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Original research article

**SPINAL CORD POSTURE IN THE SAGITTAL PLANE
AMONG YOUNG SCHOOLCHILDREN RESIDING
IN THE AREA OF KNJAŽEVAC***UDC 613.71/.72 (497.11)***Bojan Jorgić¹, Marina Milenković², Slavko Ždrale³, Saša Milenković¹,
Ratko Stanković¹, Saša Bubanj¹**¹Faculty of Sport and Physical Education, University of Nis, Serbia²February 12th Technical High School, Niš, Serbia³Faculty of Physical Education and Sport, University of East Sarajevo,
Bosnia and Herzegovina

Abstract. *In determining the postural status of the spinal column of preschool age children or young school age children, early detection of bad posture is necessary, so that it could be rectified through the proper corrective exercise. The aim of this study is to determine the state of the postural disorders of the spinal column, viewed in the sagittal plane, on a population of preschool children, and young school age children, living on the territory of the municipality of Knjaževac. The sample of participants consisted of 515 young school age and 125 preschool children. In order to determine the postural status of the spinal column in the sagittal plane, we used the 'Spinal Mouse' measuring instrument. The results have shown that in both age groups, more than 50% of the children have some form of postural disorder in the sagittal plane. The most widely distributed disorders are the kyphotic and lordotic posture, followed by kypholordosis. In terms of gender, younger school age girls have a more pronounced kypholordotic posture when compared to the boys, with 6% and 1.6% respectively. The frequency of the other postural disorders is almost identical. In the case of female preschool children, the kyphotic posture is more predominant, while in the case of the boys the lordotic posture is more frequent. The obtained data are important for designing a proper corrective gymnastics program for the improvement of the postural status of the spinal column in the sagittal plane of children living in Knjaževac.*

Key words: *kyphosis, lordosis, straight back, gender, differences*

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Corresponding author: Bojan Jorgic

Faculty of Sport and Physical Education, University of Niš, St. Čarnojevića 10a, 18000 Niš, Serbia

Phone: +381 18 510900 • E-mail: bojanjorgic@yahoo.com

INTRODUCTION

Viewed in the sagittal plane, the spinal column consists of four physiological curves, including: neck lordosis, chest kyphosis, lumbar lordosis and the lumbar – tail curvature of the spine (Živković, 2009). From the standpoint of proper posture, the shape of the chest kyphosis and lumbar lordosis are very important. The aforementioned curves have their specific angles which are permitted and desired in order for the spinal column to be able to properly counteract the force of gravity and to properly distribute the weight of the upper body. Every deviation from proper posture or increase or decrease in the physiological kyphosis and lordosis leads to deformities of the spinal column. The most frequent among these deformities are: kyphosis and lordosis, followed by kypholordosis, a round and flat back (Milenković, 2007). The deformities of the spinal column can be functional and structural. In the case of functional deformities, changes are made to the muscles and tendons, and such forms of improper posture are referred to as kyphotic and lordotic posture. In addition to the muscles and tendons, the joints and vertebra are also affected, that is, the entire locomotor apparatus, which then leads to structural or fixed deformities.

Kyphotic posture and structural kyphosis are postural disorders located at the active and passive elements of the spinal column, which is reflected in the pronounced curve in the chest (thorax). The convexity of this curvature is directed towards the back, so that in the case of pronounced and more difficult cases, it is manifested as a kind of hump, and this physical deformity is commonly referred to as a stooping posture (Milenković, 2007). The clinical picture of the kyphotic posture consists of several elements: the head is bent forward, across the vertical line, the shoulders are moved forward and down, the sternum curvature is increased, and its flexibility is decreased, the chest is either flat or concave, the shoulder blades are moved away from the spine and the back part of the thorax (scapulae alatae), the abdomen is wobbly and protruded, the knees are slightly flexed and as a whole project forward while the feet show the first signs of weakness – insufficiency (Živković, 1998).

