

## THE CORRELATIONS AMONG THE COMPLEX OF SPINE-PELVIS TRAITS AND THE FEET TRAITS IN BOYS AGED 4 TO 6 YEARS

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**Annotation.** *Purpose:* Early diagnosis is one of meaningful elements of prevention and treatment of postural defects. The objective of the study was an attempt to determine the correlations among the spine – pelvis traits and the feet traits in the population of boys aged 4 to 6 years living in rural areas and cities. *Material and method:* The study group covered 1506 boys aged 4 to 6 years. The measurement of 104 traits of the spine-pelvis and feet complex was conducted by means of the projection Moiré method for computer-based examination of body posture. *Results:* there is not much publications on the influence and correlations between the complex of the pelvis-spine traits and the feet traits. There is a correlation between the forming foot type and formation of the spine. The proposed Steinmetz suggestion assuming that if the spine can be corrected with the foot then the foot can be corrected by means of the spine, raises a number of doubts. The author emphasizes the meaning of wearing corrective footwear since proper foot positioning provided by special shoes cannot be the cause of spinal deformities. *Conclusions:* The spine-pelvis trait in the population of boys most frequently revealing significant influence on the feet traits is the height and depth of thoracic kyphosis. The foot trait among the population of boys living in cities most frequently revealing significant influence on the spine-pelvis traits was the value of the right foot length. In the rural population significant influence on the spine-pelvis traits was revealed by: the length and height of the fifth longitudinal arch of the left foot.

**Keywords:** spine, pelvis, foot, boys, prevention, treatment.

### Introduction

The percentage of postural deformities and mistakes observed in Polish society is different and it varies depending on sex, age and region [12, 13, 11, 10]. Relevant Polish literature provides numerous papers on the assessment of postural conditions in children and youth across different age groups as well as the range of analyzed features [20, 2, 6, 1, 15, 7, 14, 3]. Particularly concerning seem to be all spatial asymmetries within the spine-pelvis traits as the human body functions most effectively only when the position of all body segments in relation to one another is correct in terms of biomechanics. If only one of these segments is asymmetric, the upper and lower parts try to compensate for it [18,17]. Current development needs can be identified, among other things, by: assessing the development proportionality concerning certain traits of the body structure and the aspects of physical fitness as well as a general orthopedic examination as prevention of postural defects. The purpose of such an activity is to identify “the weakest link” within body structures and functions, namely, to search for an element whose development should be stimulated in the near future by making it easier for the body to achieve the dynamic balance in accordance with body kinetics and dynamics – being equivalent to increasing the health potential. A foot may be such a primary link.

Identifying the occurrence of a parallel process of progression or regression of the values related to selected traits of spine-pelvis and feet, does not necessarily need to mean coexistence or interdependence. Coexistence in time when the research is conducted every few years, months or even weeks may be just coexistence, but it may also be interdependence. The period of time from providing a stimulus to displaying an effect will be here a determinant. If this effect was immediate it would be sufficient to measure the traits selected for the purpose of the study before providing a stimulus and after the lapse of such a short time, assuming that all other properties have not been modified. This requires a carefully planned experiment though, which seems to be impossible in anthropology, especially in the situation where the object of observation is a human being. For the purpose of the study it was assumed that the causes are homogeneous whereas the effect depends on the cause because all respondents came from the same region of Poland and there were six editions of the study each of which took half a year. Additionally, it was assumed that body height is modified by background and lifestyle. However, body height, as a result of an integrating role of human body, is connected with bone structure, body mass and the composition of body tissues, among other things. Modifications of each of these elements will exert influence on the structure of the skeletal system and therefore, on the biodynamic relations within the skeletal system elements. However, analyzing only the correlations among individual parts in the same subjects living in the same area and using only correlation methods, we will obtain only the scale of interdependence which does not determine whether it is coexistence or the cause and effect relationship. Only in-depth statistical analysis and biomechanical knowledge displayed by the researcher will allow one to recognize whether it is coexistence or interdependence.

The objective of the study was determination of the correlations among the spine – pelvis traits and the feet traits in the population of boys aged 4 to 6 years.

## **Methodology**

The study was conducted in randomly chosen kindergartens in rural areas and cities of the Region of Warmia and Mazury and the Region of Pomorze upon obtaining permission from the Bioethics Commission, the Education Office in Olsztyn, the director of the kindergarten, the teacher in charge of a given kindergarten unit, the parent and the child. The general criteria for a child to be qualified for the study were to identify during the study a required number of similar body postures in healthy children. The study group covered 1506 boys aged 4 to 6 years. Respondents living in cities constituted 48.27 % (727 boys) of the study group, while inhabitants of rural areas – 51.72 % (779 boys). Observation concerned 104 traits of the spine-pelvis and feet complex across particular age groups. For this purpose there was used the projection Moiré method for computer-based examination of body posture. Research methods and techniques were consistent with the assumed principles [9].

