SOMATIC DEVELOPMENT OF RURAL CHILDREN WITH SCOLIOSIS

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ABSTRACT

The formation of a proper body posture is highly affected by body build and proportions. Correct silhouette is usually observed in children with solid constitution. The objective of the study was to evaluate the somatic development of rural children with structural scoliosis as compared to their peers with correct body postures.

Investigations into the biological development of rural children and youth were carried out in the years 1998—1999, in primary and secondary schools of the Southern Podlasie region. The study involved 1045 girls and 1025 boys, aged 7—19 years, including 35 subjects with structural scoliosis. Body posture was evaluated based on orthopedic examination, including the Adams' test. The somatic development of children with structural scoliosis was characterized on the basis of the following measurements: body height and mass, arm and shank circumference, elbow and knee width, and Body Mass Index (BMI). The results of measurements were plotted on centile scales, elaborated for rural children of the Southern Podlasie.

The results of the study indicate that, in most cases, body sizes of girls and boys with structural scoliosis reached values either meeting or lower than those recommended for rural children. The occurrence of extremely low values of body mass, BMI, musculature and skeleton stoutness measurements as well as extremely high values of body height in the analyzed children with scoliosis seems highly alarming.

Keywords: body posture of rural girls and boys, structural scolioses, somatic traits.

INTRODUCTION

Scolioses pose an important health problem which affects children and youth world wide (Pin et al., 1985; Soucacos et al., 1997; Karachalios et al., 1999). They usually appear in youth in the puberty period, and less frequently in school children. Scoliosis tends to progress with child's development. In the initial phase, spinal curvature may be hardly discernible. However, deformations of spine and trunk proceeding in three planes become visible with time. The formation and development of scoliosis are determined by two basic factors — etiological and biomechanical ones. The first one — highly diversified — initiates the process of curving; the latter — common for all curvatures irrespective of their etiology — controls the development of scoliosis, acting in accordance with law of universal gravitation and laws of growth. Developed structural scoliosis is characterized by considerable changes in the region of spine and trunk. Ample literature data emphasize that scoliosis is not only a deformation of the spine but most of all a systemic disease impairing the physical development of a child (Tylman, 1972; Chlebicka et al., 2000; Żaba, Torbus, 2000; Król, Pucher, 2001; Dziewulski, Szymanik, 2003). Investigati-

ons have demonstrated that advanced changes in the motion apparatus that require treatment apply to ca. 1.0—4.0% of children and youth (Loncar-Dusek et al., 1991; Zarzycki et al. 1992; Głowacki et al., 2003).

This study was aimed at evaluating the level of somatic development of rural children with structural scoliosis as compared to their peers with proper body posture.

MATERIAL AND METHODS

Investigations into the biological development of rural children and youth were carried out in the years 1998—1999 under the State Committee for Scientific Research's project No. 4PO5D02314.

Table 1. **The number of the rural girls and boys examined**

Age in years	Girls	Boys
7	73	66
8	87	81
9	83	81
10	67	92
11	88	94
12	101	93
13	101	97
14	88	87
15	65	81
16	102	74
17	91	76
18	49	57
19	50	46
Total	1045	1025

Table 2. **Arithmetic means and standard deviations calculated for the somatic traits of rural girls and boys with correct body posture**

