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Scoliosis, life style and low back pain in adolescents

Skolioza, način života i bol u donjem delu leđa kod adolescenata

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Abstract

Background/Aim. Various internal and external factors could have an influence on the appearance of scoliosis and other postural disturbances in adolescents. The aim of this study was to investigate the correlation between scoliosis and other postural disturbances, physical activity, nutritional habits, as well as its association with comorbidities and age. **Methods.** This cross-sectional study involved 212 adolescents with the average age of 12.74 ± 1.34 years that were selected by a random selection of attended class of elementary school. A modified "The Physical Activity and Postural Disturbance Test" was used for the study. For statistical analysis Pearson's test of correlation and linear regression were used to estimate the association between scoliosis and postural disturbances, age, and physical activity, nutritional habits and comorbidities in adolescents. **Results.** It was shown that there was a statistically significant association between scoliosis and age (r = 0.228, $p < 0.05$), a significant negative correlation with lordosis (r = -0.207, $p < 0.05$) and a statistically significant positive correlation between scoliosis and flatfoot (r = 0.279, $p < 0.01$), *metatarsus varus* (r = 0, 2, $p < 0.05$) and low back pain (r = 0.304, $p < 0.05$). The results of linear regression with the scoliosis, as a dependent variable, and low back pain and other diseases as independent variables have shown that low back pain was significantly associated with scoliosis ($p < 0.05$). **Conclusion.** Scoliosis in adolescents is significantly associated with age and postural disturbances, especially with foot postural disturbances, as well as with low back pain.

Key words:
adolescents; back, pain; body, posture; risk factors; scoliosis; spine, curvatures.

Apstrakt

Uvod/Cilj. Različiti unutrašnji i spoljašnji faktori bi mogli uticati na pojavu skolioze i drugih posturalnih poremećaja kod adolescenata. Cilj studije bio je da se istraži korelacija između skolioze i drugih posturalnih poremećaja, fizičke aktivnosti, navika u ishrani, kao i njena udruženost sa godinama života i komorbiditetima. **Metode.** Studijom je bilo obuhvaćeno 212 adolescenata prosečne starosti 12,74 ± 1,34 godina, koji su selektovani metodom slučajnog izbora razreda koji su pohađali u osnovnoj školi. Za istraživanje je korišten modifikovani „Test fizičke aktivnosti i posturalnih poremećaja". Za utvrđivanje udruženosti skolioze i posturalnih poremećaja, godina starosti, fizičke aktivnosti, navika u ishrani i komorbiditeta kod adolescenata korišćeni su Pearson-ov test korelacije i linearna regresija. **Rezultati.** Utvrđena je statistički značajna pozitivna korelacija između skolioze i godina života (r = 0,228, $p < 0,05$), značajna negativna korelacija sa lordozom (r = -0,207, $p < 0,05$), pozitivna sa ravnim stopalom (r = 0,279, $p < 0,01$), deformitetom stopala *metatarsus varus* (r = 0,2, $p < 0,05$) i bolom u donjem delu leđa (r = 0,304, $p < 0,05$). Rezultati linearne regresije sa skoliozom kao zavisnom varijablom, a bolom u donjem delu leđa i drugim oboljenjima kao nezavisnim varijablama, pokazali su da je bol u donjem delu leđa značajno udružen sa skoliozom ($p < 0.05$). **Zaključak.** Skolioza kod adolescenata je značajno udružena sa godinama života i posturalnim poremećajima, posebno sa posturalnim poremećajima stopala, kao i sa bolom u donjem delu leđa.

Ključne reči:
adolescenti; leđa, bol; telo, držanje; faktori rizika; skolioza; kičma, krivine.

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Introduction

The term posture represents a complex of different domains (psychological, kinesiological, biomechanical and physiological). This is the reason of disagreements about the definition, diagnosis and means of treating various disorders. Optimal load on the skeletal system, balance between antagonistic muscle groups, optimal activity of musculoskeletal system and internal body systems are essential for the maintenance of normal posture. Various external and internal factors during growth and development can influence the occurrence of postural disturbances (reversible and irreversible) of the spine (scoliosis, kyphosis, lordosis) and lower extremities [1, 2].

