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**Original empirical article**

# THE INCIDENCE OF SCOLIOTIC BAD POSTURE AMONG HIGH SCHOOL STUDENTS: PRELIMINARY STUDY

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**Abstract**. *Introduction: The available data on the incidence of scoliosis show a constant increase in the occurrence of the scoliotic bad posture, from the mid 20th century to the present. Aims: The main aims of this study were to evaluate and compare the incidence of scoliotic bad posture among the subjects in relation to their engagement in sport activities (athletes/non-athletes), gender (male/female) and handedness (right handed/left handed). Methods: The sample of subjects consisted of 240 males and females selected from a high school population whose body height was 173,55±8,74 cm, weight 64,88±10,89 kg, and age 16,76±0,91 years (Mean±St.Dev.). Frontal postural status was determined in the manner that the subjects assumed a normal upright position, and their spinal columns were overshot from the cervical (C7) vertebra to the sacral (S1) vertebra by using the "Spinal Mouse" wireless device. The existence of scoliotic bad posture to the right and to the left side was expressed by the variables LumR (lumbar right), LumL (lumbar left), ThR (thoracic right), ThL (thoracic left), ThRLumR (thoracic right-lumbar right), ThLLumR (thoracic left-lumbar right), ThRLumL (thoracic right-lumbar left), ThLLumL (thoracic left-lumbar left), while the non-existence was expressed by the variable WSBP (without scoliotic bad posture). The*

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*"SPSS version 13" package was used to process the data, and the obtained results were presented descriptively, using the t-test for independent samples and the z-test for the differences between two proportions. Results: Incidence of scoliotic bad posture was determined in 232 subjects (96,67%). Based on the significance of the z-test for the differences between two proportions (sig=0,0319), a statistically significant difference was determined in the incidence of scoliotic bad posture between athletes and non-athletes, but not between the males and females (sig=0, 9622), and not between right and left handed subjects (sig=0, 6474). Conclusion: This preliminary investigation showed extremly high incidence of scoliotic bad posture among high school students. Hoewer, determined problem is in its early stage, i.e., it can be reconstituted by certain exercises in relation to the natural history of curves.*

**Key words**: *scoliotic bad posture, incidence, high school students, athletes-non-atletes, gender, handedness.*

## INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is the single most common form of spinal deformity seen in orthopedic practice. Abnormalities of the neuromuscular system and of calcium metabolism, along with certain growth, genetic, and mechanical factors may all play roles in the pathogenesis of the disorder (Rinsky and Gamble, 1988). Scoliosis is a spinal deformity prevalent in up to 2% to 3% of the population, requiring non-operative and only occasionally operative treatment. Curve progression and patient physiological age dictate treatment regimens. Bracing and physical therapy is the mainstay for non-operative treatment, whereas soft tissue releases and fusion with instrumentation are used for operative correction. Exercise and athletic competition for the young individual has become increasingly more important in society. Athletic activity and sports participation is usually allowed for patients undergoing non-operative treatment. Return to sport after surgical correction is variable, often decided by the treating surgeon, and based on the level of fusion and sporting activity (Schiller and Eberson, 2008). There is a description of diagnosis and treatment of idiopathic adolescent scoliosis (Winter, 1990; Lonstein, 1988), but, there are no generally accepted guidelines for surgeons regarding either appropriate sports or the appropriate time to resume sports after spinal surgery (Rubery and Bradford, 2002). However, strenuous physical activity is known to cause structural abnormalities in the immature vertebral body (Wojtys et al., 2000). In general, idiopathic scoliosis is more prevalent in females and may even be higher in athletes (Omey et al., 2000). Inversely, there are conclusions that systematic exercising is probably not associated with the development of AIS (Kenanidis et al., 2008). According to the mentioned authors, actively participating in sports activities does not seem to affect the degree of the main scoliotic curve. It should be stressed that the available data on the incidence of scoliosis show a constant increase in the occurrence of the above mentioned deformity, from the mid 20th century to the present (Yawn et al., 1999; Brooks et al., 1975; Shands and Eisberg, 1955). The main aims of this study were to evaluate and compare the incidence of scoliotic bad posture among the subjects in relation to their engagement in sport activities (athletes/non-athletes), gender (male/female) and handedness (right handed/left handed).

