

## Importance of etiological factors in the development of suspected structural spine variations

Kraljević B<sup>1,2</sup>

<sup>1</sup>University of Montenegro, Faculty of Medicine (Applied Physiotherapy), Igalo

<sup>2</sup>Professional Medical School, Podgorica  
Montenegro

### Abstract

**Background:** Structural spine changes are the frequent musculoskeletal disorders occurring in the human body in the form of scoliosis, hypo- or hyper-kyphosis, hypo- or hyper-lordosis, or a combination of the above.

**Methods:** In this retrospective, observational-comparative study, we included 240 third- and fifth-grade primary school pupils of both sexes and different daily life habits from four schools in the South and North of Montenegro. Data collected included children's posture examination conducted by a qualified professional. The testing procedure included standing position inspection, elasticity test application for the iliopsoas muscle, Adam's test, and the curve rigidity test. To analyze the differences between individual groups for categorical and continuous variables, we used the chi-square test and Student's t-test for independent samples, respectively.

**Results:** We did not observe a significantly higher prevalence of suspected scoliosis among male participants who did not engage in sports activities. The presence of suspected scoliosis in participants from the South is significantly higher than in their peers from the North of Montenegro. A significantly higher prevalence of suspected scoliosis was observed among female participants who did not engage in sports activities. Suspected spinal variations are significantly more frequent among participants from the South of Montenegro ( $p < 0.001$ , Cramer's  $V = 0.319$ ) and significantly more frequent in females with lower sports engagement ( $\chi^2 = 3.941$ ,  $p = 0.042$ ). This fact could be attributed to the slower development of the central nervous system and motor control in girls in combination with their engagement in less physical activity.

**Conclusion:** The findings of this study impose doubt that multifactorial etiology, including gender, child's age, engagement in sports activities, and the manner of conducting daily activities, is crucial for developing spinal deformities and may facilitate future studies and support preventive and therapeutic procedures in treating postural changes. HIPPOKRATIA 2022, 26 (4):147-151.

**Keywords:** Spine, variations, scoliosis, kyphosis, lordosis, etiology factors, sports activities, daily activities, gender, age

**Corresponding Author:** Bojan Kraljevic, PhD, Faculty of Medicine (Applied Physiotherapy), University of Montenegro, 85347 Igalo, Montenegro, tel: +38268552299, e-mail: bojankraljevic@t-com.me

### Introduction

The most common musculoskeletal disorder in children is idiopathic scoliosis which provokes a three-dimensional spine deformity. Early detection is essential<sup>1</sup>. The school screening programs still play a vital role in enabling early diagnosis, as indicated by recent definitive evidence regarding the efficacy of bracing treatment in delaying the scoliotic curves' progression and thus preventing the need for surgery<sup>2</sup>. Scoliosis, although defined as a lateral spine curve in the frontal plane, in fact, changes occur in all three dimensions. In addition to the frontal plane lateral spinal curvature, there is transverse plane vertebral rotation and sagittal plane changes<sup>3</sup>. In the literature, the percentage of idiopathic in all scoliosis varies, ranging in the reports from 75 to 80 %<sup>4,6</sup>. Scoliosis of known cause can be congenital and acquired<sup>7</sup>.

In general, according to the Society on Scoliosis Orthopedic and Rehabilitation Treatment (SOSORT), conservative scoliosis treatment is based on physical therapy

application with kinesitherapy, intensive scoliosis rehabilitation, and treatment with brace<sup>8</sup>. It is important for the prognosis of scoliosis treatment to know, among other factors, at what growth age the spinal deformity was initially observed<sup>9</sup>. Properly selected and adequately applied sports games can have a significant preventive and curative effect, can affect the elimination of minor deformities, and affect the recovery and restore impaired functions, including positive psychological and social effects<sup>5</sup>. SOSORT guidelines regarding the correlation of children with scoliosis and playing sports report that sports are not to be prescribed for treating idiopathic scoliosis but that general sports activities are applied to achieve psychological, neuromuscular, and general health-related benefits. Prevention should aim at minimizing the impact of risk factors that can cause deformities and applying methods to prevent their occurrence<sup>10</sup>. The results of a recently published study demonstrate the gender differences in muscular strength and joint flexibility, which

can cause differences in postural status during sitting between the genders<sup>11</sup>. However, additional studies' results indicate that gender has the highest association with adolescents' posture. Therefore, further research is needed to clarify the association between physical activity and posture<sup>12</sup>; thus, this study aimed to determine the association of suspected scoliosis with age, gender, sports activities, and place of residence of the participants. Our working hypothesis was that spinal variations in participants who engage in sports activities are less frequent in boys and less frequent among participants from the North of Montenegro.

