SPINE'S SAGITTAL PLANE CURVES' COHERENCE WITH ANTHROPOMETRIC PARAMETERS IN SCHOOLCHILDREN

Vilma Mauricienė, Kristina Bačiulienė
Kaunas University of Medicine, Kaunas, Lithuania

Vilma Mauricienė. Doctoral student of Biomedicine Sciences in Kaunas University of Medicine. Lecturer of Department of Kinesiology and Sports Medicine. The field of scientific research — study of interrelation between the peculiarities of children and adolescents' body posture and factors influencing it.

ABSTRACT

The aim of this study — to identify how anthropometric measurements are connected with spine sagittal curves in schoolchildren.
Anthropometric and sagittal body posture measurements were performed for 405 schoolchildren, age range 10—13 years. Such anthropometric measurements as body height, weight, fat mass and fat free mass were assessed. Degrees of thoracic kyphosis and lumbar lordosis as sagittal profile features were evaluated.
According to the data analysis could be concluded, that coherence between anthropometric parameters and spine's sagittal profile differs according to gender. The number of statistically significant connections between these two parameters' groups was greater in boys. Anthropometric measurements had greater coherence with thoracic kyphosis in comparison with lumbar lordosis. Body weight and fat mass were statistically significantly different according to kyphosis and lordosis values in boys, although fat-free body mass had no significant difference with sagittal curves' expression. Body weight, fat mass and fat-free body mass among girls were associated only with thoracic kyphosis.

Keywords: *thoracic kyphosis, lumbar lordosis, height, weight, fat mass.*

INTRODUCTION

Asymmetric body posture lately is more and more often diagnosed among adolescents in Lithuania also in other countries. Consequences of this widely spreading health disorder are very important as for physical health and so for social and mental wellbeing. Asymmetric body posture is considered not only one of the most common adolescents' musculoskeletal system disorders (Lindišienė, Murauskienė, 1999; Juškelienė et al., 1996) but also one of the possible signs or reasons of scoliosis (Nissinen et al., 1993; Hazebroek-Kampschreur et al., 1992; Grivas et al., 2002). Spine sagittal plane curves being too much or not enough in their form expression (according to their expression size) may influence reduced musculoskeletal system functioning. The expression of sagittal curves influences not only spine's frontal plane curves (Mac-Thiong et al., 2003), but also pelvic and lower extremities' posture (Park et al., 2003; Vedantam et al., 1998; Vialle et al., 2005), back pain appearance (Joncas et al., 1996) and other

symptoms. Body posture changes and develops with age and also according to gender and anthropometric parameters. Some researchers (Le Blanc et al., 1995; Farenc et al., 2003) confirmed the influence of morphologic somatotype and body characteristic on body posture. But there is not enough data on how anthropometric measurements affect sagittal plane parameters. And the aim of this article is to reveal the coherence between some anthropometric parameters and spine sagittal alignment among schoolchildren.

MATERIAL AND METHODS

Assessment of schoolchildren's body posture and anthropometric parameters was performed according to standards of medical ethics (Declaration of Helsinki). We assessed 405 schoolchildren (210 girls and 195 boys). Mean age (*mean ± standard error mean*) was 11.6 ± 0.045 years (range 10—13) for boys and 11.48 ± 0.037 years (range 10—12) for girls.

Height of schoolchildren was measured with a steel anthropometer, weight with a weighing machine. Amount of body fat mass was calculated from skinfolds' measurements, performed with Harpenden caliper. Skinfolds' measurements were taken in two points: m. triceps brachii area and subscapular area on the right side of body with 0.2 mm precision. Amount of body fat mass (in percent) was calculated using the T. G. Lohman and M. H. Slaughter's formulae for 6—16 years old children (Heyward, Stolarczyk, 1996).

The curves of spine's sagittal plane were measured with cirtometer — graduated flexible curve that holds position given to it, placing it on the spinous processes of vertebras. The angles of thoracic kyphosis and lumbar lordosis were calculated.

Schoolchildren were divided into three groups of height, weight, fat mass and fat-free body mass. Medium value we considered value rate of mean ± ½ standard deviation. Other groups were named as big or small respectively to specific parameter.

Data were analyzed by using *SPSS 10.0 for Windows*. Student's test was used for statistical differences estimation between groups. Pearson's and Spearman's correlation analysis was used to estimate correlation between anthropometric and sagittal plane measurements. Analysis of variance (ANOVA) was performed for assessing statistical significance of differences. P value < 0.05 was considered statistically significant.

