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*Research article*

# Archery as a Means of Improving Back Muscle Function in Schoolchildren with Scoliosis

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**Abstract:** The aim of this study is to strengthen the back muscles in children aged 12 to 14 years with a diagnosis of scoliosis on physical therapy classes at school. The educational experiment was conducted at a comprehensive school from January 12 to May 15, 2025, it involved seventh- and eighth-graders. A total of 88 children aged between12 and 14 diagnosed with scoliosis participated in the study. Classes were held three times a week, 45 minutes each. In the control group, classes were conducted in accordance with the school physical education curriculum, whereas in the experimental group, children did archery exercises for 15 minutes. After the research in the experimental group, backward spinal mobility increased by 78.6% ($t=3.9$; $p<0.05$), forward spinal mobility increased by 200% ($t=4.1$; $p<0.05$), lateral spinal mobility became higher by 63.2% ($t=4.4$; $p<0.05$), back muscle strength increased by 17.4% ($t=1.9$; $p<0.05$), abdominal muscle strength increased by 48.4% ($t=4.9$; $p<0.05$). Archery can be a promising additional exercise in physical education, but its therapeutic role in specific scoliosis requires confirmation with the help of confirmed results of orthopedic and rehabilitation activities.

**Keywords:** Adolescent idiopathic scoliosis; Physical education; Spinal mobility; School-based intervention; Therapeutic exercise

## 1. Introduction

The United Nations Organization and the World Health Organization continually focus on the health issues of people of all ages. This is especially true for preschool- and school-aged children, when the body is developing and actively growing [1,2].

One of the most common health problems in children is frontal spinal curvature (scoliosis). It is the most common orthopedic condition, affecting approximately 20% of the entire Russian population [3]. The increasing number of children with scoliosis in recent years has necessitated the development of rehabilitation programs for improving spinal flexibility of this condition [4].

Scoliosis is not a localized curvature of the spine, but a general, severe disorder involving the human organs and their systems in the pathological process. Severe forms of this disease cause significant disruptions to the body's most important systems, leading to reduced life expectancy, decreased ability to work, and disability [5,6].

Changes in the respiratory, cardiovascular, and autonomic nervous systems associated with severe forms of scoliosis have been well studied in the literature both in Russia and abroad [7,8]. Disturbances in respiratory function, heart rhythm, and cardiac muscle metabolism, inadequate adaptation of the cardiovascular system to various physical activities, and a decline in several physical development indicators

should be noted. Unfortunately, children with spinal curvature tend to perform poorly academically, tire more quickly, suffer from headaches, and are more irritable [9,10].

The prevalence of scoliosis in children under 16 years of age ranges from 2 to 9%, while the prevalence of this severe disease in school-age children reaches 15-30% or more [11,12]. This spinal pathology is most common in girls, which can be explained by their less mature physical development and weak muscles. Progressive spinal curvature is observed in girls aged 7-8 and 11-13, and in boys aged 8-10 and 13-15, i.e., during periods of intensive spinal growth. In 75% of cases, scoliosis in schoolchildren is diagnosed between 7 and 12 years of age [13,14].

A specific feature of spinal curvature is that it is a childhood disease, meaning it cannot be corrected in adulthood. Therefore, it is very important to diagnose spinal problems at an early stage and treat them effectively, since the earlier scoliosis occurs, the more severe it will be in the final stage of its development [15,16].

Most traditional scoliosis classifications worldwide are based on the description of visually or radiographically detectable signs of deformity. This includes its shape, apex level, direction, and magnitude. These approaches to pathology assessment do not characterize the cause of the disease, the possible course of spinal deformity, or the principles improving spinal flexibility [17,18].

Scoliosis is the most common musculoskeletal disorder among children and adolescents. Based on the literature, the main causes of scoliosis and its negative consequences have been identified.

The literature analysis on scoliosis demonstrates the crucial importance of physical rehabilitation and exercise for children diagnosed with this condition, primarily general physical exercises. It should be noted that there is a lack of specific methods for correcting scoliotic posture at school, for example, on physical therapy classes. Currently, there is a standard physical education program in schools, which is aimed at the comprehensive and harmonious development of school-age children. This program provides a variety of physical exercises in each section, but lacks specific exercises for correcting and improving children's posture.

Therefore, there is a contradiction between the current organization of physical education in comprehensive secondary schools and the lack of specific physical exercises or methods for correcting scoliosis in school-age children.