Structural scoliosis is a three-dimensional deformity of spine with lateral curvature, changes in sagital profile end rotation in transversal plane. These lead to the appearance of truncal asymmetry with rib or lumbar prominence on the convex side of curvature. Functional scoliosis refers to a disorder in which there are no structural changes in the spine, so it has a better prognosis than structural scoliosis [3–5]. Scoliosis appears in 2–3% of population [6], but when a smaller angle of curvature (less than 10°) is taken for the definition of scoliosis [7], a significantly higher prevalence of scoliosis is registered (4.5%) [8]. Functional scoliosis is completely reversible in comparison to structural scoliosis that is mostly idiopathic scoliosis (around 90%). Scoliosis can cause serious health problems, as well as the back pain, make difficulties in breathing, disturbance of lung and heart function, psychological and social problems [7–9].

The angle of thoracic kyphosis is normally 20–40°, measured by Cobb method from Th2-Th12 [10]. Poor posture with kyphotic postural disturbance is characterized by complete correction.

Lumbal lordosis is the key postural component. Physiological lordosis is determined with the specific characteristics of every person [7].

Several studies suggested that the pediatric flatfoot as a postural disorder in the lower extremities is a frequent presentation in clinical practice [11, 12]. Potential pain and disability are the reasons to discuss the prevention and treatment of this problem.

Physical activity is necessary for normal growth and development of children. Fast growth in adolescence is associated with muscle disbalance and insufficiency. Increased sedentary activities could be the reason for poor physical condition of adolescents. Lack of physical activity is in direct relation with health problems in childhood years, as well as obesity, metabolic diseases and poor health status of musculoskeletal system [7, 13].

Results of studies confirm that regular physical activity is useful for health. Also, participation in sports activities of high level can influence the occurrence of postural disturbances and functional painful syndromes. Strenuous physical activity can cause structural changes: increased angle of thoracic kyphosis, lumbar lordosis associated with higher cumulative time of training and certain type of sport, as well as the presence of back pain [14].

Back pain is often present in children. The occurrence of the back pain is increased with age, especially in the early period of adolescence [15, 16].

The increase of sport activities and improvement of the eating behavior in childhood are identified as the target for future policy and health care planning [13]. Previous studies reported different results of researches concerning recommended guidelines from at least one hour, to moderate and intensive everyday physical activity [17–19]. The SPEEDY study (Sport, Physical activity and Eating behavior: Environmental Determinants in Young people) also studied the level of physical activity and eating behaviors in the large population of children aged 9–10, as well as individual and collective factors associated with these habits [20]. There are reports in literature about risk factors for the development of scoliosis and other postural disturbances [21, 22], about diagnostics and therapy of scoliosis [5, 23, 24], about the treatment of the other postural disturbances [1], physical activity and eating behavior in children with scoliosis [20], other postural disturbances [25], back pain in children and the causes of the pain [14, 16, 25, 26].

However, a little is known about the association between scoliosis and other postural disturbances, the association between scoliosis and physical activities, eating behavior, back pain and other diseases that could help in the identification of risky groups and promotion of changes in the domain of health behavior and habits. That is why the aim of this study was to examine the association between scoliosis and other postural disturbances, scoliosis and physical activity, scoliosis and eating behavior, as well as its association with comorbities (back pain and other diseases).

Methods

This cross-sectional study included 212 adolescents, average age of 12.74 ± 1.34 years (range of 10 to 14 years). The sample of children included elementary-school pupils from Banjaluka region, of a certain age, who were selected randomly by the attended class of elementary school (Table 1).

The exclusion criteria were the presence of congenital musculoskeletal deformities, neuromuscular diseases and injuries that resulted in deformities and/or changes of the function of the musculoskeletal system.

