Alen Ćirić[1], Denis Čaušević[1] and Almir Bejdić[1]

DIFFERENCES IN POSTURE STATUS BETWEEN BOYS AND GIRLS 6 TO 9 YEARS OF AGE

[1]*Faculty of Sport and Physical Education, University of Sarajevo, Bosnia and Herzegovina*

Original scientific paper
UDC: 572:796.012-053.5

Abstract
The aim of this research presents detection of differences in postural status between boys and girls 6 to 9 years of age. Research was conducted on a sample of 344 respondents, of which 172 girls and 172 boys under the IPA SpineLab project financed by the European Union. The postural state was checked with 17 applied variables, and was obtained by conducting "3D Posture Compact" protocol on Contemplas measuring instrument. Mann-Whitney U test showed that there were statistically significant differences ($p < .001$) in postural status between boys and girls in Sag. Distance thoracic spine – sacrum (thoracic kyphosis), Sag. Distance lumbar spine – sacrum (lumbar lordosis), Varus/Valgus left, Varus/Valgus right (X and O legs). Girls are significantly more likely to have postural problems in relation to their male peers in terms of lumbar lordosis and valgus knees, while boys have more pronounced deformity of the thoracic kyphosis. In the end, bad posture status in children and adolescents can lead to significant health problems, and it is very important to identify them at an early stage and promptly begin preventive procedures (preventive exercise program, etc.).

Keywords: **body alignment, kyphosis, lordosis, x and o legs, varus / valgus knee, 3d screening**

Introduction

The modern way of life, has a negative impact on psychological organism, especially in the period of its development (Đokić, Međedović, & Smiljanić, 2011). Therefore, observing globally, proper posture of children and youth today presents a big challenge (Bubanj et al., 2012). Today there is a growing global problem of hypokinesia with generations who will, in the future, be the bearers of the society and the community. One of the biggest problems are long-hours of improper sitting postures during the day and which ultimately lead to different postural deformities (Le Roux, 2013). Posture is defined as the alignment and orientation of the segments of the body when held in upright position (Fortin, Ehrmann Feldman, Cheriet, & Labelle, 2011). Identification of postural disorders is of great importance, especially in preadolescent period. The reason for this lies in the fact that it is extremely necessary to create an image of the body posture of children at a very early stage, that contributes to the overall growth and development and quality of life. To determine the postural status of the individual, it is necessary to apply the screening which plays an important role in the fast and reliable assessment of the normal development of children and adolescents (Kowalski et al., 2014). Good posture is one of the basic requirements of good health, normal growth and development as a whole (Torlaković, Muftić, & Kovač, 2013). The aim of this research presents detection of differences of postural status between boys and girls 6 to 9 years of age, recorded by 3D study protocol.

Methods

Sample
The research has covered 344 respondents of school population ages 6 through 9, of which (n=172) girls and (n=172) boys. All of the subjects were in the Sarajevo Canton.

Variable sample
The variables that were used in this study are the result of a three-dimensional video and provide posture information. The sample of variables consisted of 17 parameters obtained by ''3D posture compact'' protocol of testing Contemplas measuring instrument (Kovač, Kajmović, Rađo, & Manić, 2014). Obtained parameters point at eventual deflection from null (normal) value of posture status in all three planes where postural plane shifts are shown in centimeters and degrees. Bigger value in deflection (positive or negative) implies higher level of deformity.

Table 1. Variables by ''3D posture compact'' protocol of testing Contemplas measuring instrument