### Material and Methods

We examined 488 schoolchildren from four schools in Montenegro, and their evaluation sheets were divided into two groups: Group I-participants from two schools from the North and Group II-participants from two schools from the South of Montenegro. In each group, the evaluation sheets were subdivided into subgroup I-third grade (eight years of age) and subgroup II-fifth grade (ten years of age). Each questionnaire was further classified into one of the following subgroups: subgroup A-boys and subgroup B-girls. Then, 15 boys and 15 girls from each subgroup were selected using a simple random selection method for each participating school. Participants who are engaged in some sports activity (Football, Karate, Basketball, Tennis, Folklore, Judo, Handball, Boxing) practiced usually two or three times per week.

Therefore, we included in this observational-comparative study randomly selected third- and fifth-grade primary school pupils of both sexes and different daily life habits from four schools in the South and North of Montenegro. The sample included 240 participants, 120 each from the South and North of Montenegro. Participants from one primary school from each of the four cities were included in each region. The Ethical Committee of the Chamber of Physiotherapists (Member of the World Confederation for Physical Therapy) approved the study's protocol (decision No 01-835) with informed consent required. All participants agreed to undergo (provided informed consent) the study evaluation and underwent observation, measurement, and testing methods, and physiotherapists completed their evaluation sheets.

### Evaluation and Testing

The examination included an evaluation of the children's posture by inspecting the subject's standing position and the predilection test, noting changes posing suspicion of scoliosis. Information regarding gender and sports activities was recorded before initiating the section. The Evaluation list was previously developed and adopted by 12 specialists in applied physiotherapy within the Chamber of Physiotherapists.

The evaluator noted the position of the head, shoulders, and lower angles of the scapula, Lorentz's triangles, and the inclination of the pelvis. Body weight, height,

and lower extremities' length were also measured. The length of the lower extremities was measured in centimeters using tape, utilizing the umbilicus and medial malleolus as anthropometric reference points. The testing procedure included an elasticity test application for the iliopsoas muscle, conducted with the participants lying on their backs. One leg was extended as they pulled the bended knee of the other leg (with both hands) towards themselves, and the evaluator observed the position of the extended leg. Adam's test was used to determine the suspicion of structural changes in the spine's position from the standing position.

The schoolchildren were questioned whether they had been engaged in any sports activities, which type, and how often they trained, and their answers were recorded.

### Statistical analysis

We conducted a statistical analysis using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA). We prepared tables and graphs to summarize the cases and express variables as means with standard deviation (continuous) or number of cases, percentage, and range of values (categorical). All assumptions for using parametric tests were met, including the normality of data distribution. We used the chi-square and Student's t-test for independent samples to analyze the differences between individual groups for categorical and continuous variables, respectively. We set the level of the tests' statistical significance at  $p < 0.05$  or report the 95 % confidence interval.

The correlation analysis between variables with Pearson's correlation coefficient for the frequency of suspected scoliosis depends on i) engagement in physical activities, ii) region of the country residing, and iii) schoolchildren's age.

To analyze the two variables' relationship, we utilized the chi-square test, answering whether there is a dependence between the two variables.

When rejection of the set working hypothesis of independence between certain variables is confirmed ( $p < 0.05$ ), the degree of association level was further determined based on the Cramer's V coefficient analysis, which mainly refers to the frequency of suspected scoliosis and the region of the country in which respondents reside.

