

Changes in the anterior-posterior spinal curvatures in children aged 6 – 7 years

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Summary

Study aim: To assess the anterior-posterior profiles of spine curvatures in children aged 6 years and the changes in spinal profile variables one year later.

Material and methods: A group of 136 boys and 121 girls, aged 6 years (last year of kindergarten education), were studied and the study was repeated one year later when the children entered school. Standard curvature angles: α (upper thoracic spine), β (thoraco-lumbar spine), γ (lumbosacral spine) and ϵ (head anteversion in relation to the top of thoracic kyphosis); and the magnitudes of thoracic kyphosis (χ), lumbar lordosis (λ) and compensation index (μ) were determined by using a Posturometr-S device.

Results: When the children were aged 7 years, mean values of α , β and γ angles significantly increased compared with the results recorded one year earlier, especially in boys, greatest change being noted for the β angle (about 2.5° in both genders). Moreover, a high increase in the incidence of kyphotic posture (especially the kyphotic I) was noted.

Conclusions: Kyphotic posture prevailed at the early school age but the incidence of abnormal postures, as well as the mean magnitudes of principal spinal angles, markedly increased within one year. This calls for careful monitoring postural changes at that age in order to prevent stabilised postural disorders at later age.

Key words Spine curvatures – Body posture – Children

Introduction

The vertebral column and its physiologic profile is the principal determinant of standing posture. Inasmuch the right body posture depends on body equilibrium and stability, on the right position when undertaking motor tasks and on a high static/dynamic capacity [9], but the quality of body posture is determined, to a high degree, on the magnitudes of anterior-posterior spine curvatures and their balance. Flattened or excessive curvatures reflect postural disorders which may affect health [7] and physical fitness.

The age period 6 – 7 years is considered critical in postural development and, thus, requires monitoring in order to detect possible changes and to prevent their unfavourable effects [3]. The aim of this study was thus to assess the anterior-posterior profiles of spine curvatures in children aged 6 years and the changes in spinal profile variables one year later.

Material and Methods

A group of 136 boys and 121 girls, aged 6 years (last year of kindergarten education), were studied and the study was repeated one year later when the children entered school. The anterior-posterior profile of spine curvatures was recorded by using Posturometr-S device (Posmed, Poland) [13] together with standard curvature angles: α (upper thoracic spine), β (thoraco-lumbar spine), γ (lumbosacral spine) and ϵ (head anteversion in relation to the top of thoracic kyphosis); moreover, the magnitudes of thoracic kyphosis (χ), lumbar lordosis (λ) and compensation index (μ) were determined.

The individual measurement error was determined by recording all angles 10 times in 4 children. Since the within-subject variances for all angles did not differ significantly from each other, a mean standard deviation was computed which amounted to 0.60 deg. Thus, whenever a difference between the two measurements spaced

by one year exceeded $\pm 1^\circ$, the change was considered significant. Mean annual changes in angle magnitudes were assessed by applying Student's *t*-test for dependent data, and the frequencies were analysed by applying the so-called G-function (chi-square function in the logarithmic form) [11], the level of $p \leq 0.05$ being considered significant.

Results

The results of spinal angle measurements (means \pm SD) are presented in Tables 1 and 2. The scatter of individual results of all principal angles was quite pronounced.

Table 1. Mean values (\pm SD) of principal angles (deg) representing the anterior-posterior spinal curvatures in children aged 6 (I) and 7 (II) years

Angle		α	β	γ	ε
Gender					
Male n = 136	I	15.9 \pm 5.49	6.9 \pm 3.2	8.6 \pm 4.66	6.3 \pm 3.38
	II	17.4 \pm 3.51**	9.4 \pm 3.2***	10.2 \pm 4.82***	6.8 \pm 2.84
Female n = 121	I	16.6 \pm 3.37	7.7 \pm 2.49	11.3 \pm 5.13	6.9 \pm 3.31
	II	16.7 \pm 3.26	10.1 \pm 3.1***	12.3 \pm 4.49*	6.6 \pm 2.31

Legend: α – Upper thoracic spine; β - Thoraco-lumbar spine; γ - Lumbosacral spine; ε – Head anteversion
Significantly higher than one year earlier: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