Shoulder displacement	Variable expressed in centimetres indicates elevation/depression of the left/right frontal plane. Results with the positive values are in regard to the right shoulder elevation, while the negative values indicate a left shoulder elevation.
Pelvic obliquity	Variable expressed in centimetres displays elevated/lowered left/right pelvic side in frontal plane. Results with positive values indicate the elevation of right pelvic side, and results with negative value indicate the elevation of left pelvic side.
Shoulder rotation	Variable expressed in degrees indicates the rotation in longitudinal axis (transversal plane) of the left/right shoulder. If the results are positive it indicates a rotation of the upper body in which case the right shoulder is placed forward, while negative results indicate a rotation of the upper body in which case the left shoulder is placed forward.
Pelvic rotation	Variable expressed in degrees indicates rotation in longitudinal axis (transversal plane) of the left/right pelvic side. If the results are positive it indicates the rotation in which case the right side of the pelvis is placed forward, while in negative results the rotation of the left side of the pelvis is placed forward.
Trochanter rotation	Variable expressed in degrees indicates rotation of the left/right tronchanter in longitudinal axis (transversal plane). If the result is positive it indicates the rotation of the lower body in which case the right side of pelvis is rotated towards front, while the negative results indicate the front rotation of the left side of pelvis.
Condylus rotation	Variable expressed in degrees indicates the knee rotation in longitudinal axis (transversal plane). If the results are positive, it indicates the front rotation of lateral condylus of the right leg, while the negative results indicate the front rotation of the left lateral condylus.
Malleolus rotation	Variable expressed in degrees indicates the rotation of the axis which runs through malleolus of ankle joint. If the result is positive it indicates the front rotation of the lateral malleoulus of the right foot, while the negative result indicates the opposite rotation.
Sag. Distance cervical spine – sacrum*	Variable expressed in centimetres indicates the distance of the most protruded cervical (neck) vertebra in regards to the vertical line projection of the sacrum (bone at the bottom of the spine) in the sagittal plane. Positive result indicates the increased flexion of the cervical spine, while the negative results indicate the increased extension of the cervical spine.
Sag. Distance thoracic spine – sacrum*	Variable expressed in centimetres indicates the distance of the thoracic spine in regards to vertical line projections of the sacrum (bone at the bottom of the spine) in sagittal plane. Positive results indicate an increase of flexion in thoracic spine, while the negative results indicate an increase in other extension of the thoracic spine . *Higher values in the positive and negative offset do not apply for the variables "Sag. distance cervical, thoracic, lumbar – sacrum"
Sag. Distance lumbar spine – sacrum*	Variable expressed in centimetres indicates the distance of the lumbar (lower) spine in regards to the vertical line projection of sacrum (bone at the bottom of the spine) in sagittal plane. Positive result indicates an increase in lumbar spine flexion, while negative results indicate increase in the lumbar spine extension.
Varus/Valgus left	Variable expressed in degrees indicates the Varus-Valgus alignment angle of the left leg (medial/lateral) at the knee joint.
Varus/Valgus right	Variable expressed in degrees indicates the Varus/Valgus alignment angle of the right leg (medial/lateral) at the knee joint.
Flexion/Extension left	Variable expressed in degrees indicates the hyperextension and flexion of the left leg at the knee joint (sagittal plane). Positive result indicates the left leg flexion, while negative result indicates hyperextension of the left leg.
Flexion/Extension right	Variable expressed in degrees indicates the hyperextension or the flexion of the right leg at knee joint (sagittal plane). Positive result indicates the right leg flexion, while the negative result indicates the hyperextension of the right leg.
Frontal Cervical spine	Variable expressed in centimetres indicates the distance of the cervical spine in frontal plane in relation to the vertical line projection of the sacrum. If the result is positive it indicates the right displacement of the cervical spine, and the negative result indicates the left side displacement.
Frontal Thoracic spine	Variable expressed in centimetres indicates the distance of the thoracic spine in frontal plane in relations to vertical line projection of the sacrum. If the result is positive it indicates the right displacement of the thoracic spine, while the negative result indicates the left side displacement.
Frontal Lumbar spine	Variable expressed in centimetres indicates the distance of the lumbar spine in frontal plane in relation to vertical line projection of sacrum. If the result is positive it indicates the right displacement of the lumbar spine, but if the result is negative it indicates the left side displacement.

Testing protocol

Testing and assessment of posture on the measuring instrument Contemplas require ideally flat surface and outstanding precision. It is necessary to find the ideal base to set up the plate of measuring instrument Contemplas (Figure 1) on it. To avoid moving plate while children step on it, which would lead to repetition of the calibration process space, it is glued to the surface.

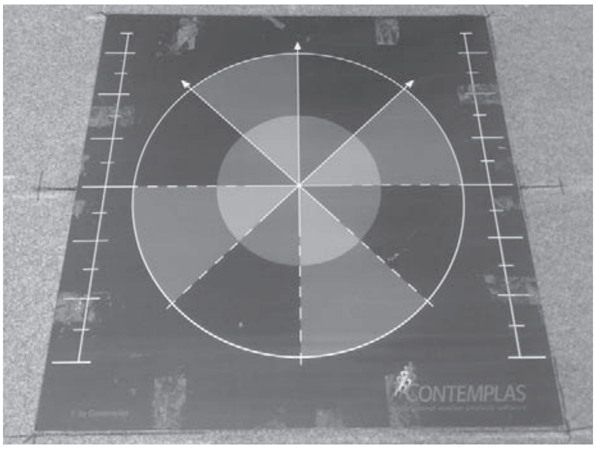


Figure 1. Screening surface

After proper plate installation, 3D calibration frame, which contains reflective markers (Figure 2) is set on it.

