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AN ASSESSMENT OF BODY POSTURE OF CHILDREN AGED 3–6 YEARS

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A – study design, **B** – data collection, **C** – statistical analysis, **D** – interpretation of data, **E** – manuscript preparation, **F** – literature review, **G** – sourcing of funding

ABSTRACT

Background: A posture defect may be defined as a syndrome of abnormalities occurring in a relaxed upright position of the body. Deviations from the typical body shape are specific for given age and gender. Life determinants and social situation have a very significant impact on the development of body posture in young people.

Aim of the study: The aim of the study was to analyse the occurrence of spinal defects in children aged 3–6 years.

Material and methods: The study included 75 children aged 3–6 years. The children were examined for spinal defects using the MORA computer system.

Results: Boys in the study showed a correlation between height and the inclination of the upper thoracic segment, whereas no such correlation was observed in girls. A significant relationship was also demonstrated between BMI and compensation and inclination of the lumbar segment in all subjects. Overall height was also noted to be significantly related to both spine length and the length of its curvature.

Conclusions: The occurrence of spinal defects is influenced by gender. BMI can have a significant impact on spinal morphology and the formation of body posture, even in pre-school age children.

KEYWORDS: posture defects, spinal defects, children, MORA system, anthropometry

Background

Body posture may be considered as the shape and position of individual segments of the torso and lower limbs in a standing position. Correct body posture depends on the interplay between neuronal, muscular and skeletal systems. At its core is the proper alignment of the spine to the pelvis, with spinal curvature cushioning the load.

A posture defect is defined as a syndrome of abnormalities, or deviations from the typical body shape occurring in a relaxed upright position of the body. Typical body shape varies with both age and gender. Posture defects can cause disturbances in the structure and function of many organs and systems of the human body. For example, they can impair lung function and thus hinder blood supply to the brain. Disrupted cushioning can result in pain and micro-head injuries during walking, running or jumping. Untreated spinal defects reduce the overall fitness and may adversely affect quality of life.

Spinal defects are a common occurrence in young people. Although the most rapid periods of spinal growth are between 6–7 years of age and during puberty [1], developing postural defects can be detected even before this, in children aged 3 to 6 years [2]. It should be remembered that body posture is a reflection of the structure and function of the whole organism [1], with contributions from morphology as well as motor habits [4–6]. Careful consideration of correct body posture has a significant impact on the development of a child, as well as on the life of an adult.

Computerised spinal examination, using the MORA system, is based on anthropometric assessment of surface images. The MORA system produces a 3D spatial image by acquiring multiple reference points across the back of the individual. Analysis of variation between

observed and expected locations creates an elevation map of the examined surface known as the Moire pattern [7].

Aim of the study

The aim of the study was to analyse the incidence of spinal defects in children aged 3-6 years.

Material and methods

The study was undertaken in a group of 75 children aged 3 to 6 years in a private kindergarten in Wrocław. The study group consisted of 41 boys and 34 girls (Table 1). Each child had their spinal morphology analysed by the MORA system, with the results forming the basis of the study.

The study was approved by the Bioethical Committee of PMWSZ in Opole no. KB/33/FI/2017.

The process consists of marking the spinous processes from C7 to S1, the corners of the lower shoulder blades and the spikes of the rear upper iliac on the patient's body.

After marking, the device records images of the patient's spine. These images are correlated with the patient's position to accurately determine posture. Three-dimensional coordinates allow the system to assess posture in frontal, sagittal and transverse planes, with graphical representation of the results.

Statistical analysis was carried out using the Statistica programme (StatSoft, Inc., version 13, USA). The normality of the distribution of all results obtained from patients were compared using the Shapiro-Wilk test, which showed their distribution was not normal. The values measured were compared between the groups with the Mann-Whitney U test, and verified using Spearman's correlation. Significance was taken as $p < 0.05$.

Results

Only results reaching statistical significance ($p<0.05$) were considered in this analysis.

The results presented in tables 2 and 3 show that patient height is significantly related to both total spinal length (Spearman correlation $p<0.0001$) and to length of the spinal curve ($p<0.0001$). This relationship was significant in both males and females.