## METHODS

The sample of subjects consisted of 240 males and females selected from a high school population whose body height was 173,55±8,74 cm, weight 64,88±10,89 kg, and age 16,76±0,91 years (Mean±St.Dev.). The sample was divided into two sub-samples numbering 120 pupils each. The subjects of the first sub-sample were actively engaged in sport activities, while the subjects of the second sub-sample were non-athletes. All of the subjects were familiar with the tasks and gave their written consent for participation in the research, which was conducted in accordance with the Helsinki Declaration, at the Faculty of Sport and Physical Education in Niš. The data for this research were gathered as part of the scientific project no. 179024, supported by the Ministry of Science and Technological Development of the Republic of Serbia (RS). Frontal postural status was determined in the following manner: the subjects assumed a normal upright position, and their spinal columns were overshot from the cervical (C7) vertebra to the sacral (S1) vertebra by using the "Spinal Mouse" wireless device. The "Spinal Mouse" (Quantum Health and Wellness Ltd, Wallasay, England) is an instrument which possesses a non-invasive, ultrasound technology and methodology for assessing postural status (Bubanj, S. et al., 2010; Zsidai and Koscis, 2001). The curvature of the spinal thoracic and lumbar region was expressed by the variables FroThorSpi and FroLumSpi (in degrees). The existence of scoliotic bad posture to the right and to the left side was expressed by the variables LumR (lumbar right), LumL (lumbar left), ThR (thoracic right), ThL (thoracic left), ThRLumR (thoracic right-lumbar right), ThLLumR (thoracic left-lumbar right), ThRLumL (thoracic right-lumbar left), ThLLumL (thoracic left-lumbar left), while the non-existence was expressed by the variable WSBP (without scoliotic bad posture). The "SPSS version 13" package was used to process the data, and the obtained results were presented descriptively, using the t-test for independent samples and the z-test for the differences between two proportions (Pallant, 2007).

## RESULTS WITH DISCUSSION

**Table 1.** Descriptive statistics of the spinal thoracic and lumbar curvature of the subjects of the entire sample (N=240).

| **SAMPLE (N=240)** | | | | | |
|---|---|---|---|---|---|
| | N | Minimum | Maximum | Mean | Std. Deviation |
| FroThorSpi in deg | 240 | 0 | 18 | 4,58 | 3,235 |
| FroLumSpi in deg | 240 | 0 | 49 | 4,89 | 6,871 |

**Table 2.** The incidence of scoliotic bad posture among the subjects of the entire sample (N=240).

| SAMPLE (N=240) | | |
|---|---|---|
| Diagnosis | N | % |
| LumR | 1 | 0,42% |
| LumL | 13 | 5,42% |
| ThR | 4 | 1,67% |
| ThL | 19 | 7,92% |
| ThRLumR | 11 | 4,58% |
| ThLLumR | 37 | 15,42% |
| ThRLumL | 76 | 31,67% |
| ThLLumL | 71 | 29,58% |
| WSCB* | 8 | 3,33% |
| Total | 240 | 100,00% |

*WSCB (Without scoliotic bad posture)

The obtained alarming incidence of scoliotic bad posture (96,67%) in this research is almost fourteen-fold higher than the incidence reported by Jenyo and Asekun-Olarinmoye (2005) in their general check-up of secondary-school children, and three-fold higher than the incidence found by Ostojić et al. (2006) in their general check-up of primary-school children, which covered a total of 2517 children aged 7-14. Ostojić et al. reported incorrect posture in 33.4% of the children. The most common type of curvature was the thoracic (39%) and the thoraco-lumbar (39%), while 14 children had a double curvature (17.8%).