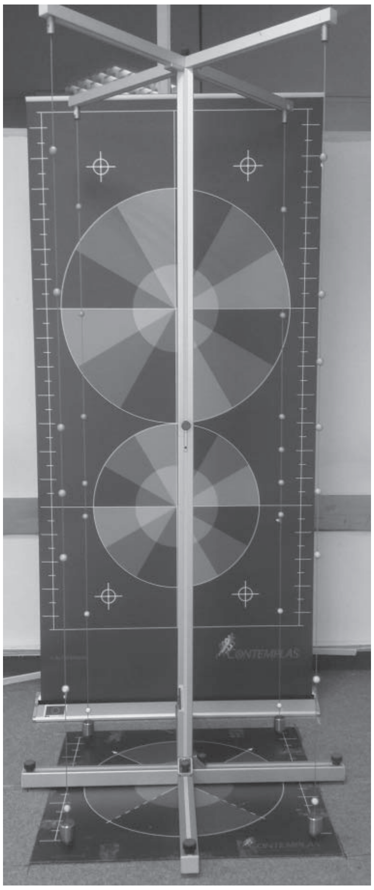


Figure 2. Calibration frame

Calibration frame is positioned in the middle of the Contemplas plate. All parts of the calibration frame must be ideally aligned, which is checked by using a spirit level. After setting the calibration box below, comes the setting of “V” frame in which there are 3 cameras that provide a three-dimensional analysis (Figure 3).

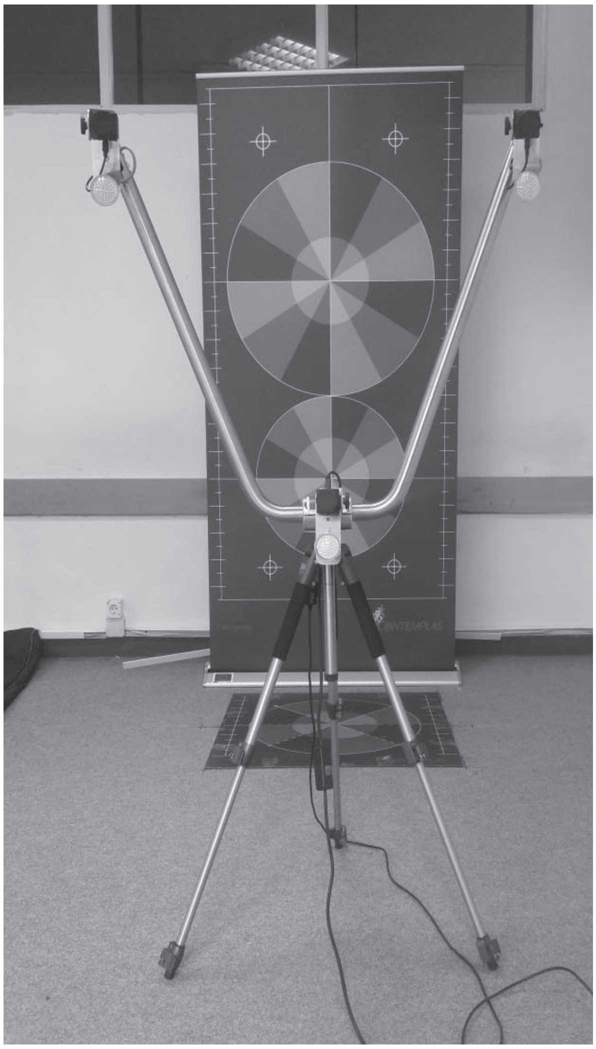


Figure 3. „V“ Camera Frame

The distance of camera from the measuring board should be at least 2 meters and 15 cm (230 cm in this study). The next step requires the software quality check of the image and the camera starts with the calibration area. Calibration process is based on the calibration box gathering width, depth and height. The next step involves preparing and placing reflective markers on specific points (depending on the test protocol) in a patient’s body. “3D Posture Compact” protocol was used in this research, which requires placing 14 markers on the body of each subject and the following specific places: the acromion (left and right), cervical spine, thoracic spine (kyphosis), lumbar spine (lordosis) crista iliaca posterior superior (left and right), sacrum, trochanter major (left and right), condyluslaterallis (left and right), malleolus laterallis (left and right) (Figure 4).