Age in years	Body height, cm	Body mass, kg	BMI, kg / m²	Width, mm		Circumference, cm	
				Elbow	Knee	Arm	Shank
	$(\bar{x} \pm SD)$	$(\bar{x} \pm SD)$	$(\bar{x} \pm SD)$	$(\bar{x} \pm SD)$	$(\bar{x} \pm SD)$	$(\bar{x} \pm SD)$	$(\bar{x} \pm SD)$
GIRLS							
7	123.50 ± 5.90	23.96 ± 4.73	15.63 ± 2.20	47.10 ± 4.42	72.00 ± 6.01	17.80 ± 1.91	25.06 ± 2.22
8	127.52 ± 5.38	25.82 ± 5.01	15.79 ± 2.17	48.90 ± 3.98	74.30 ± 5.48	18.14 ± 2.03	25.79 ± 2.24
9	132.44 ± 6.68	28.30 ± 6.32	16.00 ± 2.64	49.70 ± 3.97	76.50 ± 5.75	18.54 ± 2.65	26.59 ± 2.61
10	138.14 ± 5.76	32.47 ± 6.45	16.20 ± 2.62	53.30 ± 4.71	80.20 ± 6.14	19.65 ± 2.10	28.46 ± 3.00
11	143.75 ± 7.00	35.91 ± 8.08	17.22 ± 2.75	54.40 ± 4.43	81.80 ± 5.17	20.09 ± 2.45	29.11 ± 3.08
12	150.23 ± 6.65	39.42 ± 8.31	17.37 ± 2.87	56.40 ± 6.35	83.80 ± 5.43	20.49 ± 2.49	29.97 ± 3.34
13	155.61 ± 6.64	46.84 ± 9.52	19.20 ± 3.01	57.50 ± 5.64	86.40 ± 6.46	22.02 ± 2.43	31.95 ± 3.29
14	159.41 ± 6.67	50.86 ± 9.68	19.91 ± 3.01	58.10 ± 3.81	87.50 ± 5.72	22.93 ± 2.38	33.00 ± 3.07
15	161.15 ± 4.77	55.66 ± 11.50	21.41 ± 4.16	55.70 ± 6.69	89.20 ± 7.91	23.48 ± 2.88	35.11 ± 4.62
16	161.55 ± 5.32	56.52 ± 8.04	21.69 ± 3.12	53.50 ± 6.98	89.30 ± 7.68	23.41 ± 2.12	34.40 ± 2.57
17	162.90 ± 6.14	57.46 ± 8.18	21.64 ± 2.76	57.10 ± 5.34	87.70 ± 7.77	23.62 ± 2.19	34.52 ± 2.56
18	163.14 ± 5.34	57.95 ± 7.87	21.77 ± 2.75	58.20 ± 5.02	86.80 ± 6.85	23.63 ± 2.02	35.09 ± 2.42
19	163.41 ± 5.17	58.88 ± 7.69	22.03 ± 2.59	57.80 ± 5.56	85.50 ± 7.52	24.07 ± 2.39	35.07 ± 2.81
BOYS							
7	123.74 ± 5.36	24.63 ± 4.48	15.99 ± 2.02	49.20 ± 4.12	75.30 ± 5.01	17.64 ± 2.31	25.14 ± 2.26
8	128.93 ± 5.60	26.49 ± 3.89	15.87 ± 1.55	50.40 ± 3.81	78.00 ± 5.32	18.14 ± 1.61	25.59 ± 2.08
9	133.14 ± 5.47	28.62 ± 4.27	16.08 ± 1.65	50.90 ± 5.80	79.61 ± 5.81	18.63 ± 1.76	26.30 ± 1.97
10	139.44 ± 6.44	32.96 ± 6.85	16.84 ± 2.59	53.20 ± 5.63	83.30 ± 7.03	19.88 ± 2.36	27.92 ± 2.84
11	143.19 ± 6.19	36.03 ± 8.39	17.40 ± 2.81	54.20 ± 5.37	85.31 ± 6.74	20.62 ± 2.59	28.91 ± 2.96
12	149.58 ± 7.35	40.30 ± 9.30	17.84 ± 2.92	57.30 ± 5.22	87.92 ± 8.32	21.63 ± 2.97	30.10 ± 3.09
13	156.24 ± 8.81	44.39 ± 10.07	18.03 ± 2.82	60.20 ± 6.58	90.51 ± 6.67	22.10 ± 2.71	31.28 ± 3.01
14	161.70 ± 7.96	48.96 ± 8.76	18.61 ± 2.24	59.50 ± 7.27	91.32 ± 6.15	22.56 ± 2.19	32.24 ± 2.75
15	170.39 ± 7.57	57.06 ± 9.72	19.56 ± 2.50	64.90 ± 8.13	92.11 ± 6.22	24.14 ± 3.30	33.33 ± 3.17
16	174.70 ± 6.86	63.09 ± 9.61	20.60 ± 2.36	71.20 ± 4.19	91.58 ± 5.52	25.56 ± 2.28	35.68 ± 5.01
17	176.67 ± 6.98	66.35 ± 10.17	21.19 ± 2.39	71.80 ± 4.25	90.80 ± 5.37	26.70 ± 2.47	35.25 ± 4.11
18	176.15 ± 7.00	65.57 ± 7.32	21.14 ± 2.18	71.70 ± 4.56	90.40 ± 7.91	26.54 ± 2.30	35.22 ± 2.11
19	177.47 ± 6.99	70.73 ± 8.53	22.41 ± 1.96	73.50 ± 3.99	90.29 ± 7.18	28.84 ± 2.91	36.26 ± 2.28