Our results also demonstrate that the angle of inclination of the upper thoracic segment is significantly related to the height of the individual. As height increases, so does the angle of inclination of the upper thoracic segment. This relationship, however, only reached statistical significance in boys (Table 3). This greater predisposition to the formation of spinal defects in the thoracic segment, may lead to the subsequent development of incorrect posture.

Interestingly, the results have shown that BMI *(Body Mass Index)*, is significantly correlated with both the compensation index and the angle of inclination of the lumbar-sacral segment (Table 4). The higher the BMI, the greater the compensation value and the inclination of the lumbar-sacral segment. This abnormal compensation with increased angle of the lumbar-sacral segment can lead to significant postural defects in the future. This inclination of the lumbar segment is demonstrated to be greater in females than in males (Table 2).

In summary therefore, these results demonstrate that height is related both to overall spine length and

Table 1. Characteristics of patients, p - Mann –Whitney U test.

Variable		Male	Female	p
Number of patients (n)		**41**	**34**	
Age (years)	Median	6	6	
	Range	3–6	3–6	>0.05
Height (cm)	Median	108.0	111.0	
	Range	90.0–149.0	94.0–140.0	>0.05
Weight (kg)	Median	17.0	19.0	
	Range	13.0–39.0	13.0–38.0	>0.05
BMI	Median	15.4	15.8	
	Range	11.5–18.5	13.2–24.3	>0.05

Table 2. Comparison of the results obtained in the Mora system for females and males, p - Mann –Whitney U test.

Variable		Male	Female	p
Number of patients (n)		**41**	**34**	
Length of the spinal curve [mm]	Median	298.6	295.1	
	Range	245.3–395.5	254.5–349.8	>0.05
Height of the spine [mm]	Median	293.5	286.3	
	Range	240.1–379.9	254.5–349.8	>0.05
Inclination of the lumbar-sacral segment [o]	Median	7.5	9.4	>0.05
	Range	1.9–18.0	1.8–23.4	
Inclination of the thoracic-sacral segment [o]	Median	8.6	8.3	>0.05
	Range	3.1–15.9	3.4–12.9	
Inclination of the upper thoracic segment [o]	Median	13.2	13.3	>0.05
	Range	1.1–21.1	3.3–20.1	
Total number of curvatures [mm]	Median	27.9	30.8	>0.05
	Range	20.2–48.0	21.6–45.0	
Torso inclination angle [o]	Median	-1.7	-1.4	>0.05
	Range	-9.9–8.5	-6.8–6.7	
Thoracic kyphosis [mm]	Median	159.8	159.3	>0.05
	Range	151.0–210.0	152.8–206.3	
Lumbar lordosis [mm]	Median	166.1	163.0	
	Range	156.9–206.9	153.2–206.5	>0.05

Table 3. Spearman's rank correlation coefficient.

Spearman correlation		Number of patients n=75		Male n=41		Female n=34	
		Spearman's rank correlation coefficient	Significance level p	Spearman's rank correlation coefficient	Significance level p	Spearman's rank correlation coefficient	Significance level p
Height	Length of the spinal curve	0.75	<0.0001	0.75	<0.0001	0.76	<0.0001
	Height of the spine	0.76	<0.0001	0.75	<0.0001	0.78	<0.0001
	Inclination of the lumbar-sacral segment	0.32	0.005	0.30	>0.05	0.33	0.035
	Inclination of the thoracic-sacral segment.	-0.10	>0.05	-0.02	>0.05	-0.17	>0.05
	Inclination of the upper thoracic segment	-0.21	>0.05	0.01	>0.05	-0.45	0.003
	Total number of curvatures	0.10	>0.05	0.18	>0.05	-0.01	>0.05

Table 4. Spearman's rank BMI correlations.