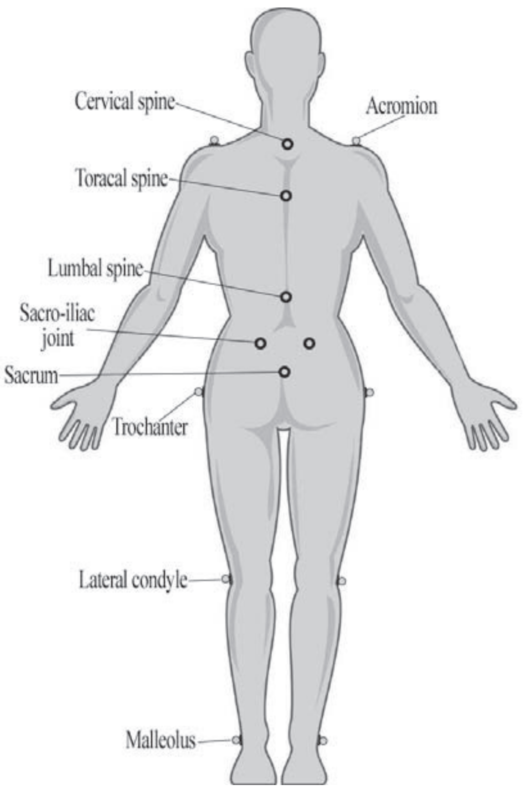


Figure 4. Setting markers "3D Posture Compact" protocol

After placing a marker, the respondent stands on the board so that his back is to the camera, with a parallel set feet hip-width apart, where axis passing through the center malleolus must be parallel with the horizontal line on the measuring board (frontal plane). Respondent is said to stand still and stare straight ahead, after which the recording begins (between the 12th and 18th second). After recording, markers are removed from the subjects and put on the next one and the process of pasting markers and recording repeats. Testing protocol is used as recommended by the author Kovač et al., 2014.

Data analysis method

Results were processed in IBM SPSS 22 software package. Since the data did not meet normality of distribution, statistically significant differences between boys and girls were found by non-parametric Mann-Whitney U test.

Results

The results for the treatment group of participants from 172 girls (the AS 7.80, SD 0.91) and 172 boys (the AS 7.65, SD 7.1) revealed statistically significant differences. Looking at the spine in the sagittal plane, the two variables showed the greatest statistical difference between boys and girls ($p < .001$). These are variables Sag. Distance thoracic spine - sacrum and Sag. Distance lumbar spine - sacrum (Table 2, Figure 1). The values in sagital plane were caused by physiological curves of the spine at the cervical, thoracic and lumbar region, and based on the distance from the outermost part of the sacrum (Kovač et al., 2014). In addition to spinal deformity, a statistically significant difference ($p < .001$) is noticeable with leg deformities, or varus and valgus's left leg and right leg (Table 2, Graph 1).