The study involved 1045 girls and 1025 boys, aged 7—19 years, attending selected primary and secondary schools of the Southern Podlasie region (tab. 1).

Body posture was evaluated with the use of an orthopedic examination that involves a body symmetry test (Kutzner-Kozińska, 1997). The system of horizontal and vertical body lines combining anthropometric points on the trunk and lower limbs was analyzed. Attention was paid to the shape of the trunk-arm triangle and the course of spinous process. The Adams' test was applied to evaluate spine position in the frontal plane and forward bending of the trunk (Głowacki et al., 2003).

Both in the children with a correct body posture as well as in those with structural scolioses, measurements of basic somatic traits, including: body height and mass, arm and shank circumference as well as elbow and knee width, were carried out with the Martin's technique (Martin, Saller, 1957). The results of body height and mass measurements were used to calculate the Body Mass Index (BMI). The calendar age of subjects was determined following guidelines of the International Biological Programme (1967), which enabled classifying the examined children to respective age categories. Next, in the children without changes in the motor system arithmetic means and standard deviations were calculated for the analyzed somatic traits in particular age categories (tab. 2). The occurrence of single cases of structural scolioses hindered the preparation of similar statistical characteristics of the somatic traits analyzed. Therefore, in the evaluation of the level of physical development of children with changes in the motor system (as compared to the children with a correct body posture) use was made of centile charts elaborated for a population of rural girls and boys from the areas of Southern Podlasie region (Skład et al., 2004).

RESULTS

Single cases of structural scoliosis occurred in children aged 8—19 years. They were reported in 35 subjects (1.7% of all subjects), including 29 girls (2.8%) and 6 boys (0.6%). The highest incidence of lateral spinal curvatures was noted in older children aged 16—19 years; they included mainly single-curve, fragmentary, right-hand scoliosis located in the thoracolumbar and thoracic segment of the spine. Double-curve scoliosis occurred less frequently, whereas three-curve scoliosis was reported only in 2 girls aged 14 and 18 years. In all cases, multi-plane changes were observed in the position of the spine, chest and pelvis that were accompanied by the asymmetry of trunk-arm triangles. Spine curvatures were resistant to any trials of active or passive correction. In all cases, either costal prominence or lumbar torus were visible in the bend forward test.

The results of the somatic traits analyzed, i. e. body height and mass, arm and shank circumference, elbow and knee width and BMI of girls and boys with structural scoliosis were presented in table 3.

The measurements indicate that in most cases (19 — 54.3%) girls and boys with scoliosis reached body height values meeting recommendations for rural children from the Southern Podlasie. Body height over the 75th centile was reported for six subjects (17.1%), and that below the 25th centile — for 10 children (28.6%), including three girls characterized by extremely low values (below 3 centile) of that somatic trait. Most of the children with scoliosis were characterized by body mass below the recommended value (16 girls and 2 boys, i. e. 51.4% of the children with structural scoliosis). This group included three girls whose body mass was lower than the value corresponding to the 3rd centile. High values of the somatic trait under scrutiny occurred in as little as two cases (5.8%): in girls aged 16 and 19 years. Such observations were not made for boys. Proper weight-height ratios (WHR), determined on the basis of the Body Mass Index, were noted in 15 girls and 2 boys with scoliosis, i. e. in 48.5% of cases. Low BMI values were observed in 13 girls and 4 boys. Solid constitution, at BMI over 75 centile, was reported only for one girl aged 16 years (tab. 4).