Spearman correlation		Number of patients n=75		Male n=41		Female n=34	
		Spearman's rank correlation coefficient	Significance level p	Spearman's rank correlation coefficient	Significance level p	Spearman's rank correlation coefficient	Significance level p
BMI	Inclination of the lumbar-sacral segment	0.28	0.015	0.13	>0.05	0.36	0.021
	Inclination of the thoracic-lumbar segment	-0.09	>0.05	-0.07	>0.05	-0.10	>0.05
	Inclination of the upper thoracic segment	-0.08	>0.05	0.10	>0.05	-0.24	>0.05
	Total number of curvatures	0.17	>0.05	0.11	>0.05	0.19	>0.05
	Compensation indicator	-0.26	0.026	0.03	>0.05	-0.46	0.002
	Torso inclination angle	-0.09	>0.05	-0.17	>0.05	-0.03	>0.05

the length of the spinal curve in both males and females. In addition, height is significantly related to the inclination of the upper thoracic segment in boys. Lastly, both compensation and inclination of the lumbar-sacral segment increase with BMI.

Discussion

Postural defects are a major problem both in pre-school and school-age children. Studies have suggested that 50–80% of all children have at least one trait which is a deviation from normal body posture [8]. However, as Maciałczyk-Paprocka et al. [2] point out, the majority of body posture studies have been carried out in school-aged children [9–11]. This study is unusual in focussing on the pre-school age group.

In agreement with our findings, several previous studies have identified the relationship between BMI and postural defects. Barczyk et al. [12], demonstrated a significant relationship between increased BMI and the occurrence of postural defects.

Ostrowska et al. [13] observed a linear relationship between body weight gain and increased lumbar lordosis. The same relationship was presented by Grabara et al. [14], whose studies showed that children with increased BMI, showed a significant deepening of lumbar lordosis compared to their peers with normal BMI.

Bogucka et al. [15] observed that up to 70% of children with a high body weight index show excessive lumbar lordosis.

Finally, Burdukiewicz et al. [16] demonstrated that whilst normal BMI is more frequently associated with normal posture, this deteriorates as BMI rises.

Considering thoracic segment abnormalities, the study conducted by Górniak et al. [17] on a group of boys from rural areas showed a significant degree of thoracic kyphosis. This result correlates with the findings presented above, showing a greater inclination of the thoracic segment in taller boys.

Mieszkowska et al. [18] report that formation of body posture at pre-school age is one of the most important periods of posturogenesis, during which intensive skeletal growth takes place, the proportions of the child's body change and there is an intensive development of the nervous system. There is a phenomenon of "filling" the silhouette related to the growth of both fat and muscle tissue. Yearly height increments are about 5 cm and body weight rises by an average of 2.5–3 kg. Meanwhile, the process of stabilizing the anterior-posterior curvature of the spine is incomplete, due to relatively poor muscle tone stabilizing the spine. In addition, as a result of starting school, their lifestyle also changes. The child forms and perpetuates correct or incorrect motor habits (e.g. as a result

of incorrect habits or environmental influences), developing motor memory. Taken together, these elements significantly influence the developing body posture [19–25].

The compensation index in relation to BMI was presented in the studies by Górniak et al. [17], in which they determined the type of posture based on the compensation coefficient value. It was found that more than 60% of the subjects have type I and II postural kyphosis. The study showed that the BMI value is statistically dependent on the compensation index, but did not confirm that increased BMI parameters are reflected in the compensation index.

Given the importance and frequency of spinal abnormalities, it is important to consider how they can be detected. According to Mieszkowska et al. [18] the assessment of postural defects may be carried out by qualified personnel both with the use of objective tools (computer analysis) and based on subjective techniques (visual comparison with the pattern) [26–29]. However, initial screening assessments of body posture can be carried out by parents or appropriately prepared teachers in kindergarten, with their findings forming the starting point for further research and analysis. Widespread uptake of such initial examinations may help prevent further development of postural and spinal defects.

Conclusions

The results of this study confirmed our initial thesis that spinal defects are commonly found in children aged 3–6 years.

The correlation between the height of the individual and the angle of inclination of the upper thoracic segment was found to be statistically significant only in boys. From the study we can conclude that body growth is important in spine formation. However, our results support the idea that the presence of spinal defects is influenced by gender.

The study also addressed the correlation between BMI and body posture formation in pre-school children. BMI was found to be strongly related to the angle of inclination of the lumbar segment and to spine compensation. This study therefore shows that the structure of the lumbar spine, as well as the index of spine compensation, vary with BMI.

Our findings indicate that even at an early age (3–6 years) there are significant changes in the spine, which affect body posture.

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