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Assessment of disorders in pelvic symmetry in 8-year-old children

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Summary

Introduction and purpose of the work

The pelvis, constituting an element of the biokinematic chain that connects the torso with the lower limbs, is an important link in the compensation of the asymmetry appearing in these parts of the body. The asymmetrical position of the pelvis may have a static or functional basis, may affect postural disorder, contribute to the development of lateral curvature or result. The aim of the study was to assess the symmetry of the pelvic position and determine the relationship between spatial arrangement of the pelvis and the results of the Derbolowsky test.

Material and method

The research covered a group of 60 children aged 8 from primary schools of the Małopolska province. The study consisted of 3 parts: clinical assessment of the spine and posture, performance of the Derbolowsky test, examination of the trunk by topography of the body surface in a standing position.

Results

Comparison of the obtained results of the difference in the length of the lower limbs in relation to the pelvic angle turned out to be statistically significant for both boys, girls and the general population. The analysis showed that in the examined group the increase in the pelvic angle by 1 degree corresponds to the increase in the difference in the length of the lower limbs by 0,36 centimeter. Differences in the pelvic angle with the Derbolowsky test values were different for groups of boys and girls, as were differences in the length of the lower limbs with the Derbolowsky test values.

Conclusions

Derbolowsky test is one of the most effective tests that differentiate pelvic torsion and skewness. The scale of pelvic torsion in children is high.

Keywords: asymmetry, children, Derbolowsky test

Introduction

The correct position of the pelvis determines the undisturbed course of biological functions. It is the pelvis that determines the proper position of the spine, which is the axis of the entire body and provides protection for the spinal nerves and parietal ganglia of the autonomic nervous system [1]. The pelvis, constituting an element of the biokinematic chain that connects the torso with the lower limbs, is an important link in the compensation of the asymmetry appearing in these parts of the body. Spatial pelvic floor disorders can be both the primary cause of postural disorder and can be compensatory changes. They can also cause many dysfunctions in the distant structures of the musculoskeletal system [2]. In addition, one of the links conditioning the correct static and functional function of the entire human musculoskeletal system and allowing to maintain favorable kinematic conditions for the peripheral parts of the body is the lumbar-pelvic-iliac complex [3].

The asymmetrical position of the pelvis may have a static or functional basis, may affect the postural disorder, contribute to the development of lateral curvature of the spine or be its result [4, 5, 6]. Disturbances in the spatial position of the pelvis manifests clinically asymmetry of the the upper front and back hip spikes in the frontal, sagittal and transverse plane [7]. Every deviation in the position, structure and function of the pelvis is reflected in the position, structure and function of the spine, so a frequent consequence of unevenness of the lower limbs is the lateral curvature of the spine [8]. On the other hand, the eventual leveling of the lower limbs does not always bring the expected correction in three-dimensional deformation of the spine, so it must be carried out with caution, and the inequality of the lower limbs may be apparent and result from asymmetrical changes within the pelvis itself [9]. In scoliosis, compensatory, linear displacements of various segments of the body appear. An example of this is the pelvis setting in the lumbar scoliosis, where the character of the sacroiliac connection forces the pelvis to be slanted, which gives the apparent inequality of the lower limbs. As a result, the location of the upper anterior hip spikes is not at the same level as the less experienced people may interpret as the unevenness of the lower limbs, perceiving the reasons for the curvature, and in this case it will be the result [10].

The ability to perceive and interpret changes in the pelvic position is very important, because such changes can be both the cause and the effect of scoliosis, but also because of the role of the pelvis in the vertical posture and compensating for dysfunctions located below or above the pelvis. Hence, a change in the pelvic position may compensate for abnormalities both in the lower limbs and in the spine [11, 12].

Aim of the study

The aim of the study was to assess the disorders in pelvic symmetry and to determine the relationship between spatial arrangement of the pelvis and the results of the Derbolowsky test.

Material and method

The research covered a group of 60 children aged 8 from primary schools of the Małopolska province. The children took part in screening tests for the detection of scoliosis, which were performed in schools using the projection moire method. The examination was carried out in the office of a school nurse or other room appointed by the school's director and consisted of 3 parts:

- clinical evaluation of the spine and posture,
- execution of the Derbolowsky test,
- examination of the torso by topography of the body surface in a standing position

The students had a written consent of the parent or guardian to take part in the research, they did not show any co-existing diseases that would prevent the examination (injury, fracture of the limbs, etc.). The anthropometric characteristics of the research group are presented in tables I and II.

