Mrozkowiak Mirosław, Posłuszny Mariusz. Sexual and environmental dimorphism of the frequency of significant correlations of body mass and height with feet features among 7-13-year-old adolescents. Journal of Education, Health and Sport. 2022;12(5):128-139. eISSN 2391-8306. DOI http://dx.doi.org/10.12775/JEHS.2022.12.05.009
https://apcz.umk.pl/JEHS/article/view/JEHS.2022.12.05.009
https://zenodo.org/record/6482300

The journal has had 40 points in Ministry of Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of December 21, 2021. No. 32343. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical Culture Sciences (Field of Medical sciences and health sciences); Health Sciences (Field of Medical Sciences and Health Sciences).

Punkty Ministerialne z 2019 - aktualny rok 40 punktów. Załącznik do komunikatu Ministra Edukacji i Nauki z dnia 21 grudnia 2021 r. Lp. 32343. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).

Received: 03.04.2022. Revised: 20.04.2022. Accepted: 25.04.2022.

Sexual and environmental dimorphism of the frequency of significant correlations of body mass and height with feet features among 7-13-year-old adolescents

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Keywords: body weight and height, feet features.

Summary

The aim of the study is to demonstrate the sexual and environmental dimorphism of the frequency of significant correlations between body weight and height with selected feet features among 7–13-year-old children.

Material and method. The research among 7-13-year-old children was being carried out over a period of 3 years in 6 semi-annual editions and allowed to register 16,462 observations of the value of 48 features describing feet, weight, and height of the body. The photogrammetric method was used to measure selected features.

Conclusions

1. Among 7-13-year-old children, the body height is more often associated with the features of the feet than the body weight.
2. Among girls, the proportions of the frequency of body height correlations are similar to the percentage of boys, where body weights are more frequent. The mass and body height shows more frequent associations with feet features among children living in the city than among children from the countryside.
3. The most frequent significant correlations between body weight and height and the features of the feet occur among boys living in the city. Whereby the percentage of body weight correlations in the rural environment is very low. The frequency of body weight and height correlations exceeds that percentage of correlations among girls, who live in the city than in those from rural environment.

1. Introduction

The literature review of the topic shows that authors often focus on the correlation between body mass and feet architecture in various aspects [1, 2, 3]. Feet are a significant static-dynamic link in the musculoskeletal system, as they keep the body weight within the actual limit of stability, being the propulsion at the same time [4]. The issue of the interdependence of feet and somatic features most often concerns the relationship of longitudinal arch of the feet [5, 6]. The observed high percentage of postural static disorders is often associated not only with the sedentary lifestyle, but also with body weight and height. The student's environment significantly influences the type and size of disorders in body posture, especially during the school period [7, 8]. A study by Drzał-Grabiec et al. on body posture, weight, and height in a group of 563 students from the first three grades of a primary school showed statistically significant differences in the characteristics describing body posture, body weight and height [9]. Research by Pauk et al. among 450 primary school students on the verification of the influence of selected epidemiological factors on the occurrence of flat feet in children, which was to lead to the development of a mathematical model of the dependence of the height of the longitudinal arch of the foot on such factors as age, gender, Cole's weight-height index and place of residence showed that age and Cole's index had the greatest influence on the height of the longitudinal arch of the foot. It has also been proved that the arch height increases with age whereas the Cole's index decreases [10]. Research by Puszczałowska-Lizis et al. in a group of 50 second graders of a primary school showed that girls in the early school period have better arched feet than boys, while in terms of

heel angle, both groups are similar to each other. It has also been proved that in both girls and boys, body weight is a feature that significantly influences the shape of the longitudinal arch of the foot, as well as the presence of correlations between the Clarke's angle and body height in boys, and their absence in girls, probably results from sexual dimorphism. Moreover, it was observed that body weight and height did not affect the transverse arch of the foot in early school children [11]. Studies by Mikołajczyk and Jankowicz-Szymańska in a group of 90 children aged 7 have shown that static flat feet are a defect often occurring in 7-year-olds, especially boys, and the fat condition and position of the lower limbs do not significantly affect the degree of arching of the feet. Additionally, it has been shown that the excessive amount of adipose tissue, visible in an increased body weight and in the thickness of the abdominal skin-fat fold, generates the probability of valgoid knee positioning in children of both sexes [3].