The aim of the study is to strengthen the back muscles in children aged 12 to 14 years with a diagnosis of scoliosis on physical therapy classes at school.

## 2. Materials and Methods

The research was conducted at a comprehensive school in Moscow from January 12 to May 15, 2025, with students of grades 7 and 8. 88 children (49 boys and 39 girls) between 12 and 14 years of age diagnosed with scoliosis participated in the study.

The pedagogical research was approved by the ethics committee of the university. Informed consent about the participation of schoolchildren in the study was obtained from each parent. All safety procedures were followed at each physical education lesson.

The diagnostic method of scoliosis was radiography. The degrees of scoliosis were determined by the Cobb angle. The severity of the deformity directly depends on the value obtained:

grade 1: up to 10 degrees is considered a slight asymmetry (initial stage), in which observation, gymnastics and physical therapy are recommended.

Grade 2: 11-25 degrees usually requires wearing a corset and increased physical activity.

Children with grade 3 and 4 scoliosis did not participate in the study.

The study involved children with improving spinal mobility, which is associated with back muscle weakness, poor habit and body asymmetry.

Inclusion criteria:

1. Children diagnosed with scoliosis up to 25 degrees on the Cobb scale.

2. Boys and girls aged 12-14 (grades 7-8 in secondary school).

3. Children who do not engage in any kind of sport, since organized physical education and sports activities can actively affect learning outcomes and make them distorted and unreliable.

Exclusion criteria:

1. Children who were healthy or had severe forms of scoliosis.

2. The age of schoolchildren went beyond 12-14 years.

3. Children who play sports or other types of active physical activity that in any way affect their performance

The design of the study was quasi-experimental.

The students were divided into the experimental and control groups so that they continued to study in their grades and their average indicators which are studied did not differ significantly at the beginning of the study. Thus, the students were divided into groups as follows:

Control group (CG) – grades 7A and 7G, grades 8B and 8G.

Experimental group (EG) – grades 7B and 7C, grades 8A and 8C.

Classes in both groups were held three times a week for 45 minutes.

In the control group (44 students), classes were conducted in accordance with the requirements of the school physical education program.

The experimental group (44 students) followed a developed curriculum. Special archery exercises were included in the main part of the lesson, they last for 15 minutes and were not included in the rehabilitation program; their aim is to improve the musculoskeletal system and physical fitness of middle-school-aged children diagnosed with scoliosis.

In the research, classic bows (Centershot Spirit model) were used, they are ideal for schoolchildren, as they repeat the shape of the Olympic bow. They are lightweight, collapsible, and the tension force can be increased as the child grows. Resistance 4-6 kilograms. The distance to the target is 13 meters. In each lesson, each student managed to complete 25 archery shots. Before the start of the first lessons, safety measures were carried out in each class when working with a bow. If the spine is curved (scoliosis), you need to shoot arrows in the direction that allows you to maintain the symmetry of the body. The main task is to evenly distribute the load on the muscles of the back and shoulder girdle.

Particular attention was paid to mastering the archery technique and practicing archery. The students were assigned to a maximum of four students per bow.

The first lesson focused on the structure of a bow and arrow and its main parts. Then, the essence of archery technique was discussed, potential errors were outlined out, and archery safety precautions were pointed.

The first practical lesson is introductory. It covers stance (arm, leg, torso, and head position), grip, proper breathing during archery, drawing, anchoring, aiming and releasing the bowstring. Potential errors are pointed out.

In addition to proper head, leg, arm, and finger position, an important aspect is the torso position, with an emphasis on the back muscles. The body should not bend or twist in any plane or axis. The basic elements include preparing to shoot, nocking the arrow, aiming, releasing the arrow, and finishing (figure 1).

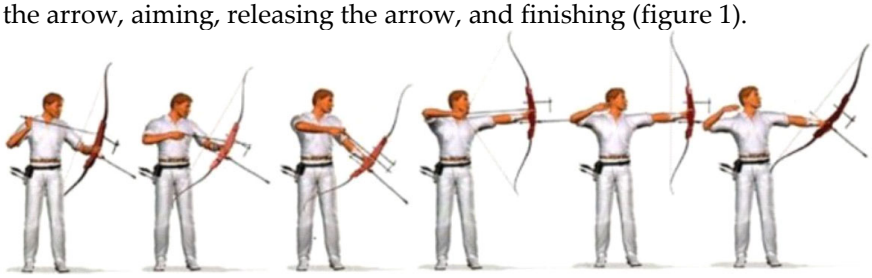


**Figure 1.** Stance in archery

The following control exercises (tests) were used to assess musculoskeletal function and physical fitness:

1. Assessing backward spinal mobility. The distance from the spinous process of the fourth cervical vertebra to the origin of the gluteal fold is measured. This distance is then measured with the head and torso tilted backward as far as possible (legs straight). The result is the difference in centimeters.