All the participants underwent a standardized physical examination of the spine and feet [5, 12] and a modified "The Physical Activity and Postural Disturbance Test" was used for each participant [9]. This test includes two parts: 'The Physical Activity Test' with the questions from the domain of physical activity, eating behaviors and comorbidities and 'The Test of Postural Disturbances' (screening on scoliosis, neck asymmetry, kyphosis, lordosis, flatfoot, *metatarsus varus*).

The domain of physical activity was related to the questions about the average time that children spent every day walking, participating in sports, learning and sitting in front of a computer. The domain of eating behaviors contains the questions about the variety of foods in nutrition and about appetite. The domain of comorbidities contains the information about the presence of the back pain and other diseases (a chronic

Table 1

Characteristics of study participants (n = 212)

Parameter	Adolescents	Total number of postural dysfunctions
Age (years), mean ± SD	12.74 ± 1.34	
Sex, n (%)		
girls	164 (77.3)	212
boys	48 (22.7)	
Sport, n (%)		
active participation	35 (16.51)	212
regular activity	177 (83.49)	
Postural disturbances, n (%)		
neck asymmetry	30 (14.15)	30
scoliosis		
functional	56 (87.5)	64
structural	8 (12.5)	
kyphosis		
functional	30 (76.9)	39
structural	9 (23.1)	
lordosis		
functional	42 (85.71)	49
structural	7 (14.29)	
flatfoot	90 (42.45)	90
metatarsus varus	8 (3.77)	8
Total		280

SD – standard deviation.

illness, as well as a chronic illness of respiratory organs, allergy, visual, hearing, heart problems).

The diagnosis of postural disturbances was based on visual screening of the spine and feet with the required Adams bending's test performed in scoliosis, test of reclination with contraction of the back extensor muscles in kyphosis and test with contraction of abdominal muscles in lordosis. Children were classified as having normal findings (estimated "0"), flexible postural disturbance or mild asymmetry (grade "1") or structural, clear, nonflexible deformity or asymmetry (grade "2"). The average time spent on a certain physical activity related to the average duration of activities every day (we did not consider the time spent in school): learning, sitting in front of a computer longer than 2 hours, the duration of walking less than 1 hour and the time spent in moderate to intensive physical activity less than 1 hour, we recorded as "1". With "0" we recorded the time spent on sedentary activities in duration less than 2 hours, walking one or more hours daily, and having moderate to intensive physical activity one or more hours every day.

We marked active participation in sport with "1"and regular activities of children of the same age with "0". If children declared that they consumed variety of foods in nutrition, this parameter was marked with "0" and if they did not, with "1".

If children did not have back pain and other diseases, this parameter was marked with "0", but if they did, it was marked with "1".

Informed consent was obtained from all subjects. All parameters that were collected and testing procedures are the part of the regular clinical and ethical procedures with children and medical practice. Study methods were approved by the institutional Ethics Committee.

For statistical analysis, we used software package SPSS 17. Statistical significance of differences was set on the level of $p < 0.05$.

Results

Characteristics of the study participants and postural disturbances, diagnosed in adolescents from the examined sample are presented in Table 1. We diagnosed the total of 280 postural disturbances, mostly flatfoot. The percentage of scoliosis was smaller in adolescents who participated in sports activities than in those who did not.

Correlation between the occurrence of scoliosis and other postural disturbances is presented in Table 2. The results of the study showed that there was a significant, but weak correlation between scoliosis and the age of

Table 2

Correlation between the presence of scoliosis and other postural disturbances (n = 212)

Tested correlations	r	*p*
Scoliosis - age	**0.228**	**< 0.05**
Scoliosis - neck asymmetry	-0.227	> 0.05
Scoliosis - kyphosis	0.145	> 0.05
Scoliosis - lordosis	**-0.207**	**< 0.05**
Scoliosis - flatfoot (*pes planus*)	**0.279**	**< 0.01**
Scoliosis - *pes metatarsus varus*	**0.200**	**< 0.05**

***Note*: Significant correlations are bolded.**
r – Pearson's test of correlation.

adolescents (r = 0.228, $p < 0.05$), scoliosis and flatfoot (r = 0.279, $p < 0.01$), scoliosis and *pes metatarsus varus* (r = 0.2, $p < 0.05$), and a negative correlation between scoliosis and lordosis (r = -0.207, $p < 0.05$).