The aim of the research is to show the frequency of significant correlations between body weight and height with selected feet features among 7-13-year-old children. The analysis of the study results was heading in four directions. The first is the answer to the question: which feet features have got the most frequently significant correlation with weight and height at the age of 7-13? The second and third are the answer to the question: which features do most often show a significant correlation in terms of sexual and environmental dimorphism? The fourth is the answer to the question: what is the frequency of significant correlations of weight and height among girls and boys within each of the environments?

2. Material and method

The research among children aged 7-13 was conducted over a 3-year period in 6 semi-annual editions and allowed to register 16,462 observations including 8953 girls and 7509 boys. For statistical analysis, body weight and height as well as 48 angular and

linear feet parameters were selected for individual age categories, gender and environment, Tab. 1. Due to the limited volume of the work, a detailed description of the somatic features of the research material and the research results obtained can be found in the author's monograph [12].

The habitual posture was basically assumed in the research to be always assessed as a relatively permanent individual characteristic of a human being. This posture reflects the individual emotional, mental, and social state of the respondent. It is the most accurate in describing the silhouette in time and place. The performed diagnostics does not determine whether the individual's posture is correct, they only present 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 a particular environment, gender, and age category. The applied measuring device determines several dozens of parameters describing the feet. It is possible to obtain a spatial image thanks to displaying lines with strictly defined parameters. The lines falling on the skin are distorted depending on the configuration of the surface. The use of a lens makes the image of the feet possible to be picked up 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. When performing the examination, one should know the photo records an image on the skin of the plantar surface of the child's feet [12].

Empirical data appeared to be quantitative and qualitative features (gender, place of residence, etc.). The calculations of the values of positional statistics (arithmetic mean, quartiles), dispersion parameter (standard deviation) and symmetry

indices (asymmetry coefficient, cluster coefficient) give a full overview of the distribution of the examined features considering age groups, gender, and environment. Correlations and significance were determined using p-value, and the frequency as a percentage value.

Tab. 1. List of registered foot features, body weight and height

No.	Symbol	Parametres		
		Label	Name	Description
1	DL p	mm	Length of right foot (p), and left foot(l)	The distance between akropodion and pterion points on the platnogram
2	DL l			
3	Sz p		Width of right foot (p), and left foot (l)	The distance between metatarsale fibulare and metatarsale tibiale points on plantogram
4	Sz l			
5	W p		Rate „W" (Wejsflog's) of right foot (p), and left foot (l)	The ratio of the length of the foot to its width DL p/Sz p = W p, DL l/Sz l = Wl
6	W l			
7	Alfa p m	degrees	Angle of right hallux valgus : Alfa p p, left: Alfa l p. Angle of right hallux varus Alfa p m, 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
8	Alfa p p			
9	Alfa l m			
10	Alfa l p			
11	Beta p m		Angle of right hallux varus V: Beta p p, left: Beta l p. Angle of right hallux valgus V: Beta p m, left: Beta l m.	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 the outermost straight line on the lateral edge of the V toe on the plantogram
12	Beta p p			
13	Beta l m			
14	Beta l p			
15	Gamma p (Gam.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
16	Gamma l (Gam.L)			
17	PS p	mm^2	Surface of the right foot(p), and left	Foot plantogram surface
18	PS l			

			foot(l)	
19	DP 1	mm	Length of longitudal arch of the right foot 1, 2, 3, 4, i 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
20	DP 2			
21	DP 3			
22	DP 4			
23	DP 5			
24	DL 1			
25	DL 2			
26	DL 3			
27	DL 4			
28	DL 5			
29	WP 1		Height of arch 1, 2, 3, 4 i 5 of the right foot (P), and left foot (L)	Distance from the ground to the highest point of arch 1, 2, 3, 4 and 5.
30	WP 2			
31	WP 3			
32	WP 4			
33	WP 5			
34	WL 1			
35	WL 2			
36	WL 3			
37	WL 4			
38	WL 5			
39	SP 1		Width of arch 1, 2, 3, 4 i 5 of the right foot (P), and left foot (L)	Bowstring of the arch length 1, 2, 3, 4 i 5.
40	SP 2			
41	SP 3			
42	SP 4			
43	SP 5			
44	SL 1			
45	SL 2			
46	SL 3			
47	SL 4			
48	SL 5			
49	Mc	kg	Body weight	Measurements were made on a medical scale with an accuracy of 0.5 cm and 100 grams
50	Wc	cm	Body height	