2. Assessing forward spinal mobility. This is performed from a standing position on a gymnastic bench with straight legs. The depth of the tilt is measured by the distance between the fingertips and the top surface of the bench using two rulers attached vertically to the bench. If the fingertips are below the edge of the bench, the result is recorded with a "+" sign; if above, with a "-" sign. The result is in centimeters.

3. Assessing lateral spinal mobility. In the starting position, the distance from the tip of the third finger of each hand to the floor is measured, then again with the torso tilted to the side as far as possible. The difference between the first and second measurements characterizes the amplitude and asymmetry of lateral mobility. The result is in centimeters.

4. Back muscle strength assessment. The student lies face down on a gymnastics goat, with the upper body up to the iliac crest suspended, hands on the hips (legs held by a partner). The score is the time it takes to complete the exercise until complete muscle fatigue.

5. Abdominal muscle strength assessment. This is determined by the number of transitions from a supine position (hands on the hips) to a sitting position and back (legs held by a partner). The score is the number of repetitions of the exercise until complete muscle fatigue.

Methods of mathematical statistics

The Student's T-Test was used to process the results of the study. The arithmetic mean (M) and the error of the arithmetic mean (m) were determined. The indicator «t» was also calculated, and the differences at $p<0.05$ were considered reliable.

## 3. Results

Before the start of the educational experiment, all students took the control test. The comparative analysis of the functional indicators of the musculoskeletal system and physical fitness level is presented in table 1.

**Table 1.** Comparative analysis of the indicators of both groups at the beginning of the study

| Indicators | CG (M±m) | EG (M±m) | t | p |
|---|---|---|---|---|
| Backward spinal mobility | 8,7 ± 0,75 | 8,4 ± 0,91 | 0,19 | >0,05 |
| Forward spinal mobility | 2,8 ± 1,28 | 3,1 ± 1 | 0,25 | >0,05 |
| Lateral spinal mobility | 15,9 ± 1,85 | 13,3 ± 1,46 | 1,1 | >0,05 |
| Back muscle strength | 76,1 ± 3,89 | 75,7 ± 5,38 | 0,06 | >0,05 |
| Abdominal muscle strength | 17,9 ± 1,16 | 15,3 ± 1,08 | 1,3 | >0,05 |

*CG – Control group, EG – Experimental group; M – average value, m – standard error.

Table 1 shows that before the study, the results in both groups did not differ significantly, indicating homogeneity between the groups.

After the research, all students re-took the assessments. The final results are presented in table 2.

**Table 2.** Comparative analysis of the indicators of both groups after the study

| Indicators | CG (M±m) | EG (M±m) | t | p |
|---|---|---|---|---|
| Backward spinal mobility | 10,2 ± 0,91 | 15,0 ± 0,88 | 4,8 | <0,05 |

| | | | | |
|---|---|---|---|---|
| Forward spinal mobility | 4,0 ± 1,12 | 9,3 ± 1,16 | 5,3 | <0,05 |
| Lateral spinal mobility | 17,1 ± 1,25 | 21,7 ± 1,26 | 4,6 | <0,05 |
| Back muscle strength | 77,5 ± 4 | 88,9 ± 4,6 | 11,4 | <0,05 |
| Abdominal muscle strength | 16,0 ± 1,28 | 22,7 ± 1,08 | 4,7 | <0,05 |

* CG – Control group, EG – Experimental group; M – average value, m – standard error.

The comparison of the final indicators in the control and experimental groups reveals that the functional indicators of the musculoskeletal system and the level of physical fitness are significantly higher in the experimental group than in the control group. While the indicators between the groups were no significant at the beginning of the study, a significant difference in the data ($p<0.05$) was observed for all five indicators after the study.

As for the intragroup indicators of children, they also have differences from the beginning to the end of the study. For example, in the control group from the beginning to the end of the study, they are shown in Table 3.