The clinical examination included: measurement of body weight and height, (Tanita weight, Martin anthropometer), evaluation of the spine processes of the spine, assessment of the location of selected anatomical torso points from the side of the subject's back, assessment of the chest arch. The relative length of the lower limbs was examined in a lying position using anthropometric tape. The Derbolowsky test was performed according to the adopted methodology, differences less than 1 centimeter were not taken into account as positive (positive test value was defined as 1, negative test as 0).

The methodology of body surface topography analysis used apparatus produced by the Polish company CQ Elektronik System. During the test it was necessary to darken the room and turn off the artificial lighting for the time of image recording. Before starting the study, selected anatomical points were marked on the child's skin, with a washable marker for the skin. The child was placed for examination in a standing position, upper back hip spikes were placed at an equal distance from the apparatus (the angle of pelvic torsion was 0 °). For this position, from a few to a dozen or so shots were recorded, from which then one was selected, fulfilling the condition of correct pelvic positioning and reflecting the patient's most frequent posture.

The results of the measurements were subjected to qualitative and quantitative analysis using MedCalk version 17.9,7, calculating appropriate descriptive quantities depending on the type of variable distribution. Evaluation of the relationship between variables was made by linear regression. The applied significance level was assumed to be $p < 0,05$. The Shapiro-Wilk test was used to check the normality of the variable distribution. In order to verify the variance, the F test was used. The dependence was measured with the determination coefficient R^2 and the Pearson coefficient.

Results

Table I. Anthropometric characteristics of the research group

	N	$\overline{X}$	SD	V
Body height	60	127,2	8,5	0,07
Body weight	60	26,6	5,3	0,20
Age	60	7,9	0,8	0,10

Table II. Anthropometric characteristics of the research group by gender

Gender	F				M			
	N	$\overline{X}$	*SD*	*V*	*N*	$\overline{X}$	*SD*	*V*
Body height	25	126,2	9,0	0,07	35	127,9	8,2	0,06
Body weight	25	25,7	5,8	0,23	35	27,2	4,9	0,18
Age	25	8,0	0,7	0,09	35	7,9	0,9	0,11

The results of mass, height and age measurements indicate similar shifts in the variables studied in the groups of boys and girls. On the basis of the size of standard deviations and coefficients of variation it can be concluded that the results are not very different and that they are scattered.

Dependence of the difference in the length of the lower limbs from the angle of inclination of the pelvis

Table III. Difference in the length of the lower limbs (Y) with respect to the pelvis angle (X)

Coefficient of determination	$R^2 = 0{,}5738$
Simple regression	$Y = 0{,}36 \cdot X - 0{,}05$

Table IV: Analysis of variance for linear regression

	Degrees of freedom	Sums of squares	Average square	Quotient F
Regression	1	22,56	22,56	78,08
The rest	58	16,76	0,2889	(p<0,0001)

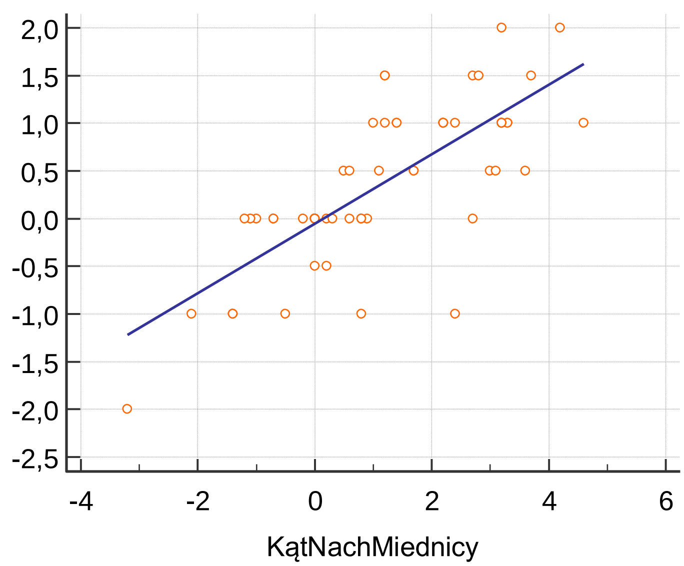

Fig. 1. Scattering of the observation of the difference in the length of the lower limbs in relation to the angle of inclination of the pelvis