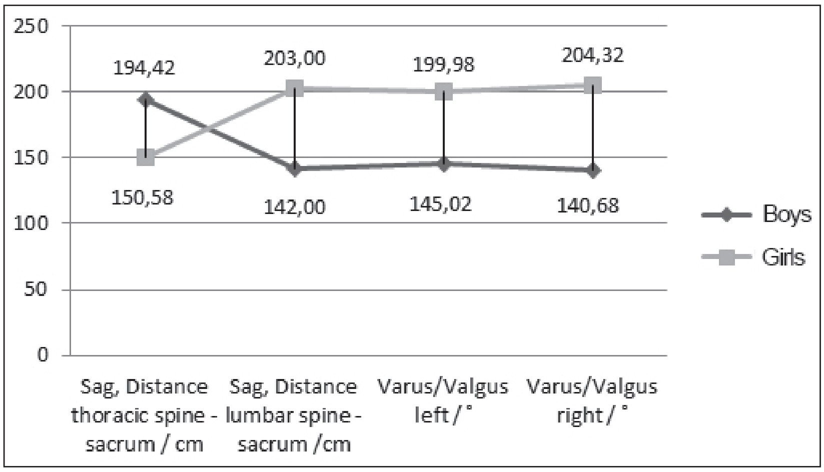
Discussion

Spinal column is vital for good and proper body posture. The assumption for normal posture, with minimal muscle extensibility and energy consumption, is optimal relationship between the spinal structures and joints (Muyor, López-Miñarro, & Alacid, 2013). The results of this research indicate that boys tend to have more prominent thoracic kyphosis deformity (76 boys, constituting 44.18 per cent) in relation to girls, while girls have greater predisposition for lumbar lordosis (48 girls, constituting 44.18 per cent). Improper kyphotic body posture is manifested through increased backward physiological curvature of thoracic region of the spine (Simov, Milinić, & Stojanović, 2011). Longitudinal research results indicate greater incidence and increased tendency among boys toward thoracic kyphosis deformity, while lumbar lordosis is principally prevalent among girls (Poussa et al., 2005). The finding of this research are further confirmed by the results that indicate that thoracic kyphosis is growing among boys ages 8, 11, and 15, but not among girls of this age (Widhe, 2001). One of the most probable causes of kyphotic posture is improper sitting body posture (bending of head toward sternum) (Simov et al., 2011), along with a growing contemporary age problem, that is, excessive computer use. Among girls, excessive computer use leads to greater incidence of lumbar lordosis, which is a result of lower body weigth in relation to boys and consequent trunk extension to raise eye height toward monitor (Straker, O'Sullivan, Smith, & Perry, 2007). Inactivity and weakening of muscle tonus, along with consequent weakening of spinal muscles, which is accompanied by incorrect sitting posture and extensive sitting periods, could lead to spinal column deformities and inadequate body posture. Considering the femur-tibia angle and the activity of epiphysis core of of the distal parts of femur and proximal tibia (Varus/Valgus knees), the research results indicate that girls are more predisposed to valgus angulation (three of six girls have prominent valgus angulation). Among possible causes of the high incidence of increased valgus are specific build features (pelvis width, pelvis inclination, weakeness of individual pelvic muscle groups, flat feet, and increased feet dorsiflexion) (McLean, Huang, & van den Bogert, 2005; Paušić, 2007). Genu valgum is a very common body deformity, which affects flexibility and stability of lower extremities, and it could, if not prevented, lead to movement amplitude limitation, as well as affect functionning of the entire locomotor system. Also, one the reasons for this condition could be the fact that children no longer play as much and are no longer sufficiently physically active in their free time, and they spend most of their time in passive states, either sitting, or lying down (Cvetković & Perić, 2009).

Table 2. Mann-Whitney U test

Variable	Gender	N	Mean Rank	Mann-Whitney U	Z	Sig. (2-tailed)
Shoulder displacement / cm	Male	172	171.76	14664.000	-.139	.890
	Female	172	173.24			
Pelvic obliquity / °	Male	172	171.14	14558.500	-.253	.800
	Female	172	173.86			
Shoulder obliquity / °	Male	172	170.76	14492.500	-.325	.745
	Female	172	174.24			
Pelvic rotation / °	Male	172	172.71	14756.000	-.039	.969
	Female	172	172.29			
Trochanter rotation / °	Male	172	169.06	14200.000	-.642	.521
	Female	172	175.94			
Condylus rotation / °	Male	172	173.22	14669.000	-.133	.894
	Female	172	171.78			
Malleolus rotation / °	Male	172	172.50	14792.000	.000	1.000
	Female	172	172.50			
Sag. Distance cervical spine - sacrum / cm	Male	172	163.53	13248.500	-1.674	.094
	Female	172	181.47			
Sag. Distance thoracic spine - sacrum / cm	Male	172	194.42	11021.000	4.089	.000
	Female	172	150.58			
Sag. Distance lumbar spine - sacrum /cm	Male	172	142.00	9546.000	-5.688	.000
	Female	172	203.00			
Varus/Valgus left / °	Male	172	145.02	10065.500	-5.125	.000
	Female	172	199.98			
Varus/Valgus right / °	Male	172	140.68	9318.500	-5.935	.000
	Female	172	204.32			
Flexion/Ext left / °	Male	172	173.50	14620.500	-.186	.852
	Female	172	171.50			
Flexion/Ext right / °	Male	172	173.59	14604.500	-.203	.839
	Female	172	171.41			
Cervical spine / cm	Male	172	167.77	13979.000	-.882	.378
	Female	172	177.23			
Thoracic spine / cm	Male	172	163.50	13243.500	-1.679	.093
	Female	172	181.50			
Lumbar spine / cm	Male	172	174.48	14451.000	-.370	.712
	Female	172	170.52			

Graph 1. Graphical representation of statistically significant differences on results between boys and girls



Conclusion

This research leads to a conclusion that a significantly higher incidence of posture issues that are manifested through lumbar lordosis and knee valgus (Distance lumbar spine – sacrum, Varus/Valgus left, Varus/Valgus right) is found among girls aged six to nine, while thoracic kyphosis deformity is more prevalent among boys (Distance thoracic spine – sacrum). The increasing number of inactive children and youth, that is, hypokinesia and sedentary lifestyles, constitute ideal conditions for development of various locomotor system diseases and deformities. The results clearly indicate that it is necessary to engage younger school-age children in structured and systemic activities and active use of their free time. Moreover, it is crucial that parents whose children suffer from different posture deformations are educated and informed about the necessity of timely engagement in kinesitherapy programmes, which could ultimately lead to posture improvements.