Scoliosis and back pain statistically significantly correlated (r = 0.304, $p < 0.05$) (Table 3), but other examined parameters did not show a significant correlation.

The results of linear regression (Table 4) showed the association between scoliosis (as a dependent variable) and other postural disturbances (F = 5.467, $p < 0.001$). We found a significantly higher association between scoliosis and flatfoot ($t = 4.155$, $p < 0.001$), as well as *pes metatarsus varus* ($t = 2.090$, $p < 0.05$) in relation to the other studied postural disturbances ($p > 0.05$).

In our study, there was no significant association between scoliosis and the domain and parameters of physical activities (walking, sport, learning, sitting in front of a computer), nor with the nutritional habits. The results of linear regression with scoliosis (as a dependent variable), back pain and other diseases (as independent variables), showed that scoliosis was significantly associated with low back pain ($t = 2.095$, $p < 0.05$).

Discussion

Postural disturbances in adolescence, especially scoliosis, are the subject of many studies, as well as of the studies of other factors that could have the influence on their occurrence and development.

We studied the occurrence of postural disturbances, the association between scoliosis and postural disturbances, and the influence of certain factors of a lifestyle on the appearance of scoliosis in adolescents. The results of our research showed that in adolescents the flatfoot was most frequently diagnosed (42.4%). It was followed by scoliosis (30.1%), lordosis (23.1%) and kyphosis (18.3%). Neck asymmetry was present in 14.15% and *pes metatarsus varus* in 3.77% of adolescents. There was higher percentage of functional spinal postural disturbances in relation to structural.

Our results are in accordance with the findings of a study carried out in Brazil in order to establish the prevalence of trunk postural deviations by visual methods on the sample of 864 scholars, 8 to 15 year-olds from the city schools [27]. Authors reported that the prevalence of postural disturbances was 16.6% for dorsal kyphosis, 27.9% for lum-

Table 3

Correlation between the presence of scoliosis and physical activity, nutritional habits and comorbidities (n = 212)

Parameters	Number (%) of adolescents	Tested correlations	r	*p*
Walking (< 2 h *per* day)	95 (44.9)	Scoliosis - walking	-0.216	> 0.05
Participation in sport	34 (16.3)	Scoliosis - sport	0.016	> 0.05
Learning (> 2h per day)	203 (95.9)	Scoliosis - learning	0.098	> 0.05
Sitting in front of a computer (> 2 h *per* day)	99 (46.9)	Scoliosis - sitting in front of computer	-0.024	> 0.05
Variety of foods in nutrition	199 (93.9)	Scoliosis - variety of foods in nutrition	-0.121	> 0.05
Appetite (good)	182 (85.7)	Scoliosis - appetite	0.108	> 0.05
Back pain	8 (3.8)	Scoliosis - back pain	**0.304**	**< 0.05**
Other diseases	56 (26.5)	Scoliosis - other diseases	-0.166	> 0.05

***Note*: Significant correlation is bolded.**
r – Pearson's test of correlation.

Table 4

Association between scoliosis (as a dependent variable) and physical activity, nutritional habits and comorbidities – linear regression (n = 212)

Domain	F	*p*	*t*	*p*
Postural disturbances	**5.467**	**< 0.001**		
neck asymmetry			-0.227	0.114
kyphosis			1.064	0.293
lordosis			-0.806	0.425
flatfoot (*pes planus*)			**4.155**	**0.000**
pes metatarsus varus			**2.090**	**0.042**
Physical activity	0.685	> 0.05		
walking (< 2 h *per* day)			-1.442	0.156
sport			0.334	0.740
learning (> 2 h *per* day)			0.603	0.550
sitting in front of a computer (> 2 h *per* day)			-0.124	0.902
Nutritional habits	0.723	> 0.05		
variety of foods in nutrition			-0.947	0.349
appetite			0.865	0.391
Comorbidities	2.905	> 0.05		
back pain			**2.095**	**0.042**
other diseases			-1.006	0.320

***Note*: Significant associations are bolded.**

bar hyperlordosis and 33.2% for scoliosis. The ages of 8 to 12 were a risk factor for lumbar hyperlordosis. Scoliotic attitude did not show a significant association with the independent variables. The need for including preventive and therapeutic procedures was indicated in order to correct bad postural habits, which could cause irreversible damages in the future [27].