The rope regression was evaluated between the difference in the length of the lower limbs and the angle of inclination of the pelvis. The result of the analysis is presented in Table III, IV and Fig. 1. A comparison of the obtained results of the difference in the length of the lower limbs in relation to the pelvic inclination angle was found to be statistically significant, the determination coefficient of R^2 was 0,5738, which means a strong linear relationship between the examined variables. Regression straight line for the difference in the length of the lower limbs Y = 0,63, for the pelvis angle x = 0,05. The analysis showed that in the examined group the increase in the pelvis angle by 1 degree corresponds to the increase in the difference in the length of the lower limbs by 0,36 centimeters. (Table III) The Shapiro-Wilk test confirmed the normality of the distribution (W =

0,96, p = 0,10), while the test of variance analysis confirmed a linear relationship (Table IV, Fig. 1).

Dependence of the difference in the length of the lower limbs from the angle of inclination of the pelvis, broken down by gender

Table V. Differences in regression lines broken down by gender

	Girls (*N*=25)	Boys (*N*=35)
Coefficient of determination	$R^2 = 0{,}4447$	$R^2 = 0{,}6840$
Simple regression	$Y = 0{,}27 \cdot X + 0{,}08$	$Y = 0{,}45 \cdot X - 0{,}14$
Test F	*F*=18,42 (*p*=0,0003)	*F*=71,43 (*p*<0,0001)
Comparison of directional coefficients	*t*=-2,20 (df=56) (*p*=0,0322)	

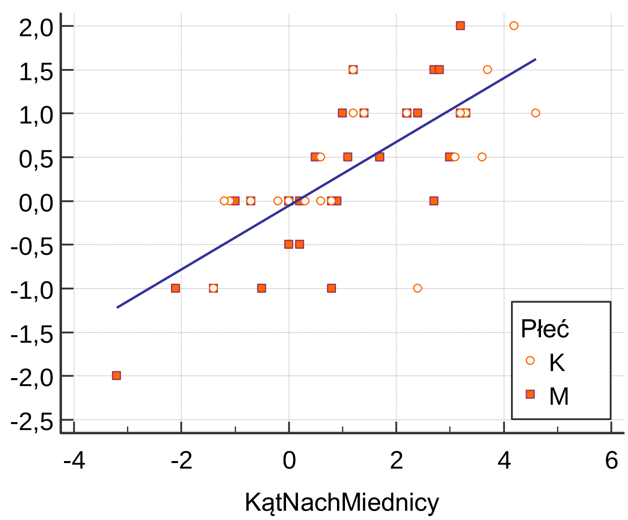

Figure 2. The distribution of the difference in the length of the lower limbs and the angle of inclination of the pelvis, broken down by gender.

A regression analysis was carried out for boys and girls, taking into account the same variables. The results turned out to be statistically significant for both boys, girls and the general population. The significance of the indicated differences, simple regressions for boys and girls has been analyzed. A statistically significant difference was found between boys and girls (p = 0,03). The group of boys is characterized by a stronger influence of the pelvic angle change on the difference in the length of the lower limbs (0,45 centimeter for each grade). Also, the dependence of the variables studied was clearly explained by the linear regression model (for girls, for boys) (Table 5).

The spread of observations around the simple regression with the distinction between sex did not show any particular tendencies in both sexes (Fig. 2).

Dependence of the difference in the length of the lower limbs from the angle of inclination of the pelvis with a distinction between the results of the Derbolowsky test

Table VI. Regression analysis with a distinction between the Derbolowsky test value

	Derbolowsky=0 (*N*=28)	Derbolowsky=1 (*N*=32)
Coefficient of determination	$R^2 = 0{,}4182$	$R^2 = 0{,}4831$
Simple regression	$Y = 0{,}25 \cdot X - 0{,}04$	$Y = 0{,}39 \cdot X - 0{,}11$