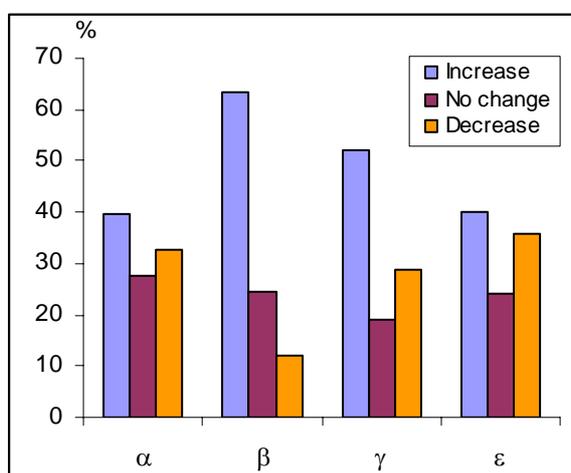


Fig. 1. Frequencies of significant individual changes (exceeding $\pm 1^\circ$) in spinal angle values at the age of 7 years vs. 6 years (all children combined, $n = 257$)

No significant gender-related differences were found in these frequencies, therefore the data of boys and girls were combined. Highest incidence of individually significant increases were found for the β angle – over 63% and lowest for angles α and ε – about 40%. Highest incidence of decreases was noted for angles α and ε –

In contrast to other angles, that of head anteversion showed no significant age-related differences. Other angles significantly ($p < 0.001$) increased in 7-year-old boys in relation to values recorded one year earlier while in girls the α angle showed no significant change and that in the γ angle was rather small and amounted to 1° ($p < 0.05$). The changes in β angle were significant ($p < 0.001$) and alike in boys and girls (Table 1).

Using the criterion of individual significant changes in spinal angles ($\pm 1^\circ$), the frequencies of specific age-related changes (increases, decreases or no change) were determined and presented in Fig. 1. Angle β increased in over 63% of all children from age 6 to 7 years and decreased in only about 10% of them.

33 – 36% and lowest for the β angle – 12%. No changes were observed in 19 (γ angle) to 28% (α angle) of children.

The augmented mean values of spinal angles, especially of the β angle, over the one-year period, resulted in a significant ($p < 0.001$) overall increase of anterior-posterior spine curvatures (σ), especially in boys; also other curvatures significantly ($p < 0.001$) increased. No changes were noted for the compensation index (μ), but its mean value was significantly ($p < 0.001$) lower in girls than in boys (Table 2).

All the measures presented above, i.e. principal angles (α , β , γ), their sums (χ , λ , σ) and compensation index (μ) served to classify children into body posture categories, i.e. kyphotic, balanced or lordotic. The frequencies of those categories are presented in Fig. 2.

No significant age-related differences were found in the frequencies of posture types, therefore the data collected in both periods were combined, separately for boys and girls. Kyphotic postures were significantly ($p < 0.01$) more frequent in boys than in girls (75 and 62%, respectively), the situation being reversed in case of balanced ($p < 0.05$) and lordotic ($p < 0.001$) postures. In addition, flat back was recorded in 9 boys on first examination

(6 years of age). One year later, 6 boys with flat back turned into normal postures (KI in 5 boys and BII in one), 3 other boys exhibited an abnormal kyphotic (KII) posture (Fig. 2).

Table 2. Mean values (\pm SD) of spine curvatures in children aged 6 and 7 years (I and II, respectively)

Variable		χ	λ	σ	μ
Gender					
Boys n = 136	I	22.9 \pm 7.7	15.5 \pm 6.4	31.3 \pm 10.4	7.4 \pm 5.7
	II	26.8 \pm 5.2***	19.7 \pm 6.4***	37.0 \pm 7.1***	7.1 \pm 6.5
Girls n = 121	I	24.3 \pm 4.6	19.0 \pm 5.9	35.6 \pm 6.7	5.3 \pm 6.3
	II	26.9 \pm 4.6***	22.3 \pm 5.9***	39.1 \pm 6.6***	4.6 \pm 5.9