### Results

Of the 240 participants, 48.3 % were engaged in some sports activity regardless of the type of sport, frequency, and duration, while 51.7 % did not engage in sports activities, which was not statistically significant ( $\chi^2 = 0.552$ ,  $p = 0.458$ ). The participants who engaged in sports activities were predominantly male (59 %) than female (41 %), but this was also not statistically significant ( $\chi^2 = 3.448$ ,  $p = 0.063$ ). Also, the percentage of participants engaged in sports activities did not differ between the third and fifth grades (50 % each).

There were statistically significantly fewer girls (40 %) engaging in sports activities than those (60 %) who did not ( $\chi^2 = 4.8$ ,  $p = 0.028$ ), while males were engaged in sports activities in a higher percentage (57 %) than those who did not (43 %) but this was not significant ( $\chi^2 = 2.133$ ,  $p = 0.144$ ).

Results demonstrated a significantly higher prevalence of suspected scoliosis among girls who did not engage in sports activities than those who did sports ( $\chi^2 = 3.941$ ,  $p = 0.042$ ). Suspected scoliosis was more prevalent in boys who did not engage in sports activities than those who did.

The prevalence of suspected scoliosis in boys did not differ between regions (50 % each), while the prevalence of suspected scoliosis in girls from the South was significantly higher than in the North of Montenegro (63 % vs 37 %, respectively;  $\chi^2 = 4.021$ ,  $p = 0.032$ ).

Based on the t-test values, we could not reject the hypothesis of independence of suspected scoliosis deformity and participants' engagement in sports activities ( $p = 0.147$ , Table 1). However, we can reject the hypothesis of independence of suspected scoliosis deformity and the region (South or North of Montenegro) participants reside ( $p > 0.001$ , Table 2). In other words, there is a moderate association between the frequency of suspected scoliosis and the region of Montenegro participants residing (Cramer's  $V = 0.319$ , Table 3).

Additionally, based on the t-test values, we could not reject the hypothesis of independence of suspected scoliosis deformity and participants' gender ( $p = 0.412$ , Table 4), neither the hypothesis of the independence of suspected scoliosis deformity and participants' age (third- or fifth-grade) ( $p = 0.355$ , Table 5).

## Discussion

The prevalence of suspected structural spine deformities in the developing skeleton of schoolchildren is

becoming more frequent. Additional research is required to define the exact role of each factor involved in developing adolescent idiopathic scoliosis<sup>13</sup>. The normal spine is capable of withstanding a wide range of positions, including lateral curvatures, in response to various stimulations. Such curves are short-lived and reversible and occur many times during the day<sup>14</sup>. Ulić demonstrated a high frequency of spine disorders in the school population of Vojvodina, ranging from 45 to 60 %<sup>15</sup>. The results of our study show that the frequency of suspected spinal deformities is higher in female than male participants, corresponding to similar results found in recently published studies<sup>12,16,17</sup>. The prevalence of suspected scoliosis is higher in boys aged 11 to 13 who, in addition to regular physical education classes, do not engage in additional sports activities compared to their peers who engage in particular sports activities<sup>18</sup>, and our results correspond to those usually presented results. However, further research is needed regarding the association between physical activity and body posture<sup>12</sup>. A study that included 330 school pupils of the third, fifth, and seventh grades of the Elementary School "Sveti Sava" in Foča pointed out the absence of scoliosis within the third grade's sample, while in the fifth grade's sample, the prevalence of this deformity was 5.49 %<sup>19</sup>.

Our study results show no significant differences in the prevalence of suspected scoliosis between genders. They indicated a greater presence of suspected spinal deformities in females and those less engaged in sports activities, corresponding to the available research results on this topic<sup>20,21</sup>. The findings of this study impose doubt that multifactorial etiology, including gender, child's age, engagement in sports activities, and the manner of conducting daily activities, is crucial for developing spinal deformities and may facilitate future studies and support preventive and therapeutic procedures in treating postural changes. Nevertheless, interpreting these results,

**Table 1:** Comparison of the prevalence of suspected scoliosis deformity depending on whether the participants engage in sports

Influence of sports activities on the prevalence of suspected scoliosis		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig	t	df	Sig (2-tailed)
Suspected Scoliosis	Equal variances assumed	7.913	0.005	1.446	238	0.15
	Equal variances not assumed			1.455	234.828	<b>0.147</b>

F: F statistic, Sig: significance level, t: t-test, df: degrees of freedom.