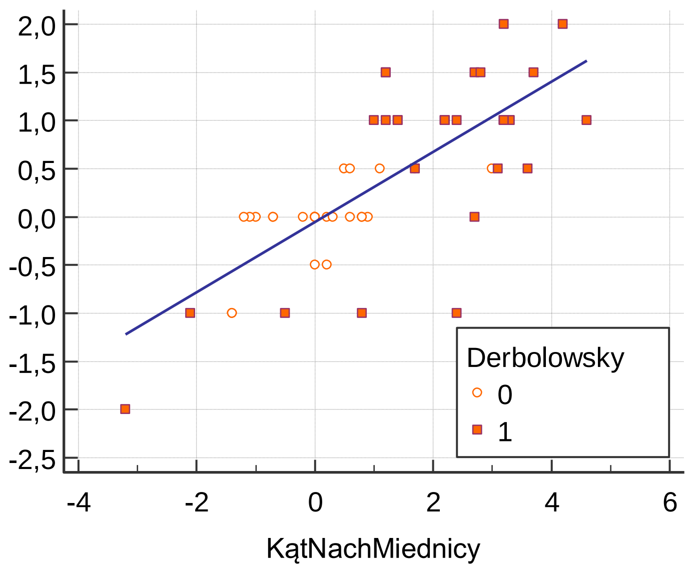

Figure 3. Spread of the observation of the difference in the length of the lower limbs and the angle of inclination of the pelvis with a distinction between the result of the Derbolowsky test

Regression analysis with a distinction between the Derbolowsky test values did not show significant differences between matched regression lines. The determination coefficient R^2 for people with a zero test result was 0,41 and with a positive result 0,48 (Table VI).

Observation around the straight line regression depending on the value of the Derbolowsky test result showed a clear division. The results of people with a value of 0 in the Derbolowsky test (N = 28) are characterized by a lack of dependence between the studied variables, whereas in patients with a positive Derbolowsky test (N = 32) a greater dispersion was observed (Fig. 3).

The relationship between the result of the Derbolowsky test and the absolute value of the pelvic angle

Table VII. Dependence of the pelvic angle and the result of the Derbolowsky test (total and within sex).

	Pearson's coefficient
All (N=60)	*r*=0,7225
Boys (*N*=35)	*r*=0,6651
Girls (*N*=25)	*r*=0,8079

The correlation has been examined for the whole population and the distinction between sex. In general, there is a strong linear relationship between the variables studied (r = 0,72). Differences in the pelvic angle with the Derbolowsky test values were different for both groups, r = 0,66 for boys, r = 0,80 for girls. There is a very strong relationship between girls with pelvic angle and test result Derbolowsky (Table VII).

Dependence of the Derbolowsky variable with the absolute value of the difference in the length of the lower limbs

Table VIII. Dependence of lower limb length and Derbolowsky score (total and within sex).

	Pearson's coefficient
All (N=60)	*r*=0,7675
Boys (*N*=35)	*r*=0,7387
Girls (*N*=25)	*r*=0,8090

There was a strong dependence of the studied variables on the general population r = 0.76. Differences in the length of the lower limbs with the Derbolowsky test values were different for both groups and were 0,73 for boys and 0,80 for girls, respectively (Table VIII).

Discussion

In the domestic literature, pelvic asymmetry is mainly related to the assessment of the quality of body posture during ontogenetic development [1,13,14]. The incidence of pelvic asymmetry is described at a level from a dozen to several dozen percent [13, 14]. In the study of 14-year-old students from Głogów, Bibrowicz, asymmetrical pelvis position, found up to 83% of children [15]. The same author in the group of 876 children of 7-9 year-olds observed pelvic asymmetry in 61% of children [13]. Similarly, the asymmetry of the pelvis in pre- and early-school children was often observed by Stander [14]. Such frequent occurrence of pelvic asymmetry may be related to the first critical period of body posture, which depends on the stage of ontogenesis, as well as lifestyle changes caused by the beginning of the schooling stage.