**Table 3.** Comparative analysis of the indicators of the control group during the study period

| **Indicators** | **Before (M±m)** | **After (M±m)** | **t** | **p** |
|---|---|---|---|---|
| Backward spinal mobility | 8,7 ± 0,75 | 10,2 ± 0,91 | 1,06 | >0,05 |
| Forward spinal mobility | 2,8 ± 1,28 | 4 ± 1,12 | 0,42 | >0,05 |
| Lateral spinal mobility | 15,9 ± 1,85 | 17,1 ± 1,25 | 1,25 | >0,05 |
| Back muscle strength | 76,1 ± 3,89 | 77,5 ± 4 | 0,25 | >0,05 |
| Abdominal muscle strength | 17,9 ± 1,16 | 16 ± 1,28 | 0,64 | >0,05 |

*M – average value, m – standard error.

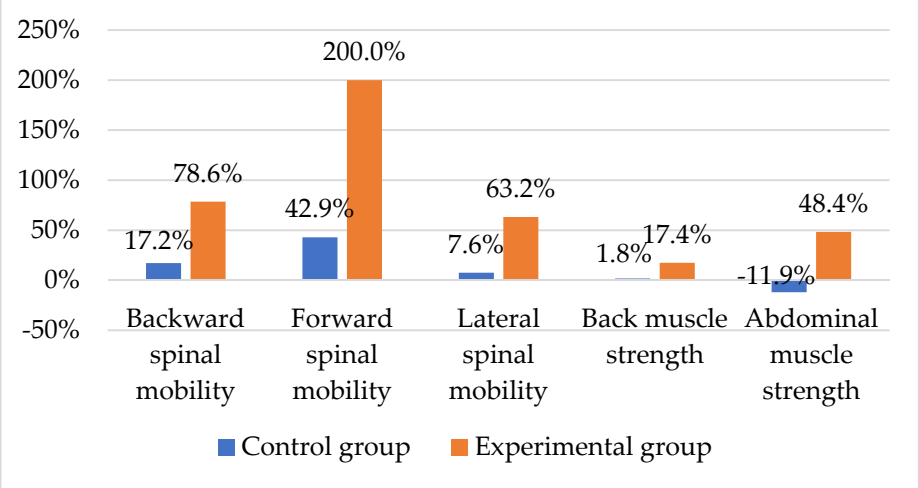
Table 3 shows that the indicators of schoolchildren in the control group underwent minor changes during the study period ($p>0,05$). At the same time, the indicators of schoolchildren in the experimental group achieved significant positive changes from the beginning to the end of the study on all 5 tests (table 4).

**Table 4.** Comparative analysis of the indicators of the experimental group during the study period

| **Indicators** | **Before (M±m)** | **After (M±m)** | **t** | **p** |
|---|---|---|---|---|
| Backward spinal mobility | 8,4 ± 0,91 | 15 ± 0,88 | 3,85 | <0,05 |
| Forward spinal mobility | 3,1 ± 1 | 9,3 ± 1,16 | 4,05 | <0,05 |
| Lateral spinal mobility | 13,3 ± 1,46 | 21,7 ± 1,26 | 4,35 | <0,05 |
| Back muscle strength | 75,5 ± 5,38 | 88,9 ± 4,6 | 1,86 | <0,05 |
| Abdominal muscle strength | 15,3 ± 1,08 | 22,7 ± 1,08 | 4,84 | <0,05 |

*M – average value, m – standard error.

The comparative analysis of the functional indicators of the musculoskeletal system and the level of physical fitness within each group is presented in a diagram (Graph 1).




**Graph 1.** Increase in indicators in both groups over the study period

The comparison of the functional indicators of the musculoskeletal system and the physical fitness level of middle-school-aged children after the educational experiment revealed the following:

In the control group, the children showed growth in 4 out of 5 indicators:

Backward spinal mobility increased by 17.2%, at t=1.1; p>0.05.

Forward spinal mobility increased by 42.9%, at t=1.3; p>0.05.

Lateral spinal mobility increased by 7.6%, at t=0.5; p>0.05.

Back muscle strength increased by 1.8%, at t=0.3; p>0.05.

Abdominal muscle strength decreased over the study period, with a result of -11.9%, at t=0.6; p>0.05. Thus, despite some positive growth in the studied indicators, the use of the standard physical education program in schools does not give significant positive results for schoolchildren diagnosed with scoliosis.