The results of the study aimed to identify the prevalence and the main risk factors of poor posture in school children in the Czech Republic have shown that poor posture was diagnosed in 38.3% of children, more frequently in boys [28]. The authors detected an increase in lumbar lordosis (32%), and round back (31%) in children. The prevalence of scoliosis was increased with age [28]. Our findings are in accordance with the results of these studies and have shown that there is a significant correlation between scoliosis and the age of children.

Many studies agree that rapid growth in puberty can be associated with asymmetrical growth of spine and the appearance of scoliosis [29–31]. We also explored the occurrence of association between scoliosis and other factors that could have the influence on the appearance of scoliosis or that could be associated with it, as well as physical activity, nutritional habits and comorbidities, which included the occurrence of the low back pain in adolescents aged about 13.

Flatfoot has been shown to cause abnormal stress on the foot and lower extremity. The results of our study have shown that there is a significant correlation between scoliosis and flatfoot, as well as between scoliosis and *metatarsus varus.*

We did not find studies that examined and found a significant correlation between scoliosis and flatfoot. However, a recently published cross-sectional study, which included 822 school children (mean age 12.2 ± 1.3 years), and was conducted with an aim to assess the prevalence of generalized joint hypermobility in school children in relation to scoliosis and to identify musculoskeletal problems, found no association between scoliosis and hypermobility [32]. All of the adolescents with scoliosis except one girl had mild scoliosis and among subjects having generalized joint hypermobility, the most common clinical finding was *pes planus* (34.3%).

These results are partly in accordance with our findings, although we have not assessed the presence of generalized joint hypermobility. The correlations between hypermobility and clinical symptoms are not clear. The authors concluded that generalized joint hypermobility should be considered in adolescents with scoliosis, which may be an important aspect of a treatment [32]. There is a report which showed that the occurrence of hypermobility was more frequent in patients with idiopathic scoliosis in comparison with healthy controls. Muscular weakness and ligament laxity are believed to contribute to the development of spinal deformity [33].

One study indicated that *pes planus* was one of the main features in children with generalized joint hypermobility [34]. However, there is a statement that this is not so only in these children, but in all children [32]. In the study conducted to estimate the prevalence of spine and feet deformities among children who are regularly involved in basketball trainings, the authors found that despite regular participation in basketball training, subjects in this study had high prevalence of deformities (spinal deformities were present in 53.13% and feet deformities in 64.06%) [35].

A recently published study that included 667 of the school children aged between 7 and 14 in Iran has shown the prevalence of flatfoot of 17.1% in the population studied [25]. The differences in the results of this study in relation to our results could be due to various characteristics of the sample and methodology of the study, but also to various life habits in different cultural environments.

The results of linear regression have shown the association between scoliosis (as a dependent variable) and other postural disturbances. It can be seen that there is a significant association between scoliosis and flatfoot, as well as *pes metatarsus varus* in relation to other examined postural disturbances. It is difficult to explain these findings etiologically, so for an explanation future studies are needed.