Source: own research

3. Obtained results

Body weight is significantly related to the following features like length, width and plantar surface of the feet, the size of the transverse arch (Gamma angle) and the angle of the fifth hallux varus of the left foot, the length of the five longitudinal arches of the right foot and the first and fourth left feet, the width of the five longitudinal arches of the right and left foot, the height of the first, third, fourth and fifth longitudinal arch of the right foot and the height of the first, second, third and fourth of the left foot. The height of the body is significantly related to the length and width of the feet, the plantar

surface, the angle of the fifth hallux valgus, and the length and width of the five longitudinal arches, the height of the five longitudinal arches of the feet, the size of the transverse arch (Gamma angle) and hallux valgus of the right foot.

The statistical analysis shows that among 7-13-year-old children, the frequency of significant correlations between body height and feet features is 83.33%, and body weight is 70.83%. The inference of the frequency of significant correlations only within gender shows that among boys the body height is 79.16%, and body weight is 45.83%, whereas among girls it is 81.25% and 62.5%, respectively. The profile of the analysis in terms of the environment showed that among individuals living in the city, the frequency of significant correlations between body height and feet features was 83.33%, and body weight was 60.41%, whereas among those living in the countryside it was 81.25% and 45.83%, respectively, Table 2, Fig. 1.

A more precise conception of the percentage of significant correlations within the environment showed that among boys from the city the body height was associated with feet features at the level of 75.0%, and body weight only at 41.66%, among those living in the countryside it was 70.83% and 6.25%, respectively. The frequency of significant correlations of body height among girls from urban areas is 81.25%, and body weight at 60.41%, whereas from rural areas it is at77.08% and at 41.66%, respectively. Table 3, Fig. 2.

Tab. 2. Percentage of significant correlations between height and weight of the body with the features of the feet depending on age, sex, and environment (n) K = 8953, M = 7509

Analysis profile	Body height and weight	Percenatage of correlation
Age from 4 to 6	Wc	83,33
	Mc	70,83
Sex	M Wc	79,16
	M Mc	45,83
	K Wc	81,25
	K Mc	62,5
Environment	M Wc	83,33
	M Mc	60,41
	W Wc	81,25
	W Mc	45,83

Source: own research

Legend of tab. 2, fig. 1: Wc - body height, Mc - body weight, versicle "Gender": M - male, F - female, versicle "Environment": M - city, W - village.

Tab. 3. Percentage of significant correlations between body height and weight with the feet features of male and female sex of both environments (n) K = 8953, M = 7509

Analysis profile	Body height and weight	Percenatage of correlation
M M	Wc	75,0
	Mc	41,66
M W	Wc	70,83
	Mc	6,25
K M	Wc	81,25
	Mc	60,41
K W	Wc	77,08
	Mc	41,66

Source: own research

Legend of tab. 3, fig. 2: MM – male sex, city, MW – male sex, village, KM – female sex, city, KW – female sex, village.

4. Discussion

The presented correlations are important from the point of view of the ongoing posturogenesis in the selected age range. They should draw the attention of parents and teachers to the undoubtedly large influence of height and weight on posture features not only considering feet.

5. Conclusions

1. There is more frequent association between the height of the body and feet features than with body weight among 7-13-year-old children.

2. Body height is more frequently associated with features of the feet than body weight among boys and girls. The proportions of the frequency of correlations with body height among girls are similar to the percentage of boys, but body weight is more frequent. Moreover, there is more frequent association of body weight and height with feet features among children living in a city than those living in the countryside.

3. The most common significant correlations between body weight and height and the features of the feet occur among boys living in the city. Whereby the percentage of body weight correlations in the rural environment is very low. The frequency of body weight and height correlations among girls living in the city exceeds the percentage of those of the rural environment.