**Table 3.** Descriptive statistics of the spinal thoracic and lumbar curvature among athletes (N=120) and non-athletes (N=120).

| ATHLETES/NON-ATHLETES | | | | | | |
|---|---|---|---|---|---|---|
| Variables | ATHL/NONATHL | N | Minimum | Maximum | Mean | Std. Deviation |
| FroThorSpi in deg | Athletes | 120 | 0 | 13 | 4,97 | 3,183 |
| | Non-athletes | 120 | 0 | 18 | 4,19 | 3,252 |
| FroLumSpi in deg | Athletes | 120 | 0 | 49 | 5,64 | 8,672 |
| | Non-athletes | 120 | 0 | 32 | 4,13 | 4,296 |

**Table 4.** The t-test for independent samples of the spinal thoracic and lumbar curvature among athletes (N=120) and non-athletes (N=120).

| ATHLETES/NON-ATHLETES | | | | |
|---|---|---|---|---|
| | t-test for Equality of Means | | | |
| | t | df | Sig. (2-tailed) | Mean Difference |
| FroThorSpi | -1,875 | 238 | ,062 | -,779 |
| FroLumSpi | -1,710 | 238 | ,088 | -1,511 |

Based on the significance of the t-test (Table 4), it can be concluded that there are no statistically significant differences in the variables FroThorSpi (Sig=0.06) and FroLum-Spi (Sig=0.09) between the athletes and the non-athletes.

**Table 5.** The incidence of scoliotic bad posture among athletes (N=120) and non-athletes (N=120).

| | ATHLETES | | NON-ATHLETES | |
|---|---|---|---|---|
| Diagnosis | N | % | N | % |
| LumR | 0 | 0,00% | 1 | 0,83% |
| LumL | 4 | 3,33% | 9 | 7,50% |
| ThR | 0 | 0,00% | 4 | 3,33% |
| ThL | 11 | 9,17% | 8 | 6,67% |
| ThRLumR | 3 | 2,50% | 8 | 6,67% |
| ThLLumR | 20 | 16,67% | 17 | 14,17% |
| ThRLumL | 37 | 30,83% | 39 | 32,50% |
| ThLLumL | 38 | 31,67% | 33 | 27,50% |
| WSCB | 7 | 5,83% | 1 | 0,83% |
| Total | 120 | 100,00% | 120 | 100,00% |

*WSCB (Without scoliotic bad posture)

Based on the significance of the z-test for the differences between two proportions (sig=0,0319), a statistically significant difference was determined in the incidence of scoliotic bad posture between athletes and non-athletes. The results for the incidence of scoliotic bad posture in this research in relation to the engagement of the subjects in sport activities are not in agreement with the results obtained from the research conducted by Yoo et al. (2001), who found a higher incidence of truncal asymmetry and scoliotic spinal columns among 116 volleyball players than in the general population of 46428 Korean middle school students. Despite the higher frequency of prevalence, Cobb's angle in volleyball players was below 15°, whereas in the control group it showed severe scoliosis, which in Cobb's angle reached up to 45°. The authors concluded that asymmetrical muscle development can produce mild scoliosis. However, this does not have the potential for a severe progression as found in some cases of idiopathic scoliosis. In addition, Tanchev et al. (2000), in an anamnestic, clinical, radiographic research of 100 girls actively engaged in rhythmic gymnastics, found a ten-fold higher incidence of scoliosis (12%) in mentioned athletes, than in their non-athlete compeers (1.1%).

**Table 6.** Descriptive statistics of the spinal thoracic and lumbar curvature among the males (N=118) and females (N=122).

**MALE-FEMALE**

| Variables | MALE/FEMALE | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| FroThorSpi in deg | Male | 118 | 0 | 13 | 4,85 | 3,127 |
| | Female | 122 | 0 | 18 | 4,32 | 3,328 |
| FroLumSpi in deg | Male | 118 | 0 | 46 | 5,39 | 7,379 |
| | Female | 122 | 0 | 49 | 4,41 | 6,335 |

**Table 7.** The t-test for independent samples of the spinal thoracic and lumbar curvature among the males (N=118) and females (N=122).

| | t-test for Equality of Means | | | |
|---|---|---|---|---|
| | t | df | Sig. (2-tailed) | Mean Difference |
| FroThorSpi | -1,269 | 238 | ,206 | -,529 |
| FroLumSpi | -1,103 | 238 | ,271 | -,978 |

Based on the significance of the t-test (Table 7), it can be concluded that there are no statistically significant differences in the variables FroThorSpi (Sig=0.21) and FroLum-Spi (Sig=0.27) between the males and the females.