Lordotic posture and structural lordosis represent postural disorders in the lumbar portion of the spinal column, characterized by an increased lordotic curve with a convex feature facing forward. The clinical picture of this disorder has the following characteristics: the head is tilted backward, behind the vertical line, the chest is flat or slightly protruded, the lumbar curve is increased, the pelvis is moved forward and downward, the inclination of the pelvis is enhanced, the abdomen is wobbly and protruded, the hips are protruding forward, the knees are hyperextended and the feet are passive, insufficient, with more or less pronounced features of flat-footedness (Koturović & Jeričević, 1988).

Kypholordosis is a deformity of the sagittal plane, which occurs as an increase in the chest and lumbar curve which extends the physiological boundaries. A flat back represent a disorder which is characterized by a lack of physiological curvature of the spinal column.

Determining the postural status of the spinal column of children of the preschool age and young school age children is important for the early detection of bad posture, while the deformities are still in the functional stage, so that they could be rectified with using appropriate, corrective exercise.

Thus, the aim of this research is to determine the state of postural disorders of the spinal column viewed from the thorax and lumbar region of the spinal column in the sagittal plane among preschool children and young school age children living on the territory of the Knjaževac municipality.

METHODS

Subjects

This study included 515 young school age children, first to fourth grade students of elementary schools in Knjaževac and 162 preschool children. Prior to testing, parental permission was obtained.

Procedure

In order to evaluate the state of the postural status of the spinal column in the sagittal plane, we used the 'Spinal Mouse' (Idiag, Fehraltorf, Switzerland, www.idiag.ch) measuring instrument. It is a non-invasive method of measuring postural status, along with the use of the appropriate software. The validity and reliability of this instrument was evaluated in the research of Mannion, Knecht, Balaban, Dvorak & Grob (2004) and Post & Leferink (2004). This method of determining the state of the postural status of the spinal column was already used in studies carried out on the population of school age children (Bubanj, Živković, Živković, Milenković, Bubanj et al., 2012).

Statistical analysis

All of the data will be shown as frequencies in terms of percentages. In order to determine whether there was any statistically significant differences in the distribution of the spinal column deformities in the sagittal plane in comparison to the normal postural status in the thorax and lumbar part of the spinal column, the Chi square test was used.

RESULTS

Tables 1 – 4 show the results obtained for the young school age children.

Table 1 The postural status of the spinal column in the sagittal plane among school age children

Variables	Frequency	Percent
N	189	36.7
KIF	96	18.6
LOR	76	14.8
PRL	134	26.0
KL	20	3.9
Total	515	100.0

N – no deformity, KIF – kyphotic posture, LOR – lordotic posture,
PRL – a flat back, KL – kypholordosis

The results shown in table 1 indicate that the younger school age children most frequently suffer from postural disorders related to a flat back, followed by kyphosis, then lordosis and finally kypholordosis.

Some authors (Milenković, 2007; Živković, 2009) consider a flat back not to be a postural disorder, and when calculating statistically significant differences in terms of the number of children with and without postural disorders in the sagittal plane omit the PRL variable, that is, the flat back deviation.

Table 2 shows the results of the Chi square test without the PRL variable. The obtained results indicate that there is no statistically significant difference in the number of children with and without postural disorders of the spinal column in the sagittal plane.

Table 2 The results of the Chi square test

Variables	Frequency	Percent	Chi square test	
N	189	49.6	Chi-Square	0.024
DEF	192	50.4	df	1
Total	381	100.0	Asymp. Sig.	0.878

N- no deformity, DEF- overall postural disorders
(kyphotic and lordotic posture, and kypholordosis, without a flat back deviation)

Table 3 The state of postural disorders in the sagittal plane among young school age boys

Variables	Frequency	Percent
N	98	39.4
KIF	45	18.1
LOR	38	15.3
PRL	64	25.7
KL	4	1.6
Total	249	100.0

N - no deformity, KIF – kyphotic posture, LOR – lordotic posture,
PRL – a flat back, KL – kypholordosis

Table 4 The state of postural disorders in the sagittal plane in the case of the young school age girls

Variables	Frequency	Percent
N	90	33.8
KIF	49	18.4
LOR	42	15.8
PRL	69	25.9
KL	16	6.0
Total	266	100.0

N – no deformity, KIF – kyphotic posture, LOR – lordotic posture,
PRL – a flat back, KL – kypholordosis

Tables 3 and 4 show the results for the young school age boys and girls separately. In the case of the girls, a greater number of kypholordotic disorders can be noted than in the case of the boys, while in the other postural disorders there is equal distribution.