Reference

Bubanj, S., Živković, M., Živković, D., Milenković, S., Bubanj, R., Stanković, R., Stojiljković, D. (2012). The incidence of sagittal postural deformities among high school students: Preliminary study. *Acta Kinesiologica, 6*(2).

Cvetković, N., & Perić, D. (2009). Effects of specific games directed at the prevention of flat feet in pre-school children. *Sport-Science & Practice, 1*(1), 45-57.

Đokić, Z., Međedović, B., & Smiljanić, J. (2011). Stanje uhranjenosti, posturalni status i kvalitet sprovođenja nastave fizičkog vaspitanja u osnovnim školama. *TIMS Acta-Journal of sport sciences, tourism and wellness, 5*(1), 10-19.

Fortin, C., Ehrmann Feldman, D., Cheriet, F., & Labelle, H. (2011). Clinical methods for quantifying body segment posture: a literature review. *Disability and rehabilitation, 33*(5), 367-383.

Kovač, S., Kajmović, H., Rađo, I., & Manić, G. (2014). Trend Projections of Body Deformities Occurrence between the ages of 5 and 12, Metrically Objectified and Estimated by 3D Postural Status Screening. *Homosporticus, 16*(2), 5-13.

Kowalski, I. M., Protasiewicz-Fałdowska, H., Dwornik, M., Pierożyński, B., Raistenskis, J., & Kiebzak, W. (2014). Objective parallel-forms reliability assessment of 3 dimension real time body posture screening tests. *BMC Pediatrics, 14*(1).

Le Roux, D. F. (2013). Prevention of poor posture in school children. *Health, 2013*.

McLean, S. G., Huang, X., & van den Bogert, A. J. (2005). Association between lower extremity posture at contact and peak knee valgus moment during sidestepping: Implications for ACL injury. *Clin Biomech (Bristol, Avon), 20*, 863-870.

Muyor, J. M., López-Miñarro, P. A., & Alacid, F. (2013). The Relationship Between Hamstring Muscle Extensibility and Spinal Postures Varies With the Degree of Knee Extension. *Journal of Applied Biomechanics, 29*(6), 678-686.

Paušić, J. (2007). Konstrukcija i vrednovanje mjernih postupaka za procjenu tjelesnog držanja u dječaka dobi od 10 do 13 godina. *Doktorska disertacija. Kineziološki fakultet Sveučilišta u Zagrebu*.

Poussa, M. S., Heliövaara, M. M., Seitsamo, J. T., Könönen, M. H., Hurmerinta, K. A., & Nissinen, M. J. (2005). Development of spinal posture in a cohort of children from the age of 11 to 22 years. *European Spine Journal, 14*(8), 738-742.

Simov, S. B., Milinić, S. M., & Stojanović, D. O. (2011). Učestalost pojave lošeg držanja tela i ravnih stopala kod dece predškolskog uzrasta. *Apollinem Medicum et Aesculapium, 9*(2), 5-8.

Straker, L. M., O'Sullivan, P. B., Smith, A., & Perry, M. (2007). Computer use and habitual spinal posture in Australian adolescents. *Public health reports, 122*(5), 634.

Torlaković, A., Muftić, M., & Kovač, S. (2013). A correction of posture of pre-school girls under the impact of various kinesyological operators. *Homo Sporticus, 15*(2).

Widhe, T. (2001). Spine: posture, mobility and pain. A longitudinal study from childhood to adolescence. *European Spine Journal, 10*(2), 118-123.

This research was carried out with the grant of the IPA Cross-Border Cooperation Project: "Improving Testing Abilities on Postural and Spinal Column Status - SpineLab"

Corresponding author:
Alen Ćirić, MA
Faculty of Sport and Physical Education,
University of Sarajevo
Bosnia and Herzegovina
Mob: 061/220-068
E-mail: alenciric@outlook.com