**Table 8.** The incidence of scoliotic bad posture among the males (N=118) and females (N=122).

| | MALE | | FEMALE | |
|---|---|---|---|---|
| Diagnosis | N | % | N | % |
| LumR | 0 | 0,00% | 1 | 0,82% |
| LumL | 6 | 5,08% | 7 | 5,74% |
| ThR | 0 | 0,00% | 4 | 3,28% |
| ThL | 11 | 9,32% | 8 | 6,56% |
| ThRLumR | 3 | 2,54% | 8 | 6,56% |
| ThLLumR | 22 | 18,64% | 15 | 12,30% |
| ThRLumL | 36 | 30,51% | 40 | 32,79% |
| ThLLumL | 36 | 30,51% | 35 | 28,69% |
| WSCB | 4 | 3,39% | 4 | 3,28% |
| Total | 118 | 100,00% | 122 | 100,00% |

*WSCB (Without scoliotic bad posture)

Based on the significance of the z-test for the differences between two proportions (sig=0, 9622), no statistically significant difference was determined in the incidence of scoliotic bad posture between the males and females. The results of the incidence of sco-liotic bad posture in this research in relation to the gender of the subjects are not in agreement with the results of the research conducted by Zurita et al. (2008), who found a higher incidence of scoliotic bad posture among male pupils aged 8-12 years. Panayotis et al. (1997) in their general check-up of primary-school children, which covered a total of 82901 children aged 9-14, reported a total of 1436 children (1.7 %) with structural scoliosis (361 of the 41939 boys i.e., 0,9% and 1075 of the 40962 girls i.e., 2,6%).

**Table 9.** Descriptive statistics of the spinal thoracic and lumbar curvature among the right-handed (N=195) and left-handed (N=45) subjects.

| RIGHT HANDED/LEFT HANDED | | | | | | |
|---|---|---|---|---|---|---|
| Variables | RIGHTH/LEFTH | N | Minimum | Maximum | Mean | Std. Deviation |
| FroThorSpi in deg | Right Handed | 195 | 0 | 18 | 4,60 | 3,252 |
| | Left Handed | 45 | 0 | 13 | 4,51 | 3,194 |
| FroLumSpi in deg | Right Handed | 195 | 0 | 49 | 5,04 | 7,106 |
| | Left Handed | 45 | 0 | 38 | 4,24 | 5,768 |

**Table 10.** The t-test for the independent samples of the spinal thoracic and lumbar curvature among the right-handed (N=195) and left-handed (N=45) subjects.

| | t-test for Equality of Means | | | |
|---|---|---|---|---|
| | t | df | Sig. (2-tailed) | Mean Difference |
| FroThorSpi | ,153 | 238 | ,879 | ,082 |
| FroLumSpi | ,703 | 238 | ,483 | ,799 |

Based on the significance of the t-test (Table 10), it can be concluded that there are no statistically significant differences between the right-handed and the left-handed subjects.

**Table 11**. The incidence of scoliotic bad posture among the right handed (N=195) and left handed (N=45) subjects.

| | RIGHTHANDED | | LEFTHANDED | |
|---|---|---|---|---|
| Diagnosis | N | % | N | % |
| LumR | 1 | 0,51% | 0 | 0,00% |
| LumL | 11 | 5,64% | 2 | 4,44% |
| ThR | 3 | 1,54% | 1 | 2,22% |
| ThL | 16 | 8,21% | 3 | 6,67% |
| ThRLumR | 8 | 4,10% | 3 | 6,67% |
| ThLLumR | 33 | 16,92% | 4 | 8,89% |
| ThRLumL | 62 | 31,79% | 14 | 31,11% |
| ThLLumL | 55 | 28,21% | 16 | 35,56% |
| WSCB | 6 | 3,08% | 2 | 4,44% |
| Total | 195 | 100,00% | 45 | 100,00% |

*WSCB (Without scoliotic bad posture)

Based on the significance of the z-test for the differences between two proportions (sig=0, 6474), no statistically significant difference was determined in the incidence of scoliotic bad posture between the right handed and left handed subjects. Milenković et al. (2004) presented the hypothesis that an abnormal writing posture for left-handed people can cause scoliotic changes in the bone structure of the spinal column. The obtained incidence of scoliotic bad posture in relation to handedness (96,92% in the right handed; 95,56% in the left handed) in this research is higher than the incidence found by Sanchez et al. (2010) in their general check-up of primary-school children, which included a total of 682 children of the male sex, aged 6-12. The aforementioned authors reported incorrect posture in 9.4% of the children (N=64), i.e., in 59 right handed, and 5 left handed boys.