In most examined girls and boys with structural scoliosis (18 cases — 51.5%), the results of arm circumference measurements were within the recommended values, i.e. between the 25th and 75th centile. A considerable group was constituted by children characterized with lower values of arm circumferences — nine girls and two boys (a total of 31.4%) were between the 25th and 10th centile, whereas four girls — below 10th centile. Only two girls with scoliosis, aged 16 and 19 years, demonstrated a high degree of arm musculature, with values of that trait ranging from the 90th and 97th centile on a centile scale of children from the Bialskopodlaski region. Likewise the above-mentioned trait, shank circumference values met recommendations in most of the subjects with scoliosis (19 cases — 54.3%). Lower values of musculature measurements were reported for ten girls and two boys (34.2%). In that group, two girls aged 11 and 15 years, reached values below the 3rd centile. It should be also emphasized that four females were characterized by shank circumference values over the 75th centile, including one (16 years of age) exceeding the 90th centile (tab. 4).

The level of skeleton stoutness was determined based on the width of an elbow and a knee. Measurements of elbow width of four girls and two boys (17.2%) exceeded the 50th centile. The

Table 3. **Somatic parameters of rural girls and boys with structural scoliosis**

Age in years	Body height, cm	Body mass, kg	BMI	Width, mm		Circumference, cm	
				Elbow	Knee	Arm	Shank
Girls							
8	123.50	22.00	14.42	45.0	70.0	17.30	24.50
10	136.20	31.70	17.00	57.0	83.0	19.20	29.30
11	136.40	27.60	14.83	53.0	72.0	17.00	27.20
	132.00	24.80	14.23	46.0	79.0	18.50	22.30
	143.70	34.50	16.71	53.0	80.0	19.20	28.30
12	147.00	36.10	16.71	53.0	82.0	18.50	29.50
13	159.40	38.30	15.07	54.0	81.0	19.00	30.00
	152.20	46.10	19.90	57.0	85.0	21.20	34.30
14	161.70	41.70	15.95	57.0	83.0	20.30	29.30
	159.00	44.60	17.64	50.0	83.0	20.00	30.20
	146.50	39.00	18.17	58.0	77.0	22.00	28.00
	159.50	48.50	19.06	56.0	80.0	23.20	33.40
15	157.00	45.20	18.34	45.0	82.0	21.00	31.60
	157.20	42.70	17.28	58.0	86.0	20.20	29.40
16	164.00	56.70	21.08	49.0	89.0	22.30	35.20
	171.70	76.20	25.85	64.0	98.0	27.30	39.80
17	162.10	53.80	20.47	53.0	91.0	23.80	34.00
	162.20	49.70	18.89	58.0	77.0	23.80	31.60
	157.30	43.70	17.66	51.0	87.0	20.20	30.40
	171.50	58.60	19.92	53.0	89.0	22.60	35.00
	158.10	53.80	21.52	57.0	93.0	22.50	33.60
	164.90	48.90	17.98	60.0	83.0	21.20	33.20
18	170.30	49.90	17.21	56.0	86.0	20.20	31.50
	159.00	55.90	22.11	58.0	84.0	22.20	37.40
	169.60	50.30	17.49	53.0	87.0	22.00	32.50
19	161.20	56.10	21.59	54.0	84.0	24.20	35.80
	170.50	68.80	23.67	54.0	99.0	27.90	37.50
	152.20	50.20	21.67	58.0	78.0	23.30	33.00
	159.40	57.10	22.47	71.0	93.0	24.20	34.40
Boys							
8	138.00	26.10	13.71	48.0	77.0	17.00	26.30
16	175.70	58.30	18.89	70.0	89.0	24.60	33.70
	177.40	62.70	19.92	72.0	91.0	25.60	34.30
17	179.40	62.50	19.42	76.0	90.0	24.00	33.00
	169.70	57.2	19.86	72.0	91.0	24.30	32.30
18	173.40	60.20	20.02	70.0	80.0	25.00	33.90

other subjects with scoliosis recorded lower values of that trait, including 11 children meeting the recommended values (over the 25th centile), whereas 4 girls (11.4%) were characterized by extremely low stoutness of the skeleton, obtaining elbow width values below the 3rd centile. While analyzing the results of knee width measurements, the distribution of values of that trait on centile charts appeared to be similar to that of the aforementioned traits. 45.7% of the analyzed girls and boys (16 subjects) were within the recommended values. Smaller knee widths, between the 3rd and 25th centile, were reported for 11 subjects, i. e. 31.4% of all children, whereas those below the 3rd centile — for three girls and one boy (11.4%

of all cases). High values of the trait measured, over the 90th centile, were observed in two girls (5.8%) (tab. 4).