Legend: χ - Thoracic kyphosis; λ - Lumbar lordosis; σ - Sum of angles C₇-L₅; μ - Compensation index; *** Significantly (p<0.001) higher than one year earlier

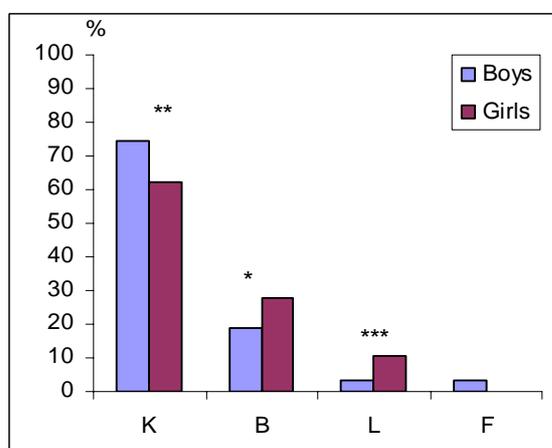


Fig. 2. Frequencies of body posture types in boys (n = 136) and girls (n = 121) aged 6 and 7 years (all data combined)

K - Kyphotic; B - Balanced; L - Lordotic; F - Flat back; Significant difference between boys and girls: * p<0.05; ** p<0.01; *** p<0.001

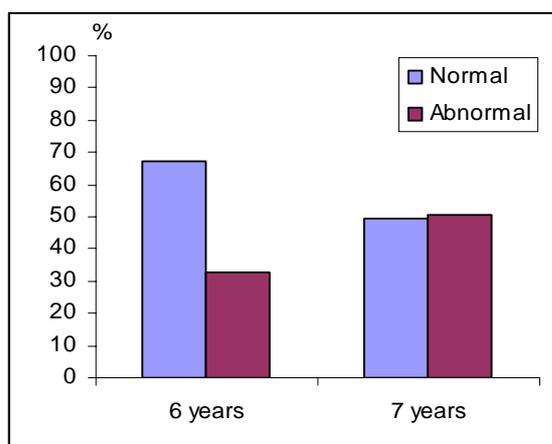


Fig. 3. Frequencies of normal and abnormal body postures recorded in boys and girls combined (n = 257) at the age of 6 and 7 years

Body posture types classified as normal: Kyphotic I, Balanced I and II, Lordotic I; classified as abnormal: Kyphotic II, Balanced III, Lordotic II and Flat back

When classifying posture types into two categories - normal (KI, BI, BII and LI) and abnormal (KII, BIII, LII and F), no significant gender-related differences were observed but a pronounced change took place over the one-year period. Namely, the frequencies of normal and abnormal postures on first examination (6 years of age) amounted to two-thirds and one-third, respectively, and on second examination the frequencies were identical (about one-half each) and that difference proved highly significant (p<0.001).

Discussion

The dominance of the α angle over the sum of β and γ angles in children aged 6 and 7 years brought about a prevalence of kyphotic posture observed in those children. Similar observations were reported for Polish children from various areas by other authors [6,8,12]. In contrast, others found the balanced posture dominating among children aged 7 years, the kyphotic one representing a minor percentage [1] and in Belgian children at early school age a mild thoracic kyphosis was noted at the age of 6 years, which increased one year later, resembling that typical for adults. Zajt-Kwiatkowska *et al.* [17] and Kluszczynski [5] reported an abnormal spine profile in the sagittal plane, especially an augmented thoracic kyphosis. The principal spinal angles increase with age, highest values being attained by the α angle in boys, somewhat smaller by the γ angle in girls, β angles being the smallest ones [16] and this was confirmed by other authors [2,4,10,18]. One year later the angles increased, especially the β angle. The age 6 - 7 years is regarded as the first critical period in posturogenesis, when the body posture worsens; yet, a pronounced development of thoracic kyphosis and of lumbar lordosis takes place especially during the growth spurt [15].

Summing up, kyphotic posture prevailed at the early school age but the incidence of abnormal postures, as well as the mean magnitudes of principal spinal angles, markedly increased within one year. This calls for careful monitoring postural changes at that age in order to prevent stabilised postural disorders at later age.

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