## **Statistical methods**

Measurement results concerning boys aged from 4 to 6 years gathered during six half year editions were subjected to statistical analysis. Due to extensive research material there were determined the values of order statistics (arithmetic mean, quartiles), distribution of traits (standard deviation) and symmetry indicators (asymmetry index, concentration index) providing an overview of the analyzed traits considering age groups and the sex. For selected 104 traits the analysis concerned the significance of changes within mean values over subsequent years within one sex, correlation and multiple regression to determine correlations among the feet traits and a complex of the spine-pelvis traits. The relationships between the spine and pelvis traits and the feet traits were determined based on linear regression analysis. The selection of significant spine and pelvis traits was conducted by means of the backward method using t-Student and F-Snedecor tests.

## **Research results**

### **Correlations among the complex of the spine-pelvis traits and the feet traits**

#### **Boys living in cities**

The spine-pelvis traits which most frequently revealed a significant relationship with the feet traits included (in descending order): the height and depth of thoracic kyphosis, less frequently: the value of maximum deflection of spinous process line, asymmetry value, scapula height, less frequently: the width of asymmetric trunk triangles (when the left one is wider), Figure 1.

The spine-pelvis traits most frequently revealed a significant correlation with feet traits (in descending order): the length of the right foot and the height of the second longitudinal arch of the right foot, less frequently the height of the fourth longitudinal arch of the left foot, less frequently the height of the third one of the right foot and the height of the fifth arch of the left foot.

As far as the analyzed traits in the sagittal plane are concerned, significant correlations with the feet traits were most frequently displayed by: the height of thoracic kyphosis which affected: the value of toe 5 varus deformity and the transverse arch of both feet, the length and width as well as the height of the fifth arch of the right foot and the fourth one of the left foot. Less frequently with the depth of thoracic kyphosis which affected the length of both feet, the value of toe 5 varus deformity, transverse arch and length of the second and the width of the third longitudinal arch of the left foot, the surface of plantokonturogram and the height of the fifth arch of the right foot.

As far as the analyzed traits in the frontal plane are concerned, significant correlations with the feet traits were most frequently displayed by: the value of scapula height asymmetry which significantly affected the length of the second, the height of the fifth and the width of the fourth longitudinal arch of the left foot, the length of the third, the height of the second and third arch of the right foot. Less frequently the value of maximum deflection of spinous process line which affected the width of the second longitudinal arch of the right foot and the first one of the left foot, the length and height of the fourth arch, the width and surface of plantokonturogram of the left foot. Less frequently the value of asymmetric trunk triangles (when the left one is wider) which affected the width of the first and fourth longitudinal arch of the right foot, the height of the fifth and the width of the fourth arch of the left foot.

As regards the analyzed traits in the transverse plane, significant correlations with the feet traits were most frequently displayed by: the value of scapula projection asymmetry (when the left scapula is more protruding) affecting the transverse arch, the height of the second longitudinal arch and the width of the right foot.

#### **Boys living in rural areas**

The spine-pelvis traits most frequently revealing significant correlations with the feet traits included (in descending order): the height of thoracic kyphosis, the left pelvic tilt angle, less frequently: the length of thoracic kyphosis, less frequently the angle of trunk flexion to the right, the value of scapula projection asymmetry, Figure 1.

The spine-pelvis traits most frequently revealed a significant correlation with the feet traits (in descending order): the width of the first longitudinal arch of the right foot, less frequently the value of the transverse arch of the left foot, less frequently the width of the third longitudinal arch of the left and right foot.

As far as the analyzed traits in the sagittal plane are concerned, significant correlations among the feet traits were most frequently displayed by: the height of thoracic kyphosis affecting the length and height of the fifth, the width of the first and third longitudinal arch of the right foot, the height of the fifth arch and the width of the third arch of the left foot. Less often the length of thoracic kyphosis affecting the transverse arch of the left foot, the length of the third arch of the right foot, the height of the first and fifth arch and the width of the third arch of the left foot.