**Table 2:** Comparison of the prevalence of suspected scoliosis deformity depending on the region (South or North of Montenegro) of participants' residence.

Influence of regional factors on the prevalence of suspected scoliosis		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig	t	df	Sig (2-tailed)
Suspected Scoliosis	Equal variances assumed	99.228	0	-4.662	238	<0.001
	Equal variances not assumed			-4.463	159.107	<b>&lt;0.001</b>

F: F statistic, Sig: significance level, t: t-test, df: degrees of freedom.

**Table 3:** The dependence of the frequency of suspected scoliosis deformity and the region (South or North of Montenegro) of participants' residence.

		Count	Region		Total
			South	North	
Suspected scoliosis	Left	Expected Count	23 13.4	6 15.6	29 29.0
		% within REGION	20.7%	4.7%	12.1%
		Count	7 3.2	0 3.8	7 7.0
	Right	Expected Count	3.2	3.8	7.0
		% within REGION	6.3%	0.0%	2.9%
	Physiological	Count	81 94.4	123 109.7	204 204.0
% within REGION		73.0%	95.3%	85.0%	
Total		Count	111 111.0	129 129.0	240 240.0
		% within REGION	100.0%	100.0%	100.0%
<b>Chi-Square Tests</b>					
		Value	df*	Asymp.Sig (2-sided)	
<b>Pearson Chi-Square</b>		<b>24.400<sup>a</sup></b>	<b>2</b>	<b>0.00</b>	
<b>Symmetric Measures</b>					
			Value	Approx.Sig	
<b>Nominal by Nominal</b>		<b>Phi****</b>	0.319	0.000	
		<b>Cramer's V</b>	<b>0.319</b>	<b>0.000</b>	
<b>N of Valid Cases</b>			240		

df: degrees of freedom, Asymp.Sig: asymptotic significance, Approx.Sig: approximate significance, Phi: Phi correlation coefficient.

**Table 4:** Comparison of the prevalence of suspected scoliosis deformity depending on the gender of the participants.

Influence of gender on the prevalence of suspected scoliosis		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig	t	df	Sig (2-tailed)
Suspected Scoliosis	Equal variances assumed	2.342	0.127	0.822	238	0.412
	Equal variances not assumed			0.822	236.747	<b>0.412</b>

F: F statistic, Sig: significance level, t: t-test, df: degrees of freedom.

**Table 5:** Comparison of the prevalence of suspected scoliosis deformity depending on the participants' school grade (corresponding to age).

Influence of school grade (age) on the prevalence of suspected scoliosis		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig	t	df	Sig (2-tailed)
Suspected Scoliosis	Equal variances assumed	3.564	0.06	-0.93	238	0.355
	Equal variances not assumed			-0.93	232.2	<b>0.355</b>

F: F statistic, Sig: significance level, t: t-test, df: degrees of freedom.

one should consider as a limitation the evaluators' large number (introducing possible observation bias) and the lack of analysis of the spinal variations representation among the individual sports and the frequency of their application. After all, more studies are needed examining the potential multifactorial causes for developing spinal deformities, which was one of the motivations for con-

ducting current research.

### Conclusion

The presented results show no significant differences in the frequency of suspected scoliosis between genders, the general prevalence of sports, and the participants' age. In the boys, no difference was observed between the sub-

groups depending on engagement or not in sports activities. In contrast, a significant difference in the presence of suspected scoliosis was recorded between participants residing in the South compared to the North of Montenegro. Also, a significant and more pronounced suspicion of scoliosis was found in the female schoolchildren attending primary schools in the South of Montenegro. Multifactoriality that affects the development of spinal deformities (including gender, child's age, engagement in sports activities, and the way of performing daily activities) should always be considered when investigating etiological factors regarding the origin and development of spinal deformities.

### Conflict of interest

The author has no conflicts of interest to disclose.

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