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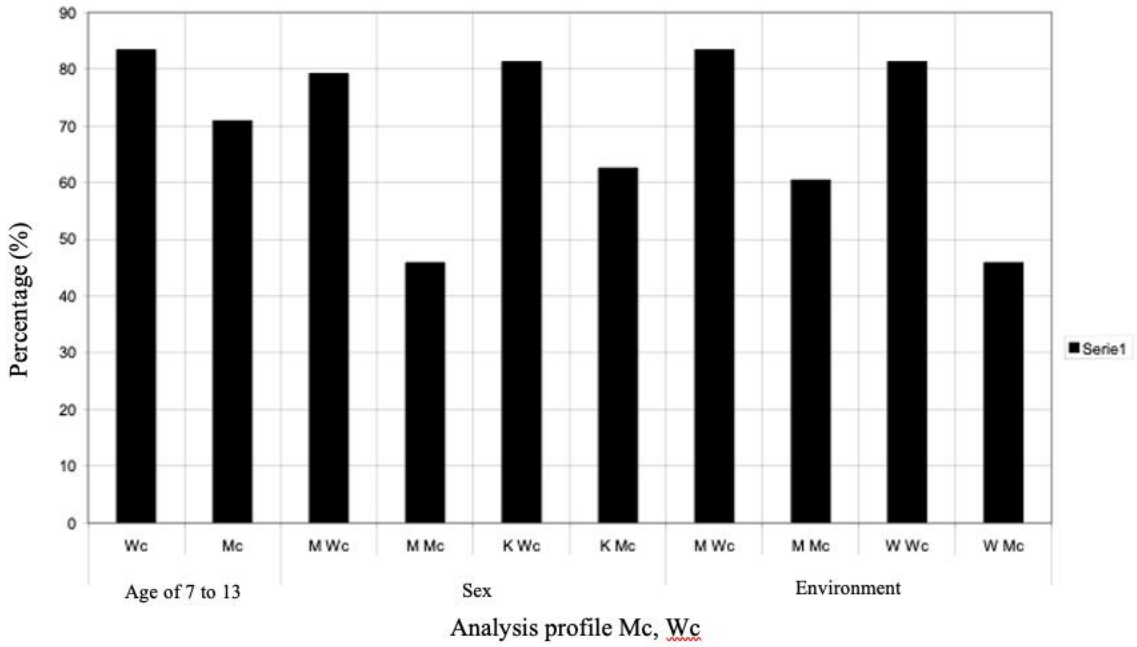

Fig.1 The percentage of significant correlations of the body weight and height w feet features depending on the range of age, sex, and environment (n) K=8953, M=7509

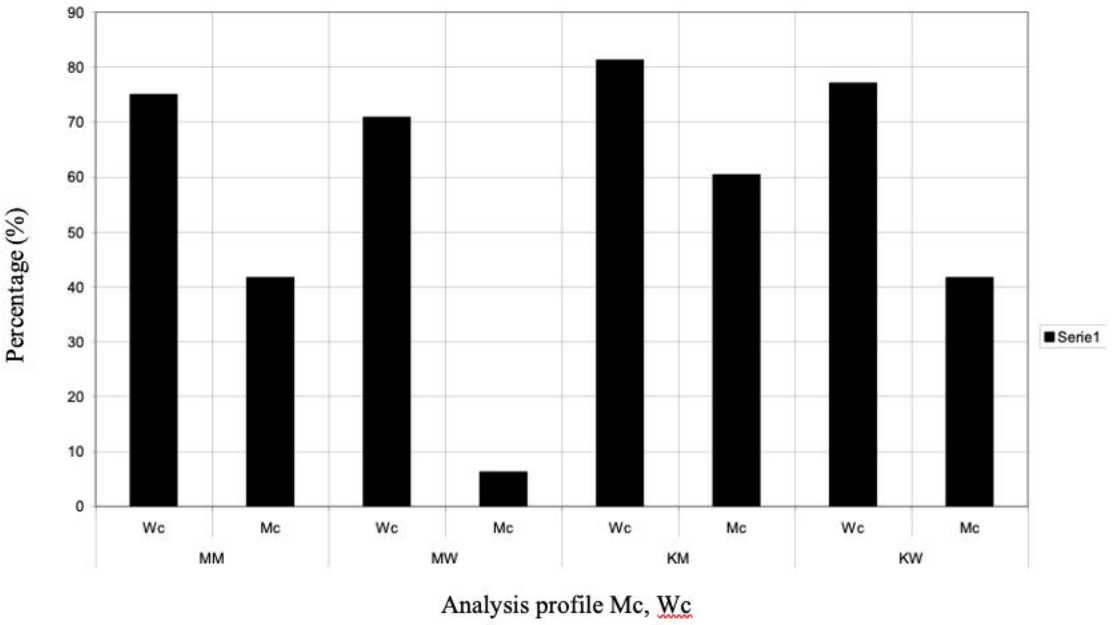

Fig.2 The percentage of the body weight and height of females and males depending on environment (n) K=8953, M-7509