SUMMARY AND DISCUSSION

Analyses carried out within the study point to similar tendencies and incidence of structural scoliosis in rural children and youth from the Southern Podlasie compared to observations made in other regions (Tylman, 1972; Soucacos et al., 1997; Król, Pucher, 2001; Dziewulski, Szymanik, 2003). A characteristic feature is the higher incidence of scoliosis in girls than in boys as well as the fact that irreversible changes in the motion

Table 4. **Level percentile grids of somatic parameters of girls and boys with structural scoliosis**

Somatic parameters		Percentile							
		< 3	3—10	10—25	25—50	50—75	75—90	90—97	> 97
Body height	Girls	3 (10.3%)	1 (3.4%)	5 (17.3%)	9 (31.1%)	6 (20.7%)	2 (6.9%)	3 (10.3%)	—
	Boys	—	—	1 (16.7%)	1 (16.7%)	3 (50.0%)	—	1 (16.7%)	—
	∑	3 (8.6%)	1 (2.9%)	6 (17.1%)	10 (28.6%)	9 (25.7%)	2 (5.7%)	4 (11.4%)	—
Body mass	Girls	3 (10.3%)	7 (24.1%)	6 (20.7%)	6 (20.7%)	5 (17.3%)	1 (3.4%)	1 (3.4%)	—
	Boys	—	—	2 (33.3%)	2 (33.3%)	2 (33.3%)	—	—	—
	∑	3 (8.6%)	7 (20.0%)	8 (22.8%)	8 (22.8%)	7 (20.0%)	1 (2.9%)	1 (2.9%)	—
BMI	Girls	5 (17.3%)	4 (13.8%)	4 (13.8%)	4 (13.8%)	11 (37.9%)	—	1 (3.4%)	—
	Boys	-	1 (16.7%)	3 (50.0%)	2 (33.3%)	—	—	—	—
	∑	5 (14.3%)	5 (14.3%)	7 (20.0%)	6 (17.1%)	11 (31.4%)	—	1 (2.9%)	—
Width elbow	Girls	2 (6.9%)	2 (6.9%)	9 (31.1%)	12 (41.4%)	2 (6.9%)	—	2 (6.9%)	—
	Boys	—	—	2 (33.3%)	4 (66.7%)	—	—	—	—
	∑	2 (5.7%)	2 (5.7%)	11 (31.4%)	16 (45.8%)	2 (5.7%)	—	2 (5.7%)	—
Width knee	Girls	2 (6.9%)	5 (17.3%)	3 (10.3%)	10 (34.5%)	5 (17.3%)	3 (10.3%)	1 (3.4%)	—
	Boys	—	1 (16.7%)	1 (16.7%)	3 (50.0%)	1 (16.7%)	—	—	—
	∑	2 (5.7%)	6 (17.1%)	4 (11.4%)	13 (37.2%)	6 (17.1%)	3 (8.6%)	1 (2.9%)	—
Circumference arm	Girls	4 (13.8%)	4 (13.8%)	9 (31.1%)	8 (27,6%)	2 (6.9%)	1 (3.4%)	—	1 (3.4%)
	Boys	—	—	1 (16.7%)	3 (50.0%)	1 (16.7%)	1 (16.7%)	—	—
	∑	4 (11.4%)	4 (11.4%)	10 (28.6%)	11 (31.4%)	3 (8.6%)	2 (5.7%)	—	1 (2.9%)
Circumference shank	Girls	3 (10.3%)	2 (6.9%)	5 (17.3%)	11 (37.9%)	4 (13.8%)	2 (6.9%)	1 (3.4%)	1 (3.4%)
	Boys	1 (16,7%)	—	4 (66,6%)	1 (16,7%)	—	—	—	—
	∑	4 (11.4%)	2 (5.7%)	9 (25.7%)	12 (34.3%)	4 (11.4%)	2 (5.7%)	1 (2.9%)	1 (2.9%)

Note. Number of persons: girls = 29, boys = 6.

system occur in single cases of younger children and their number increases with age, especially between 16 and 19 years of life.