As far as the analyzed traits in the frontal plane are concerned, significant correlations among the feet traits were most frequently displayed by: the pelvic tilt angle which significantly affected the length of the second, third and

fifth longitudinal arch of the left foot, the width of the third and fifth longitudinal arch of the right foot. Less frequently the angle of trunk flexion to the right significantly affected the width and transverse arch of both feet.

As regards the analyzed traits in the transverse plane, significant correlations among the feet traits were most frequently displayed by: the value of scapula projection asymmetry affecting the width of the first and fifth longitudinal arch of the right foot as well as the width of the second and third arch of the left foot.

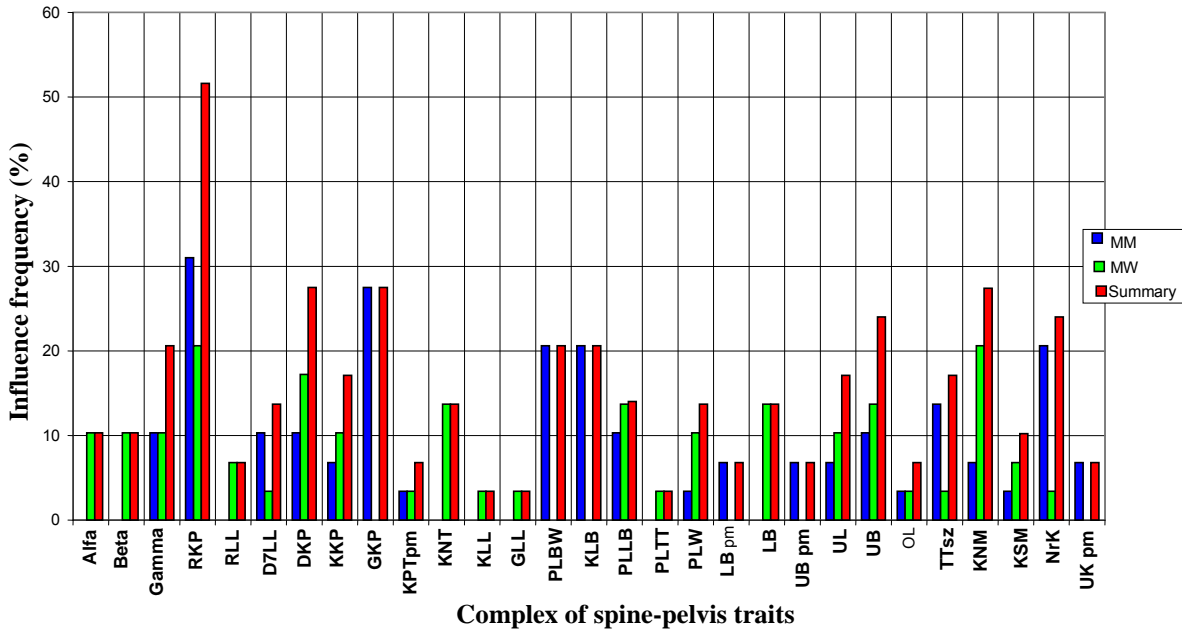


Fig. 1 Percentage of significant correlations among the complex of the spine-pelvis traits and the feet traits in the population of boys aged 4 to 6 years from rural areas and cities (n) MM=727, MW=779

**The correlations between the feet traits and the complex of the pelvis-spine traits**

Boys living in cities.

The feet traits most often revealing a significant correlation with the complex of the spine-pelvic traits were displayed by (in descending order): the length of the right foot, the value of toe 5 varus deformity on the right foot, less frequently the length of the fifth longitudinal arch of the left foot, the height of the first and second longitudinal arch of the right foot, the width of the fourth and fifth longitudinal arch of the left foot, Figure 2.

The feet traits most frequently displayed a correlation with (in descending order): the value of asymmetry in the width of trunk triangles when the right triangle was wider, the value of scapula height asymmetry when the right scapula was in a higher position, the height of the right scapula angle, the thoracic-lumbar spine angle and the depth of thoracic kyphosis.

As far as the analyzed traits of the left foot are concerned, significant correlations with the complex of the spine-pelvis traits were most frequently displayed by: the value of plantokonturogram surface which affected the thoracic-lumbar spine angle, lumbar lordosis length, the value of the right lower scapula angle, height asymmetry of the lower scapula angles (when the right one is in higher position), the value of maximum deflection of spinous process line and trunk flexion angle in sagittal plane.

Boys living in rural areas.