RESULTS

The mean values of children's height, weight, fat mass and fat-free body mass are presented in the table.

The height of schoolchildren's had statistically significant difference according to gender. The analysis revealed no significant difference for weight among boys and girls. There was significant difference of body fat mass amount; it was greater in girls ($p < 0.05$). Amount of fat-free mass was greater in girls, but no significant difference was established. Thoracic kyphosis mean value was different between gender groups ($p < 0.05$), although there was no difference in lumbar lordosis. Proportional distribution according to kyphosis expression was similar in boys and girls, but it was different analyzing lumbar lordosis. Boys tended more often have decreased lordosis then girls. Variation of height, amount of body fat mass and lordosis was greater in boys.

The correlation analysis (Pearson's coefficient) revealed no strong significant correlation between anthropometric and sagittal plane measurements in both boys and girls. Significant but weak positive correlation was detected between body weight and thoracic kyphosis ($r = 0.225$, $p = 0.002$) and between body weight and lumbar lordosis ($r = 0.206$, $p = 0.005$) in girls; and body fat mass and lordosis ($r = 0.203$, $p = 0.009$) in boys. The correlation analysis (Spearman's coefficient) revealed additional significant weak correlation between body fat mass and thoracic kyphosis in girls ($r = 0.229$, $p = 0.003$) and in boys ($r = –0.214$, $p = 0.006$).

Parameters	Boys			Girls		
	Parameter's groups					
	Small	*Medium*	*Big*	*Small*	*Medium*	*Big*
Height	140.16 ± 0.88	149.65 ± 0.47	155.31 ± 0.73	144.11 ± 0.66	150.52 ± 0.31	156.01 ± 0.41
Weight	31.53 ± 0.64	39.57 ± 0.47	48.03 ± 1.2	31.98 ± 0.48	38.56 ± 0.48	50.89 ± 1.3
Fat mass	10.51 ± 0.27	16.34 ± 0.58	28.04 ± 2.47	13.76 ± 0.39	19.42 ± 0.42	29.61 ± 1.44
Fat-free mass	27.5 ± 0.45	32.13 ± 0.43	36.68 ± 0.42	26.85 ± 0.39	31.1 ± 0.28	36.67 ± 0.65

Table. **Mean values (± standard error of mean) of schoolchildren's height, weight, fat mass and fat-free mass**

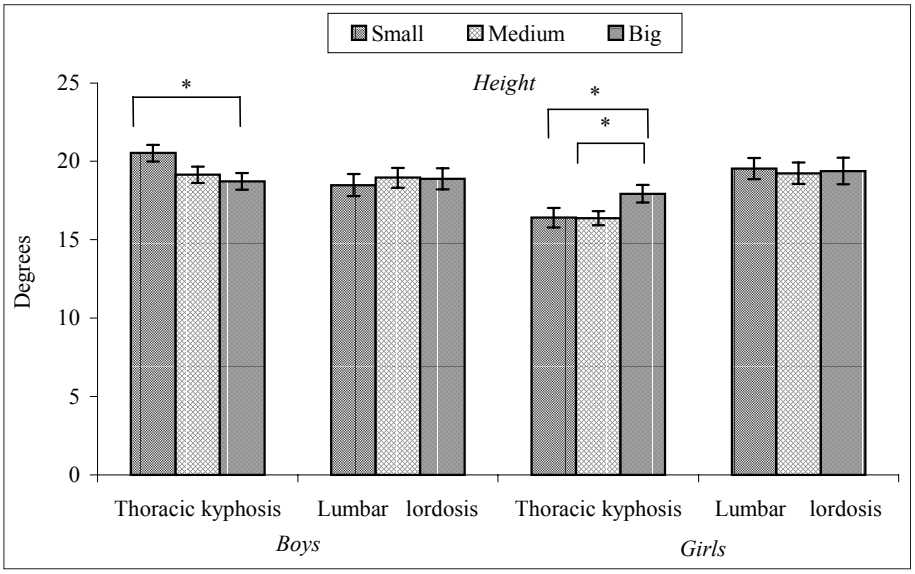


Fig. 1. **Degrees of thoracic kyphosis and lumbar lordosis according to height groups among boys and girls**

Note. * — $p < 0.05$.