There are different reports about the results of the studies on adhering to the recommended guidelines for at least of 1 hour of moderate to intensive everyday physical activity [17–19]. A recently published study reported that there is a relationship between the physical activity of a child and the occurrence of postural defects [21]. The percentage of scoliosis in relation to participation in sports was smaller in the group of the adolescents who participated in sports activities (28.6% in regard to the adolescents who did not 30.5%), but in our research we did not obtain a significant association between scoliosis and the domain and parameters of physical activity (walking, sport, learning, sitting in front of a computer). The variation in the results of studies mostly depends on the characteristics of the participants included in the study and on the applied research method. However, in the majority of studies the results have shown that the level of physical activity decreases with age, especially in children at final elementary school age. This period is potentially important for the use and promotion of health protection procedures, as well as for doing sports activities. It is reported that, on average, children spent 4 hours weekly participating in sports activities and 14 hours weekly watching TV or playing computer games. In the group of children that did not do sport there was a significantly higher probability of the occurrence of poor posture than in children doing sport [28]. In our research, the percentage of scoliosis, kyphosis, lordosis and flatfoot was lower in adolescents that participated in sports activities than in their peers who did not.

However, one recently published article reported that performing competitive sports can be significantly associated with scoliosis [22]. The authors of cross-sectional study that examined the prevalence of spinal deformities and low back pain in adolescent competitive swimmers (n = 112) and normal controls (n = 217) of the same age (12.5 years), reported that competitive swimming was associated with the increased risk for trunk asymmetries, hyperkyphosis and with increased low back pain in females by 2.1-fold. Although

swimming was discussed as an option in the treatment of scoliosis, these results showed contrary [36].

Scoliosis is not significantly associated with the variety of foods in nutrition in our research. There are reports about the association between the nutritional status and scoliosis in children in other studies [37, 38]. Patients with idiopathic scoliosis had significantly lower weight compared with healthy controls [38].

Scoliosis and low back pain significantly correlate in our study. Parameters of physical activities (walking, sport, learning, sitting in front of a computer) do not show a significant correlation with scoliosis, which also holds for parameters from the domain of nutritional habits (variety of foods in nutrition, appetite) and from the domain of comorbidities (other diseases). These results are in accordance with other studies that reported that children with poor posture had reported pain in the lumbar spine more frequently [4, 14, 28, 39].

Scoliosis in children is considered to be painless. However, the true prevalence of back pain in scoliosis is essentially unknown. It is commonly accepted that every child who has scoliosis and reports back pain should be examined thoroughly, especially if the patient has a painful left thoracic curve. The association between scoliosis and back pain has been demonstrated in the study which found that 23% of patients with adolescent idiopathic scoliosis at the initial time of presentation had back pain, and that an additional 9% developed back pain during the period of observation [40].

The presence of scoliosis was found on radiographs in 18% (16/87) of patients in one study. Five out of 16 (31%) patients had no other underlying pathology to explain their symptoms, and therefore, scoliosis was considered to be the direct cause of their back pain. [41].

Scoliosis is significantly associated with the low back pain in our study. An increased number of adolescents with back pain, which is associated with static physical activity, as well as with standing, sitting or weightlifting during daily activities, was reported. The yearly incidence of back pain during growth increases from 12% at the age of 11 to 22% at the age of 15. Idiopathic scoliosis is not related to back pain, even in big curves, but significant thoracolumbar or lumbar scoliosis can be painful itself because of asymmetrical load of the muscles [14].

A recently published study included 116 adolescents with the average age of 13.6 years suffering from spinal pain and reported that there were 32 cases of non-specific low back pain, 31 of lumbar or thoracolumbar scoliosis and 23 of Scheuermann's disease [42]. The study in which the prevalence of the low back pain was examined on the sample that included 966 adolescents from Portugal, aged between 10 and 16, and association with risk factors, showed that 152 (15.7%) of adolescents had low back pain at the present time and 456 (47.2%) had experienced it in the last year [43]. The authors reported that low back pain is a common condition in children and adolescents, and the prevalence has been increasing over the years.

Students who sit with the spine incorrectly positioned have 2.49 times greater probability of experiencing low back pain. Those who adopt an incorrect standing posture have a 3.39 times greater chance of experiencing low back pain [43].

Conclusion

The results of our research have shown that scoliosis is significantly associated with postural disturbances and with low back pain. These results could be of significance for planning preventive, diagnostic and therapeutic procedures that would include changes in behavior and habits in adolescence, as well as creating the system of education (parents, teachers and children) in regard to postural disturbances, risks and factors that could be associated with them.

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