 2, 3, 4, and 5 (P), and the left foot (L)	The length of the arch from the 1st, 2nd, 3rd, 4th and 5th metatarsal bones to the pterion point
59	DP 2			
60	DP 3			
61	DP 4			
62	DP 5			
63	DL 1			
64	DL 2			
65	DL 3			
66	DL 4			
67	DL 5			
68	WP 1		Height of arch 1, 2, 3, 4 and 5 of the right foot (P), and left foot	Distance from the ground to the highest point of arch 1, 2, 3, 4 and 5.
69	WP 2			
70	WP 3			
71	WP 4			
72	WP 5			
73	WL 1			
74	WL 2			
75	WL 3			
76	WL 4			
77	WL 5			
78	SP 1		Width of arch 1, 2, 3, 4 and 5 of the right foot (P), and left foot (L)	Bowstring of the arch length 1, 2, 3, 4 and 5.
79	SP 2			
80	SP 3			
81	SP 4			
82	SP 5			
83	SL 1			
84	SL 2			
85	SL 3			
86	SL 4			
87	SL 5			

Source: own research

3. Results

Tab. 2. Environmental dimorphism of the frequency of significant correlations of the torso features with the feet features

(n) M=5552, W=10910

Feature name	Environment		Feature name	Environment	
	Urban area	Rural area		Urban area	Rural area
DCK	39,21	27,45	ŁB	7,84	15,68
Alfa	11,76	23,52	ŁB-	9,8	7,84
Beta	13,72	11,76	OL	7,84	17,64
Gamma	23,52	31,37	UL	3,92	9,8
KKP	25,49	23,52	KLB	7,84	9,8
RKP	39,21	31,37	KLB-	13,72	
DKP	35,29	15,68	UB	15,68	19,6
GKP	29,41	9,8	UB-	15,68	21,4
KLL	11,76	19,6	LŁW-	9,8	19,6
DLL	29,41	17,64	TS	21,56	5,88
RLL	27,45	15,68	TT-	17,64	19,6
GLL	19,6	13,72	KNM		5,88
KNT-	19,6	9,8	KSM		9,8
KPT-	23,52	23,52	UK-		5,88

Source: own research

The result analysis of the research in terms of the environmental dimorphism of the torso parameters most often differentiating significant relationships with the feet features showed that among the propositus from the urban environment it is the size of the line asymmetry of the shoulder blades, where the left one is higher (KLB-). The result analysis of the research obtained on propositus from the rural environment showed that the differentiating features were the value of the right-hand pelvic tilt angle in the transversal plane (KSM) and the maximum deviation of the spinous process to the left (UK-), tab. 2, fig. 1.

Tab. 3. Dimorphism of the feet features of the most frequent significant relationships with the features of the torso

(n) M = 5552, W = 10910

Feature's name	Environment		Feature's name	Environment	
	M	W		M	W
SZP	54,2	23,8	DP3	6,5	10,8
SZL	60,8	52,1	DP4	8,6	
DLP		17,3	DP5	6,5	6,5
DLL	22,0		SP1	8,6	22,0
AlfaP	17,2	8,6	SP3	28,6	13,0
AlfaL	13,0	8,6	SP4	6,5	10,8
BetaP	45,6	17,2	SP5		8,6
BetaL	32,5	28,6	WL1	26,0	28,6
GamP		10,8	WL2	8,6	23,8
GamL	15,1	26,0	WL3		15,2
PSP	30,3	36,8	DL1		15,2
PSL		17,3	DL2	24,2	17,2
WP1	19,5	15,2	DL3		8,6
WP2	34,7	32,5	DL4		6,5
WP3		10,8	SL1		13,4
WP4	17,3		SL2	8,6	
DP1	28,1	19,9	SL3	24,2	6,5
DP2	10,8	23,8	SL4	17,3	

Source: own research

The result analysis of the research on the environmental dimorphism of the feet features, which the torso features most often show a significant relationship with, showed that the values of the following parameters among the propositus of the urban environment are height and length of the fourth longitudinal arch of the right foot (WP4, DP4), and the width of the second and fourth arch of the left foot (SL2, SL4). On the contrary, among the results of test on subjects from the rural environment, the values of the following features are right foot heel angle (GamP), left foot plantocontourgraph surface (PSL), height of the third arch and width of the fifth arch of the right foot (WP3, SP5), height of the third and length of the first, third and fourth arch of the left foot (WL3, DL1, DL3, DL4), and width of the first arch of the left foot (SL1), tab. 3, fig. 2.