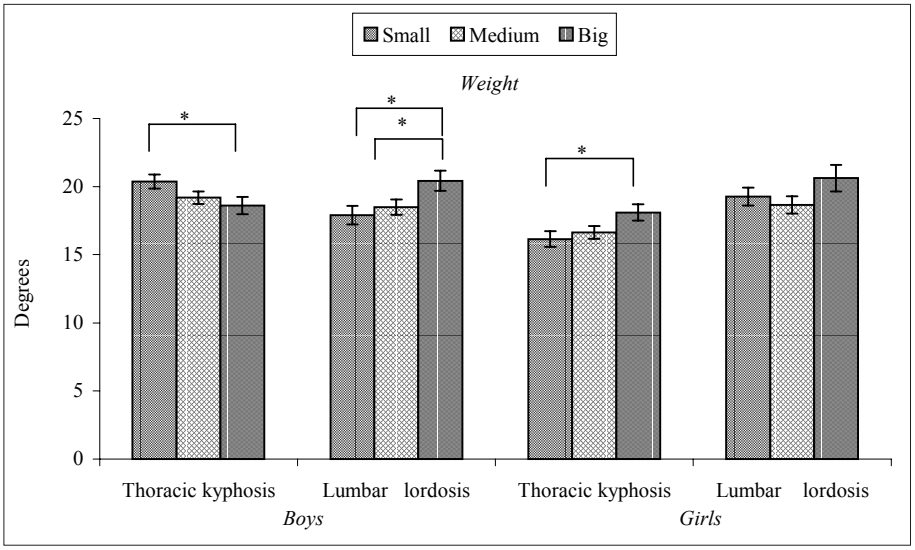


Fig. 2. **Degrees of thoracic kyphosis and lumbar lordosis according to weight groups among boys and girls**

Note. * — $p < 0.05$.

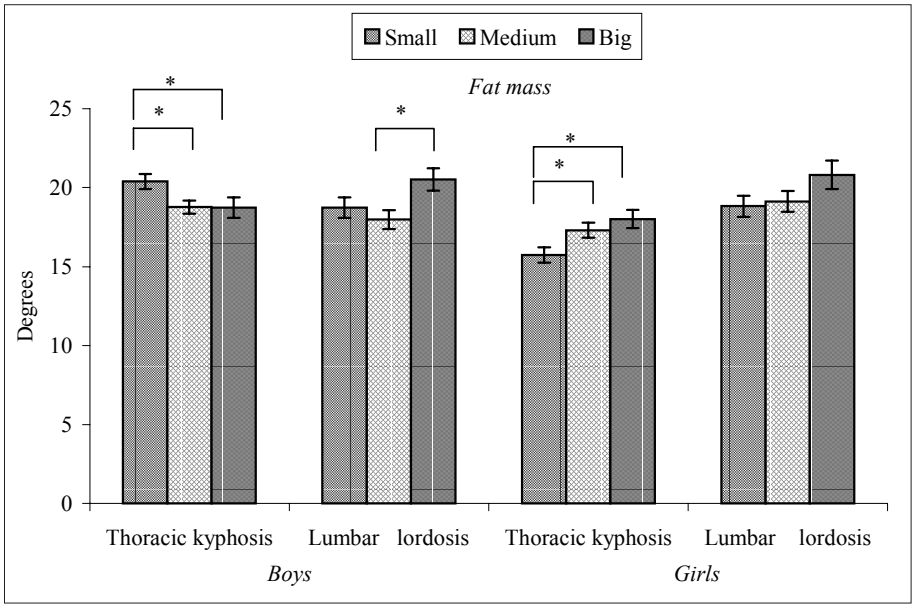
But there was no correlation between body fat mass amount and lumbar lordosis in boys.

The analysis of variance performed for mean values of kyphosis as calculated by each of height groups yielded significant statistical differences among boys, and showed no significant difference among girls. Mean values of lumbar lordosis calculated by each of height groups had no significant differences also in girls and boys. It was established that thoracic kyphosis of boys with small height was greater than kyphosis of boys with big height. Lordosis of boys with small height was smaller than lordosis of those with big height, but difference wasn't statistically significant (Fig. 1). Kyphosis in girls with big height was more expressed ($p < 0.05$) than in those with medium and small height. Lordosis expression was similar in all height groups among girls.

The analysis of variance performed for the mean values of kyphosis as calculated by each of weight groups yielded significant statistical differences among boys and girls. Mean values of lordosis have significant difference only among boys. Boys with small weight had greater thoracic kyphosis than those with big weight ($p < 0.05$) and their lordosis was statistically significant smaller (Fig. 2). Boys with big weight had greater lordosis than those with medium and small weight ($p < 0.05$). Kyphosis was greater among girls with big weight.