## CONCLUSION

Postural status control in primary school and high school students is a necessary tool in detection of spine deformities. This preliminary investigation showed extremly high incidence in scoliotic bad posture among high school students. Hoewer, determined problem is in its early stage, i.e., it can be reconstituted by certain exercises in relation to the natural history of curves. Causes of high incidence could be multiple by nature: ge-

netic, environmental, mechanical, neuromuscular, and a like. Hence, in that context, further investigations of postural status improvement are needed. Concerning the applied methodology of spinal postural status assessment, the ultrasound-based spinal column examination system proved to be easy and well accepted both by researchers and subjects.

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# UČESTALOST POJAVE SKOLIOTIČNOG DRŽANJA MEĐU SREDNJOŠKOLCIMA: PRELIMINARNO ISTRAŽIVANJE

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*Uvod: Podaci koji su dostupni o učestalaost skolioze ukazuju na pojavu skoliotičnog držanja od sredine 20. veka pa da danas. Ciljevi: Glavni ciljevi ovog istraživanja bili su da se izvrši evaluacija i da se poredi učestalost skoliotičnog držanja među srednjoškolcima u odnosu na njihovo učešće u sportskim aktivnostima (sportisti/nesportisti), pol (muški/ženski) i to da li su desnoruki ili levoruki. Metode: Uzorak ispitanika sastojao se od 240 muškaraca i žena koji su izabrani iz populacije srednjoškolaca čija je prosečna visina bila 173,55±8,74 cm, težina 64,88±10,89 kg, i starost 16,76±0,91 (Mean±St.Dev.). Frontalni posturalni status određen je tako što su ispitanici zauzeli normalan uspravni položaj, a položaj njihove kičme zabeležen od cervikalnog (C7) do sakralnog (S1) kičmenog pršljena upotrebom "Spinal Mouse" bezičnog instrumenta. Postojanje skoliotičnog držanja udesno ili ulevo bio je izražen varijablama LumR (lumbarno desno), LumL (lumbarno levo), ThR (desni deo grudnog koša), ThL (levi deo grudnog koša), ThRLumR (desni deo grudnog koša-lumbarno desno), ThLLumR (levi deo grudnog koša-lumbarno desno), ThRLumL (desni deo grudnog koša-lumbarno levo), ThLLumL (levi deo grudnog koša-lumbarno levo), dok je izostanak tog stanja izražen varijablom WSBP (bez lošeg skoliotičnog držanja). "SPSS version 13" je program korišćen da se obrade podaci, a prikupljeni podaci su prikazani deskriptivno, upotrebom t-testa za nezavisne uzorke i z-testa za razlike među proporcijama. Rezultati: Učestalost skoliotičnog držanja utvrđena je kod 232 ispitanika (96,67%). Na osnovu značajnosti z-testa za razlike među proporcijama (sig=0,0319), statistički značajna razlika uočena je u učestalosti skoliotičnog lošeg držanja među sportistima i nesportistima, ali ne između pripadnika muškog i ženskog pola (sig=0, 9622), ali ne između desnorukih i levorukih ispitanika (sig=0, 6474). Zaključak: Ovo preliminarno istraživanje pokazalo je jako visoku stopu učestalosti skoliotičnog lošeg držanja među srednjoškolcima. Ipak, uočeni problem je u ranoj fazi razvoja, tako da se na njega može uticati uz pomoć raznih vežbanja.*

Ključne reči: *skoliotično držanje, učestalost, srednjoškolci, sportisti i nesportisti, pol, dominantna ruka.*