Tables 5 to 8 show the results obtained for the preschool age children.

Table 5 The postural status of the spinal column in the sagittal plane among the preschool children

Variables	Frequency	Percent
N	44	35.2
KIF	27	21.6
LOR	17	13.6
PRL	33	26.4
KL	4	3.2
Total	125	100.0

N – no deformity, KIF – kyphotic posture, LOR – lordotic posture, PRL – a flat back, KL – kypholordosis

The results shown in table 5 indicate that among the preschool children as well as the young school age children the most frequent postural disorders were the flat back, followed by kyphosis and then lordosis and finally kypholordosis.

As in the case of young school age children, when calculating the Chi square test the PRL variable was omitted. The obtained results shown in table 6 indicate that there is an equal number of preschool age children with without postural deformities in the sagittal plane.

Table 6 The results of the Chi square test

Variables	Frequency	Percent	Chi square test	
N	44	47.8	Chi-Square	0.174
DEF	48	52.2	df	1
Total	92	100.0	Asymp. Sig.	0.677

N – no deformity, DEF – overall postural disorders (kyphotic and lordotic posture, and kypholordosis, without a flat back deviation)

Tables 7 and 8 show the results for the preschool boys and girls separately.

Based on the obtained results we can note that among the boys lordosis is more prominent, while among the girls kyphosis is more prominent. In addition, none of the tested girls showed signs of kypholordosis.

Table 7 The state of postural disorders in the sagittal plane for the preschool age boys

Variables	Frequency	Percent
N	26	37.1
KIF	8	11.4
LOR	15	21.4
PRL	17	24.3
KL	4	5.7
Total	70	100.0

N – no deformity, KIF – kyphotic posture, LOR – lordotic posture, PRL – a flat back, KL – kypholordosis

Table 8 The state of postural disorders in the sagittal plane among the preschool girls

Variables	Frequency	Percent
N	18	32.7
KIF	19	34.5
LOR	3	5.5
PRL	15	27.3
KL	0	0
Total	55	100.0

N – no deformity, KIF – kyphotic posture, LOR – lordotic posture,
PRL – a flat back, KL – kypholordosis

DISCUSSION

Among the young school age children, the obtained data indicate an overwhelming presence of postural disorders such as kyphosis and lordosis, as well as kypholordosis. As much as 50.4% of all children suffer from one of these disorders. The PRL variable, which refers to children whose spinal column tends towards the flat back, was not included in the Chi square test, because the situation would have been more alarming. The PRL variable was not calculated since it is not a proper postural disorder, and is more a type of muscle weakness which should be treated using the appropriate exercise program for strengthening the musculature of the body (Milenković, 2007). Dragić, Midić, & Midić (2012), in a similar study carried out on a sample of 435 young school age children on the territory of Vršac, determined an even greater number of children with some kind of postural disorder in the sagittal plane, more precisely 83.9%. The reason why there were so many afflicted children might be that the sample included children from a special school, a population of children among whom postural disorders are more pronounced. A somewhat greater number of young school age children with postural disorders in the sagittal plane than the one determined in this study can be found in the study of Protić – Gava, Šćepanović, Jevtić, & Kadovi, (2011). They determined that 67.3% of children have a postural disorder. Hodžić, Gerdijan, Mikić, & Katanić, N (2010) also determined that more than 50% of young school age children, more precisely, 53.6% of them have a postural disorder of the spinal column, with the difference that scoliosis was determined in 9.6% of the cases, a deformity not included in this study. A somewhat smaller, but more disconcerting percentage of 43% of girls with a postural disorder was determined in the study of Beganović & Bešović (2012).