The study indicates the occurrence of differences in the body build of children with structural scoliosis compared to their peers with a correct body posture. Values of the analyzed somatic traits of girls and boys with lateral spinal curvature usually met or fell below the recommended values. Those children were also characterized by a tendency towards higher body slenderness, which was linked with more frequently obtained lower values of body mass. In the group examined, there occurred even cases of extremely low values of the somatic traits described (below the 3rd centile). In contrast, there were only few cases with high values of the measurements analyzed.

Our observations are convergent with findings of other authors. Literature data indicates that children with scoliosis are usually lighter, slightly higher, and demonstrate more slender constitution than their peers with a correct body build (Loncar-Dusek et al., 1991; Hagglund et al., 1992; Chlebicka et al., 2000; Kołodziej et al., 2003; Burdukiewicz et al., 2004). Although M. Chrzanowska (1976) as well as R. Żaba and O. Torbus (2000) did not observe any significant differences in body height between children with lateral spinal curvature and those without lesions in the motion apparatus, still they emphasized a discernible tendency for an increasing incidence of scoliosis in higher individuals.

Little attention has ever been paid to the evaluation of musculature and stoutness of the skeleton in children with faulty postures, although some authors claim that substantially lower mesomorphy identified in girls with scoliosis compared to their peers with a correct body posture is likely to be a prognostic value for the early detection of idiopathic scoliosis with a higher risk of progression (Le Blanc et al., 1997).

R. Przewęda (1963) noticed that individuals characterized by a solid body build — with the prevalence of mesomorphy — usually demonstrate correct postures. As claimed by that author, individuals with a predominating ectomorphy factor are predisposed to faulty postures since the prevalence of longitudinal sizes and body leptosomization enhance the lability of a silhouette and development of improper habits in its bearing.

Correlations between musculature and stoutness of the skeleton and the quality of body posture were also investigated by E. Chlebicka et al. (2000), M. Chrzanowska (1976) as well as R. Żaba and O. Torbus (2000). Those authors claimed that children with lateral spinal curvature were characterized by a lower degree of skeleton musculature and stoutness compared to their peers with correct body postures.

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SKOLIOZE SERGANČIŲ KAIMO VAIKŲ SOMATINIO VYSTYMOSI YPATUMAI

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SANTRAUKA

Taisyklinga vaiko laikysena priklauso nuo kūno konstitucijos ypatumų, ypač kūno dalių proporcijos. Šio tyrimo tikslas buvo įvertinti kaimo vaikų, kuriems diagnozuota skoliozė, laikysenos ir somatinio vystymosi ypatumus. Duomenys gauti 1998 ir 1999 m. tiriant Lenkijos Jugo Podlaska regiono pradinių ir vidurinių mokyklų vaikus. Tirti 1045 mergaitės ir 1025 berniukai, kurių amžius — 7—19 metų. Iš jų 35 moksleiviams diagnozuota struktūrinė skoliozė. Kūno laikysena buvo vertinama ortopedinės apžiūros metodu ir panaudojant Adamso testą. Vaikų somatinio išsivystymo lygis įvertintas išanalizavus ūgio, kūno masės, žasto ir blauzdos apimties, alkūnės ir kelio sąnario pločio rodiklius, taip pat jų santykį su bendrosios kūno masės ir kūno masės indekso (KMI) reikšmėmis. Tyrimo rezultatai parodė, kad tiek berniukų, tiek mergaičių, kuriems buvo diagnozuota struktūrinė skoliozė, daugelis somatinio išsivystymo rodiklių nesiskyrė nuo jų bendraamžių, o bendrosios kūno masės ir KMI rodikliai mažesni dėl blogesnio raumenyno išsivystymo.

Raktažodžiai: kaimo vaikų laikysena, struktūrinė skoliozė, somatiniai požymiai.

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