In the experimental group, the indicators significantly and reliably improved during the research:

Backward spinal mobility increased by 78.6%, with t=3.9; p<0.05.

Forward spinal mobility increased by 200%, with t=4.1; p<0.05.

Lateral spinal mobility increased by 63.2%, with t=4.4; p<0.05.

Back muscle strength increased by 17.4%, with t=1.9; p<0.05.

Abdominal muscle strength increased by 48.4%, with t=4.9; p<0.05.

Thus, the test results demonstrate a significant increase in spinal mobility in the experimental group compared with the control group. This demonstrates the effectiveness of archery on physical therapy classes as a rehabilitation tool for children between 12 and 14 years of age diagnosed with scoliosis.

## 4. Discussion

A well-formed posture is:

1. Optimal biomechanics - the load is evenly distributed, joints and intervertebral discs wear out much more slowly.

2. Proper functioning of internal organs - the straightened chest does not constrain the lungs, and the straight position of the body does not squeeze the abdominal organs.

3. Confidence and well-being appear - a person looks more fit, visually slim, while reducing muscle fatigue.

Therefore, it is necessary to deal with the problem of spinal muscles, especially at school age. Engage in physical activity outside of school.

The literature review revealed that scoliosis is the most common musculoskeletal disorder among children and adolescents. The main causes of scoliosis are [1,4]:

1) a sedentary lifestyle;

2) unequal size of the lower limbs;

3) metabolic disorders in connective tissue;
4) muscle contractures;
5) constitutional pathologies;
6) severe illness;
7) prolonged poor posture.

The school physical education curriculum can be adjusted by using special archery exercises aimed at improving the musculoskeletal system and physical fitness of middle-school-aged children diagnosed with scoliosis [3,6].

Based on the literature reviewed, the method for improving back muscle strength in middle-school-aged children using archery was developed and tested.

The results of the educational experiment showed that changes in spinal mobility indicators in the control and experimental groups prove that the control group, which followed the standard rehabilitation program, showed no significant changes compared with the experimental group. During classes in the experimental group archery exercises were involved, which is not included in the rehabilitation program. For all indicators studied, the average indicators in the experimental group showed significant increases from the beginning to the end of the educational experiment, demonstrating the effectiveness of integrating archery into the educational process for children between 12 and 14 years of age diagnosed with scoliosis.

It should be noted that archery is only used for thoracolumbar scoliosis with the peak of the curvature at the level of the Th11-11 vertebrae. The bow is held in the hand on the convex side of the curvature, and the bowstring is pulled by the hand corresponding to the concave side of the deformity.

The mechanism of archery is such that when drawing the bow, the even distribution of load across the shoulder girdle naturally straightens the upper spine, and stooped posture can disappear forever if archery is practiced regularly [12,17]

The problem of scoliosis is that in its early stages, patients typically have no complaints. Therefore, it is essential to constantly monitor the child's posture, and assist in developing muscle activity [9,14].

Drawing the bowstring increases chest expansion, improving blood circulation in the shoulder girdle, upper back, neck, chest, and arms, which in turn improves circulation in the spinal cord and brain. Archery training helps develop arm muscles. A large load is also on the press, thighs, buttocks, and calf muscles [5,18]

The scientific novelty lies in the fact that, for the first time, archery has been included into the school physical education curriculum as a means of rehabilitation for children diagnosed with scoliosis.

The theoretical significance lies in the improvement of physical rehabilitation methods by incorporating special exercises for children diagnosed with scoliosis into classroom activities.

The practical significance lies in the use of archery on physical therapy classes for the prevention and improving spinal flexibility of spinal disorders.

If we compare generally accepted approaches to the treatment of scoliosis, such as Schroth, SEAS, BSPTS and corrective exercise programs, then this study for the first time focused on the use of archery in schoolchildren aged 12-14 with scoliosis and it proved its effectiveness.

## 5. Conclusions

Archery on physical therapy classes for children between 12 and 14 years of age proved its effectiveness in the research. Archery can be a promising additional exercise in physical education, but its therapeutic role in specific scoliosis requires confirmation with the help of confirmed results of orthopedic and rehabilitation activities. Spinal mobility indicators significantly and reliably improved, as well as back and abdominal muscle strength. Technically, archery can be performed even at an older age, but this requires further study. However, using a bow and an arrow in primary school is inappropriate, as the specific nature of the exercise places specific demands

on the student's height, physical fitness, and mental preparedness. It is important not to miss the opportunity to address spinal issues early and effectively, as these can subsequently lead to respiratory impairment due to chest deformity, digestive problems due to internal organ displacement, cardiovascular disease due to pressure on blood vessels and the heart, limited mobility, chronic back pain, and psychological complexes related to appearance.