The feet traits most frequently revealing a significant correlation with the complex of the spine-pelvis traits included (in descending order): the length of the fifth longitudinal arch of the left foot, revealing a correlation with the thoracic-lumbar spine angle, the height of thoracic kyphosis, the height and depth of lumbar lordosis. The height of the fifth longitudinal arch of the left foot, revealing a correlation with: the height of the right scapula angle, the value of asymmetric trunk triangles height when the right one is in higher position, the value of maximum deflection of spinous process line to the left, Figure 2.

The feet traits most frequently displayed correlations with (in descending order): the height of the lower right scapula angle and the value of asymmetric trunk triangles height when the right one is in higher position, less often with the lumbosacral angle and lumbar lordosis depth.

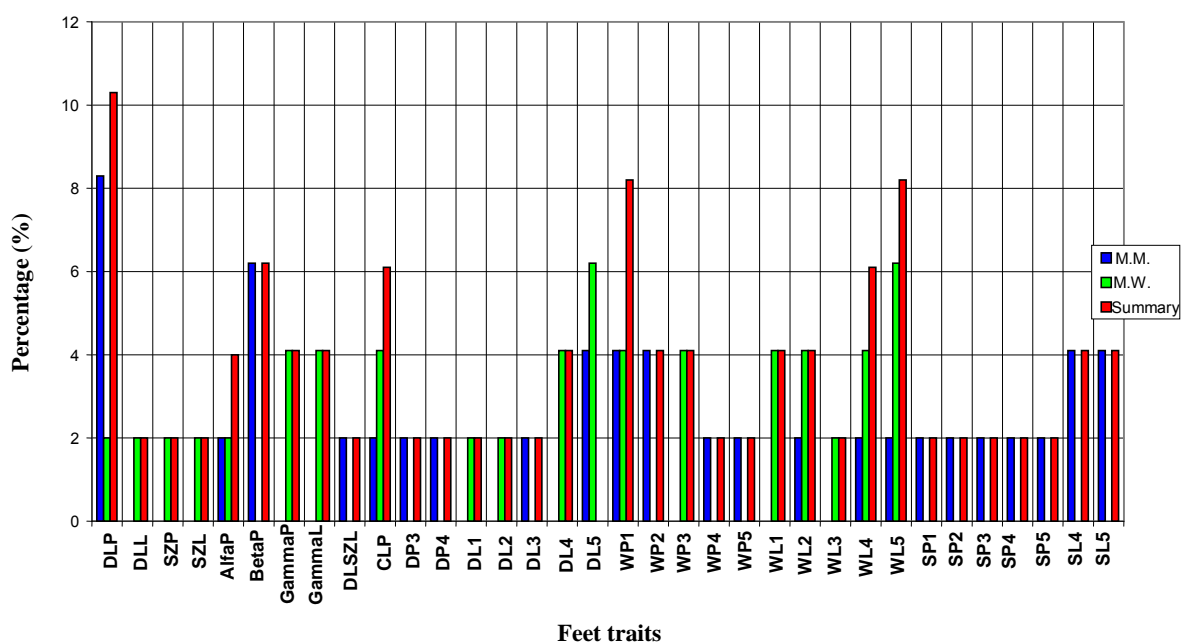


Fig. 2 Frequency of significant influence of feet traits on the complex of spine-pelvis traits in the population of boys aged 4 to 6 years from rural areas and cities (n) MM=727, MW=779

### Discourse

There are only few publications on the influence and correlations between the complex of the pelvis-spine traits and the feet traits. Steinmetz [19] assumes there is a correlation between the forming foot type and formation of the spine. However, the proposed suggestion assuming that if the spine can be corrected with the foot then the foot can be corrected by means of the spine, raises a number of doubts. In addition, the author emphasizes the meaning of wearing corrective footwear since proper foot positioning provided by special shoes cannot be the cause of spinal deformities. Pilot studies conducted by Drzał-Grabiec and Snela [4] in the population of girls and boys aged from 7 to 9 years revealed correlations between the longitudinal arch of the right and left foot measured with Clarke's angle and the length parameters describing the body posture.

### Conclusions

1. The spine-pelvis trait in the population of boys most frequently revealing significant influence on the feet traits is the height and depth of thoracic kyphosis. These traits most frequently displayed significant influence on the height of the second longitudinal arch and the length of the right foot. Among the rural population of boys significant influence on the feet traits was revealed by: the height of thoracic kyphosis and the pelvic tilt angle to the left. They most often displayed significant influence on: the width of the first longitudinal arch of the right foot and transverse arch of the left one.
2. The foot trait among the population of boys living in cities most frequently revealing significant influence on the spine-pelvis traits was the value of the right foot length. These traits most often displayed significant influence on the value of trunk triangles width asymmetry when the right triangle is wider. In the rural population significant influence on the spine-pelvis traits was revealed by: the length and height of the fifth longitudinal arch of the left foot. These most often displayed significant influence on the value of asymmetric trunk triangles height when the right one was in higher position.