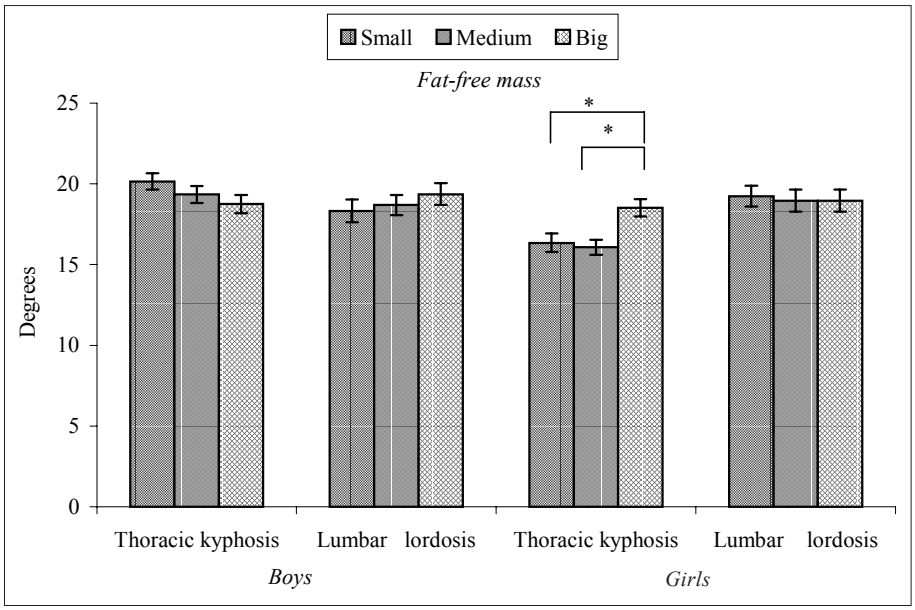
The analysis of variance revealed statistical significant differences among thoracic kyphosis and lumbar lordosis mean values according to amount of fat mass in boys. Among girls statistical significant difference was only in kyphosis mean values. Thoracic kyphosis of boys with small amount of fat mass was greater than kyphosis of boys with medium and big amount of fat mass ($p < 0.05$) (Fig. 3). Boys with big amount of fat mass had greater lordosis than those with medium

Fig. 3. **Degrees of thoracic kyphosis and lumbar lordosis according to fat mass groups among boys and girls**



Note. * — $p < 0.05$.

Fig. 4. **Degrees of thoracic kyphosis and lumbar lordosis according to fat-free body mass groups among boys and girls**



Note. * — $p < 0.05$.

fat mass. Girls with small amount of fat mass had minimal kyphosis and lordosis values.

The analysis revealed no significant differences between lordosis mean values and different fat-free body mass groups in both gender groups. Differences were significant only in kyphosis mean values among girls. Girls with bigger fat-free body mass tended to have greater kyphosis values (Fig. 4) than girls with medium and small fat-free body mass ($p < 0.05$).

Although many authors have established correlation between anthropometric and posture parameters (Nissinen et al., 2000; Tambovtseva, Panasiuk, 2000), our research data analysis revealed that among the schoolchildren, who participated in this research, there was no strong statistically significant correlation between anthropometric and spine's sagittal profile measurements. This could be due to absence of researches of anthropometric data influence on sagittal plane curves, because usually "posture" is used for describing frontal plane alignment. Although data grouping in our research showed some consistent patterns according to the relationship of these parameters.

The relations between anthropometric data and sagittal curves were different according to the participants' gender. This peculiarity could be due to different beginning of growth spurt and posture development among different genders (Nissinen et al., 2000; Tambovtseva, Panasiuk, 2000).

According to our research data, height had no statistically significant influence on lumbar lordosis, but it was connected with thoracic

kyphosis in boys. The analysis of Lithuanian children's morphological features (Tutkuvienė, 1995) also confirmed that the children with bigger or smaller than medium height have greater possibility for scoliosis or kyphosis development. Height was the strongest predictor for the development of trunk abnormalities in both sexes among the children of 11 and 13 years old in The Netherlands (Hazebroek-Kampschreur et al., 1994).

Researchers also emphasize body weight and fat mass influence on posture, especially scoliosis (Allard et al., 2004; Farenc et al., 2003). The data of this research also confirm coherence between weight and fat mass and kyphosis in both sexes. Lumbar lordosis was associated with anthropometric data only in boys.

CONCLUSIONS

1. Coherence between anthropometric parameters and spine's sagittal profile differs according to gender. The number of statistically significant connections between these two parameters' groups was greater in boys.
2. Anthropometric measurements have greater coherence with thoracic kyphosis in comparison with lumbar lordosis.
3. Body weight and fat mass were statistically significantly different according to kyphosis and lordosis values in boys, although fat-free body mass had no significant difference with sagittal curves expression. Body weight, fat mass and fat-free body mass among girls were associated only with thoracic kyphosis.