In the light of the above, it seems very important to assess the body posture of children in early school age, a skillful interpretation of changes in the asymmetric position of the pelvis, which will verify the diagnosis to a certain extent: shortening of the lower limb. A diagnosis made in such a hurry may have negative consequences. Not analyzing whether it is an anatomical or functional shortening and without providing the reason for this condition, and as a treatment recommending only the "shorter leg" heel, we condemn the young patient very often to mediocre effects of such therapy. Thus, the skillful interpretation of pelvis asymmetry and possible shortening of the lower limb is so important, i.e. whether we are dealing with a real shortening of the lower limb or with an apparent shortening of the lower limb or twisting of the pelvis. It is therefore necessary to assess the position of the individual pelvic bone points: upper front and back hip spikes and the side plate comb. Two situations seem to be possible: pelvic skewness - all these bone points are positioned lower on the same side, pelvic torsion - eg upper hind hip spike on the left side is set lower than on the right side, and upper front hip spike on the left is higher. The test for diagnosis of functional shortening of the lower limb can be the Derbolovsky test, which shows the position of the medial ankles in the sitting position. In the case of anatomical shortening of the limb, the medial ankle will continue to be positioned higher, while in the case of pelvic torsion it will be lower, i.e. it will "extend" seemingly. It is also important that in the case of pelvic torsion the position of the upper front and back hip spikes is changed, while the hip combs are usually set to the same height.

The use of the Debolowsky test for abnormalities in the sacroiliac joint was the subject of Bemis's research [16]. In the research group of 51 people with impaired function of the sacroiliac joint, he noticed different height of the upper hind spikes and a positive result of the overtaking test.

The authors of this publication confirmed the relationship between the asymmetry in the arrangement of the upper front and back hip spikes, and the positive result of the Derbolovsky test, which may support the pelvic torsion, not the skew that translates into a real shortening of the lower limb. In our own studies in the group of 8 year old children, a very strong correlation was found between the result of the Derbolowsky test and the absolute value of the pelvic angle (r = 0,72). The research also showed a discrepancy in the correlation (absolute value) of the pelvic angle with the Derbolowsky test values for boys and girls. For girls there is a very strong linear relationship between the variables studied (boys r = 0,66, girls r = 0,80). A strong correlation was also found between the result of the Derbolowsky test and the absolute value of the difference in the length of the lower limbs (r = 0,76).

Levit pointed to a more frequent lowering of the front upper hip spikes on the right side, which according to him is associated with the occurrence of functional pelvic sprain [17]. Savory thinks that there is a physiological basis for the appearance of functional pelvic sprain. In connection with the lateralization of the body we deal with a specific functional specialization of the lower limbs, in which one leg fulfills a more supportive role, the other one is a motorized one. Loading one limb can lead to an asymmetrical position of both hip bones relative to each other. Such a condition may lead to an alleged shortening of the lower limb [18]. Also, according to Gnat, pelvic asymmetries may not only be related to pathological changes, but also a form of adaptation of the motor system to the transmission of asymmetric mechanical loads [2]. In turn, Preece believes that the occurrence of observed changes in pelvic position may be affected by asymmetries related to individual differences in the pelvic anatomical structure [19].

In the light of the above observations and own observations, it can be assumed that asymmetries in the pelvic region occurring in the development period may result in the activation of spontaneous compensation mechanisms, which in turn may result in multifaceted disturbances of the spinal axis. Regardless of the hypothetical causes of disorders in pelvic asymmetry, the problem seems to be the scale of the phenomenon. There is no doubt, however, that the limb length alignment must be carried out with great care, as it does not always bring the expected correction, especially in relation to three-dimensional spinal distortions. Inequalities of the lower limbs may be apparent, and result from asymmetrical changes within the pelvis itself [9]. The relation of disorders in the spatial position of the pelvis in relation to lateral spinal curvatures was analyzed by Śliwiński and Miko, recommending the early detection of asymmetry and their correction, which depends on the real or apparent inequality of the lower limbs [5].

The authors of the study are of the opinion that one should not underestimate the signs of asymmetry in the posture of the body, also in relation to the structure and function of the pelvis.

Therefore, in assessing the silhouette of children in the early school period pay attention to even minor deviations in the pelvic symmetry, because they can lead to deformation and pathological effects.

Conclusions

- Derbolowsky's symptom is one of the effective tests that differentiate pelvic torsion and skewness
- The scale of pelvic torsion in children is high. Considering the health consequences that may be associated with this irregularity, in the assessment of the posture of the child's body in the early school-age should take into account a reliable assessment of possible disorders of pelvic symmetry (skewness, sprain).

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