### References:

- 1 Białko A. Postural defects and lateral spinal curvatures in children from Zachodniopomorskie Province, *Scientific Conference on Physical activity of people at different age*, Polish Scientific Society of Physical Culture, 2004, pp. 203-210.
- 2 Bitman F., Badke G. Postural disorders in children and youth. *Journal of Physical Education and School Hygiene*, 1988, vol.6, pp. 34-39.
- 3 Dąbrowska J., Rudzińska A., Witkoś J., Gędek M. *Changes in body posture in children during the period of two years of school education*, All-Polish Scientific Conference, 6-8.06.08, Bielsko Biała, 2008, pp. 89-96.
- 4 Drzał-Grabiec J., Snela P. Spinal curvatures and foot defects in children: an experimental study. *Spine*, 2012, vol.1, pp. 36-47.
- 5 Grabarczyk M., Jankowiak J. Body postures in children from selected background. *Ontogenesis and health promotion*, University of Zielona Góra Press, 2002, pp. 87-89.

- 6 Kasperczyk T., Szmigiel C. Body postures in children and youth based on ontogenetic determinants, *Spondyliatra*, 1990, vol.2(2/3), pp. 28 - 31.
- 7 Knapczyk M. Assessment findings concerning body posture in 6 and 13-year old children from kindergartens and schools located in Wilda district in Poznań, *International Scientific Conference on Physical development of children and youth, their motor activity in health and selected disease entities*, Poznań, 2004, pp. 15-20.
- 8 Miałkowska J. Postural development in children and youth aged 7-14 years. *Studies and Monographs* [Studia i Monografie], 2001, vol.59, pp. 187-201.
- 9 Mrozkowiak M. *Determinants of selected postural parameters and their variability based on the Moiré method*. University of Zielona Góra Press, 2010, pp. 59 - 70.
- 10 Mrozkowiak M. Sexual differentiation in prevalence of correct body postures, postural defects and scoliosis in children and youth aged 4-19 in selected regions of Poland. *Physical activity of people at different age*. 2007, vol.11(2), pp. 110-116.
- 11 Mrozkowiak M. Environmental differentiation in prevalence of correct body postures, postural defects and scoliosis in children and youth aged 4-19 in selected regions of Poland. *Physical activity of people at different age*. 2007, vol.11(2), pp. 105-109.
- 12 Mrozkowiak M. Age differentiation in prevalence of correct body postures, postural defects and scoliosis in children and youth aged 4-19 in selected provinces of Poland. *Annales Universitatis Mariae Curie-Skłodowska, Sectio D: Medicina*, 2007, vol.62(18/5), pp. 189-192.
- 13 Mrozkowiak M. Diverse prevalence of correct body postures, postural defects and scoliosis in children and youth aged 4-19 in selected regions of Poland. *Physical activity of people at different age*. 2007, vol.11(2), pp. 99-104.
- 14 Nowotny J., Czupryna K., Rudzińska A., Nowotny-Czupryna O. *Body postures in 13-year old children against their postures at the age of 7*. All-Polish Scientific Conference, Bielsko Biała. 2008, pp. 56-64.
- 15 Prętkiewicz-Abacjew E., Wróblewska A., Zajt-Kwiatkowska J., Rogo B., Zeyland-Malawka E. Observations and comments on the assessment of body posture based on the study using the Moiré method. *Pediatrics Poland* [Pediatria Polska], 2001, vol.76(9), pp. 643-650.
- 16 Przewęda R. Health status of Polish youth. *Physical education and sport*. 1997, vol.16(1-2), pp. 15-45.
- 17 Shumway-Cook, Horak M. *Balance rehabilitation in the neurologic patient: course syllabus*. Seattle: Neuroscience Education and Research Association. 1992, pp. 67-74.
- 18 Shumway-Cook, Woollacott M. *Motor control. Theory and practical applications*. 2001, 200 p.
- 19 Steinmetz M. Foot, spine, stroke and lachaussure [Le pied, le rachis, la course et lachaussure]. *Sports Medicine* [Medicine du Sport], 1984, vol.58(1), pp. 34-45.
- 20 Wolański N. Types of body postures and their definitions. *Physical culture*, 1957, vol.11(7), pp. 520 - 529.

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