REFERENCES

Allard, P., Chavet, P., Barbier, F. et al. (2004). Effect of body morphology on standing balance in adolescent idiopathic scoliosis. *American Journal of Physical Medicine and Rehabilitation*, 83 (9), 689—697.

Le Blanc, R., Labelle, H., Forest, F., Poitras, B., Rivard, C. H. (1995). Possible relationship between idiopathic scoliosis and morphologic somatotypes in adolescent females. *Annales Chirurgical,* 49 (8), 762—767.

Farenc, I., Rougier, P., Berger, L. (2003). The influence of gender and body characteristics on upright stance. *Annals of Human Biology*, 30 (3), 279—294.

Grivas, T. B., Dangas, S., Samelis, P., Maziotou, C., Kandris, K. (2002). Lateral spinal profile in school-screening referrals with and without late onset idiopathic scoliosis 10 degrees—20 degrees. *Studies in Health Technology and Informatics*, 91, 25—31.

Hazebroek-Kampschreur, A. A., Hofman, A., Van Dijk, A. P., Van Linge, B. (1994). Determinants of trunk abnormalities in adolescence. *International Journal of Epidemiology,* 23 (6), 1242—1247.

Hazebroek-Kampschreur, A. A., Hofman, A., Van Dijk, A. P., Van Linge, B. (1992). Prevalence of trunk abnormalities in eleven year old children in Rotterdam, The Netherlands. *Journal of Bone Orthopaedics,* 12 (4), 480—484.

Heyward, V. H., Stolarczyk, L. M. (1996). *Applied Body Composition Assessment*. P. 91—97.

Joncas, J., Labelle, H., Poitras, B. et al. (1996). Dorso-lumbal pain and idiopathic scoliosis in adolescence. *Annales Chirurgial*, 50 (8), 637—640.

Juškeliene, V., Magnus, P., Bakketeig, L. S., Dailidiene, N., Jurkuvenas, V. (1996). Prevalence and risk factors for asymmetric posture in preschool children aged 6—7 years. *International Journal of Epidemiology*, 25 (5), 1053—1059.

Lindišienė, D., Murauskienė, N. (1999). Skoliozės paplitimas tarp Kauno miesto moksleivių ir jos prevencija. *Ugdymas. Kūno kultūra. Sportas*, 4, 22—26.

Mac-Thiong, J. M., Labelle, H., Charlebois, M., Huot, M. P., De Guise, J. A. (2003). Sagittal plane analysis of the spine and pelvis in adolescent idiopathic scoliosis according to the coronal curve type. *Spine,* 1, 28 (13), 1404—1409.

Nissinen, M. J., Heliövaara, M. M., Seitsamo, J. T. et al. (2000). Development of trunk asymmetry in a cohort of children ages 11 to 22 years. *Spine*, 25, 570—574.

Nissinen, M, Heliövaara, M, Ylikoski, M, Poussa, M. (1993). Trunk asymmetry and screening for scoliosis: a longitudinal cohort study of pubertal schoolchildren. *Acta Paediatrica*, 82 (1), 77—82.

Park, H. W., Kim, H. S., Hahn, S. B. et al. (2003). Correction of lumbosacral hyperlordosis in achondroplasia. *Clinical Orthopaedis,* 414, 242—249.

Tambovtseva, R. V., Panasiuk, T. V. (2000). Age and constitutional features in the forming of posture in children 7 to 14 years of age. *Morfologiia*, 118 (4), 87—90.

Tutkuvienė, J. (1995). *Vaikų augimo ir brendimo vertinimas*. Vilnius. P. 8.

Vedantam, R., Lenke, L. G., Keeney, J. A., Bridwell, K. H. (1998). Comparison of standing sagittal spinal alignment in asymptomatic adolescents and adults. *Spine,* 15, 23 (2), 211—215.

Vialle, R., Levassor, N., Rillardon, L. et al. (2005). Radiographic analysis of the sagittal alignment and balance of the spine in asymptomatic subjects. *Journal of Bone and Joint Surgery. American Volume,* 87-A (2), 260—267.

Vilma Mauricienė
Kaunas University of Medicine
Jankaus str. 2, LT-50275 Kaunas
Lithuania
Tel +370 37 730580
E-mail vilmaur@kmu.lt

Received on February 10, 2005
Accepted on May 18, 2005