In terms of gender, girls have a more pronounced kypholordotic body posture when compared to boys, with values of 6% and 1.6%, respectively. The frequency of the other postural disorders is almost identical. Similar to the results obtained in this study, Protić-Gava & Krneta (2010) and Đokić, Međedović, & Smiljanić (2011) found no significant differences in postural disorders in terms of gender.

In the preschool age and young school age groups, there is more than 50% or more precisely 52.2% of children with a postural disorder of the spinal column in the sagittal plane. The PRL variable, which has the same frequency for both the girls and boys, was not taken into consideration. Most of the children suffer from kyphotic disorders, then lordotic disorders, and least of all kypholordosis. Postural disorders of the sagittal plane were also determined for children of the preschool age in the study of Romanov, Stupar, Međedović, & Brkin (2014), in as many as 45.86% of children, which is only a slightly smaller percent than the one determined in this study. Unlike in the current study, Simov,

Minić, & Stojanović (2011) determined, based on their analysis of a sample of 968 preschool children, that only 10.03% of the children had postural disorders. In the case of distribution in relation to gender, among the boys there was evidence of a greater frequency of lordotic posture, while among the girls kyphotic posture was more pronounced. These results partly match those of Romanov et al. (2014). These authors also determined more extensive lordotic postures among boys.

Exercise programs should be put into effect as soon as possible, so that the existing disorders could be reduced to a minimum before children enter puberty. The positive effects of properly organized and realized corrective exercise programs among young school age children were confirmed in numerous studies (Protić-Gava, Krneta, Bošković, & Romanov, 2010; Gojković & Fulurija, 2012).

CONCLUSION

Based on the obtained results, we can conclude that many young children (over 50%), living on the territory of the Knjaževac municipality have postural disorders in the sagittal plane in the thoracic and lumbar portion of the spinal column. At the same time, kyphotic posture is the most frequent, followed by lordotic posture and kypholordosis. The obtained data are very disturbing and require the application of appropriate corrective exercise programs.

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POSTURALNI STATUS KIČMENOG STUBA U SAGITALNOJ RAVNI KOD MLAĐE DECE NA PODRUČJU KNJAŽEVCA

Utvrđivanje posturalnog stusa kičmenog stuba kod dece predškolskog i mlađeg školskog uzrasta je bitno zbog ranog otkrivanja lošeg držanja kako bi ono moglo da se ispravi odgovarajućim korektivnim vežbama.

Cilj ovog istraživanja je utvrditi stanje posturalnih poremećaja na kičmenom stubu posmatrano u sagitalnoj ravni kod dece predškolskog i mlađeg školskog uzrasta koja žive na teritoriji Opštine Knjaževac. Uzorak ispitanika je činilo 515 dece mlađeg i 125 dece predškolskog uzrasta. Za utvrđivanje posturalnog statusa kičmenog stuba u sagitalnoj ravni korišćen je merni instrument „Spinal Mouse“. Rezultati su pokazali da kod obe starosne grupe dece ima više od 50% dece koja imaju posturalne poremećaje na kičmenom stubu posmatrano u sagitalnoj ravni. Najzastupljeniji su kifotično i lordotičnog loše držanja tela, a zatim kifolordoza.

Posmatrano u odnosu na pol, devojčice mlađeg školskog uzrasta imaju zastupljenije kifolordotično loše držanje tela u odnosu na dečake 6% u odnosu na 1.6%. Zastupljenost ostalih posturalnih poremećaja je gotovo indentična. Kod predškolskog uzrasta, kod devojčica je zastupljenije kifotično loše držanje tela, dok je kod dečaka zastupljenije lordotično loše držanje tela. Dobijeni podaci su od značaja, u smislu sprovođenje odgovarajućeg programa korektivne gimnastike za poboljšanje posturalnog statusa kičmenog stuba u sagitalnoj ravni kod mlađe dece koja žive u Knjaževcu.

Ključne reči: kifoza, lordoza, ravna leđa, pol, razlike