4. Conclusions

1. The frequency of significant relationships of the torso features with the feet features that differentiate the rural environment from urban is greater, however, the features of the urban environment have more frequent relationship with the feet features at a different level of significance. Features of the frontal and transversal plane differentiate the rural environment, whereas the urban area is differentiated only by the frontal plane.

2. The frequency of significant relationships of the feet features with the torso features that differentiate the rural environment from urban is greater. These are the morphological features whereby that characterize the longitudinal arch of the feet. The features that differentiate the urban environment are features that describe only the longitudinal arch.

Literature

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Fig.1 Environmental dimorphism of significant correlations of torso features with feet features among 7-13 years old youth (n) M=5552, W=10910

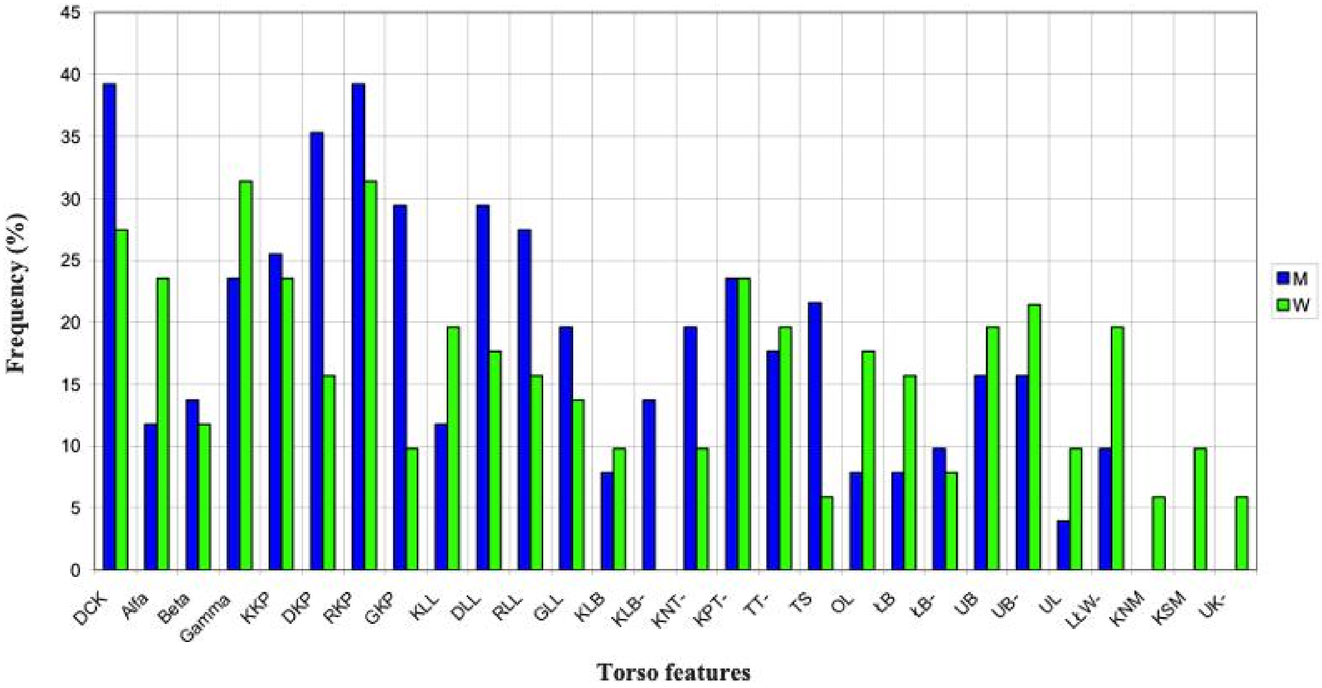

Fig. 2 Environmental dimorphism of feet features of the most frequent and significant correlations with torso features among 7-13 years old youth (n) M=5552, W=10910