**Study Limitation:** quasi-experimental design; non-randomized allocation; class-based group assignment; absence of long-term follow-up; absence of radiographic follow-up outcomes; absence of quality-of-life measures; absence of pain assessment.There are several factors in this study that require further investigation. In future studies, it is recommended to use a larger sample to minimize bias and include a gender criterion for a more diverse study. In addition, this study should be conducted over a longer period of time to achieve optimal results.

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**Data Availability Statement:** The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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**References**

1. Kalmuratova BS, Tursynbekova KhK, Bekniyazova N. Methods of prevention and physical rehabilitation of children with scoliosis. Bulletin of Science and Practice. 2020;6(5):153-156.
2. Kamalova ShM, Teshaev ShZh, Khamidova NK. Parameters of physical development of 8-year-old children in normal and with scoliosis. Morphology. 2020:157(2-3):92-93.
3. Sarnadsky VN, Batorov DYu, Shchuchkina OA. Comparison of the possibilities of scoliosis diagnosis in the screening of schoolchildren by methods of computer optical topography and videorastereography using topographers todp and formetric. Spine Surgery. 2023;20(1):16-27.
4. Kamalova ShM, Haribova EA. Changes in anthropometric parameters of physical development of children with scolio-sis. Society and Innovations. 2021;2(2):424-432.
5. Shibkov SV. Physical rehabilitation of children of senior school age with grade 1-2 scoliosis. Bulletin of Science. 2023;4(2):188-200.
6. Lubovinina OG, Rodionova IE., Tyrtseva ES. Effectiveness of rehabilitation of children with scoliosis according to the school of healthy spine program. Issues of balneology, physiotherapy and therapeutic physical education. 2023;100(3-2):119.
7. Maksutova GI, Mikhailova SV, Stadnik OS. The use of adaptive sports in inclusive education of schoolchildren with sco-liosis using the example of golf. Bulletin of the South Ural State University. 2023;15(1):108-117.
8. Lee GB, Priefer DT, Priefer R. Scoliosis: causes and treatments. Adolescents. 2022;2(2):220-234.
9. Parkhimovich TV, Paramonova NA. The use of yoga elements to correct the posture of schoolchildren with scoliosis who study in special medical groups Scientific Notes of the Belarusian State University of Physical Culture. 2022;25:220–226.
10. Senkoylu A, Riise RB, Acaroglu E, Helenius I. Diverse approaches to scoliosis in young children. EFORT open reviews. 2020;5(10):753-762.
11. Vorobyeva TG, Bednaya NN. Correction of scoliosis of the 1st degree by fitball exercises in children aged 7-9 years. In-ternational Scientific Research Journal. 2020;6-2:85-87.
12. Zhang YB, Zhang JG. Treatment of early-onset scoliosis: techniques, indications, and complications. Chinese medical journal. 2020;133(3):351–357.

13. Fatykhov IR, Guryanova EA. The effect of mechanotherapy on pain in children with scoliosis. Russian Journal of Pain. 2021;19(5):69-70.
14. Özden, CB, Çolak TK. Are clinical pilates exercises an effective treatment for scoliosis? A randomized clinical trial. Journal of Health and Allied Sciences NU. 2023;13(3):365-372.
15. Li X, Shen J, Liang J. Effect of core-based exercise in people with scoliosis: A systematic review and meta-analysis. Clin-ical rehabilitation. 2021;35(5):669-680.
16. Bakula A, Šantić M, Milinković M. The importance of corrective exercises in the treatment of scoliosis in school-age children. Zdravstveni glasnik. 2022;8(2):59-66.
17. Tolo VT, Herring JA. Scoliosis-specific exercises: a state of the art review. Spine deformity. 2020;8(2):149-155.
18. Chen Y, Zhang Z, Zhu Q. The effect of an exercise intervention on adolescent idiopathic scoliosis: a network meta-analysis. Journal of Orthopaedic Surgery and Research. 2023;18(1):655