IMPACT OF PREVENTIVE EXERCISE PROGRAMS ON SCOLIOSIS

Veselinović Zorana[1], Hajder Đorđe[1], Bjelica Bojan[1], Pržulj Radomir[1], Aksović Nikola[2], Dobrescu Tatiana[3], Bubanj Saša[4]

[1]Faculty of Physical Education and Sports, University of East Sarajevo, Republika Srpska, Bosnia & Herzegovina
[2]Faculty of Sports and Physical Education, University of Priština-Kosovska Mitrovica, Leposavić, Serbia
[3]Faculty of Movement, Sport and Health Sciences, Vasile Alecsandri University, Bacau, Romania
[4]Faculty of Sport and Physical Education, University of Niš, Serbia

REVIEW ARTICLE
DOI: 10.5937/ATAVPA25139V

Abstract: *The aim of the study was to determine the effect of various corrective and preventive programs on scoliosis, one of the most common postural disorders in children and young people. Electronic databases such as PubMed, Web of Science, Scopus, MEDLINE, ERIC and Google Scholar were used in the literature review. Based on predefined criteria, ten studies that met quality standards were analyzed. The results of the study indicate that preventive programs that include specialized exercises, corrective gymnastics and individually tailored interventions significantly contribute to reducing the angle of spinal curvature and improving postural condition. It has also been shown that regular application of such programs has a positive effect on the functional abilities and psychophysical health of participants. Future research should focus on the long-term effects of preventive programs, including their application in different age groups and degrees of scoliosis. It is also recommended to examine the effectiveness of programs that combine corrective exercises with modern technological solutions, such as posture monitoring sensors and virtual reality. In addition, it is important to expand the samples to populations from different settings so that the results can be generalized and applied in a broader context.*

Key words: *Corrective gymnastics, exercises, rehabilitation, postural disorders.*

INTRODUCTION

Specific deformation caused by poor posture is not just one of the disorders, but includes several deformations, caused by active muscle tension. Poor posture is only one of the characteristics of weakness of the whole body and especially the joint-muscular apparatus, caused by weakness of other parts of the locomotor system (Bogdanović, 2005; Hajder, 2023). The period of growing up from 9-12 years, or the rapid transition from childhood to adolescence, causes significant changes in morphological characteristics and motor abilities that can indirectly affect postural status (Wojtys, 1987). Obesity and increased body weight in children lead to increased difficulties in movement and maintaining statistical balance (Shumway-Cook, 2001). Postural stability, sensory and motor systems in the period from 4-6 years go through a transitional period until they reach adult maturity at 7-10 years (Forssberg & Nashner, 1982; Shumway-Cook & Woollacott, 1985).

Reduced physical activity, school bags, excessive body weight, inappropriate school furniture are just some of the external influences that contribute to the development of spinal deformities in adolescents and primary school children during the growth period (Bunnell, 1986; Wiggins, 2003; Boos, 2008; Ha et al., 2015). In the last 15 years, the statistical percentage of deformities has increased significantly, especially idiopathic scoliosis deformities, which have increased in boys from 0.25% to 2.25% and in girls from 0.93% to 1.37% (Schlenk, 2003; Bogdanović, 2008; Altaf, 2013; Ailon, 2015). Spinal deformities, in addition to impairing and making motor skills difficult, can cause serious health problems such as disorders of the cardiorespiratory and locomotor systems due to a narrow and asymmetrical chest (Aebi, 2005; Youssef, 2013; Diebo, 2019). A deformity like this is accompanied by a decrease in physical activity, back pain, increased forced posture, the appearance of depression, fatigue, and a decrease in work capacity (Janicki, 2007; Berdishevsky, 2016; Gámiz-Bermúdez, Obrero-Gaitán, Zagalaz-Anula, & Lomas-Vega 2022). The above symptoms are most pronounced in adolescents and occur even in school-age children. In response to this problem, it is necessary to apply adequate corrective gymnastics exercises that will strengthen weakened muscles and bring the spine to a normal-correct state. In addition to corrective exercises, time plays a key role (Fusco et al., 2011). Disorders discovered in time while the spine is still functional are much easier to eliminate or correct than disorders that

progress or have already turned into deformity, where recovery is much more difficult and takes longer.

Therefore, the aim of this systematic review was to determine the effect of various corrective and preventive exercise programs on scoliosis, one of the most common postural disorders in children and young people.

MATHERIAL AND METHODS

Search Strategy

The literature review used electronic databases such as Scholar Google, PubMed, MEDLINE, relevant journals in the field of sports and medical sciences, as well as scientific publications that could answer the problem posed. Keywords for the electronic search included: "corrective gymnastics", "exercises", rehabilitation", "postural disorders".

Study selection

EndNote citation management software was utilized for literature screening, while duplicate detection was performed using Mendeley reference management software (v. 2.111.0, Copyright © 2024 Elsevier Ltd., Barcelona, Spain). The selection of papers was determined based on title, keywords and relevance to the topic, and the electronic databases PubMed, Web of Science, Scopus, MEDLINE, ERIC and Google Scholar were searched. Two criteria were set for the selection of papers. The first criterion refers to research that analyzes the effects of preventive and corrective programs, with an emphasis on physical exercises and therapeutic approaches aimed at improving postural status and alleviating scoliosis symptoms. The second criterion includes the time frame of the analysis, whereby papers published between 2012 and 2021 were considered, in order to ensure the relevance and timeliness of the data. Based on the defined criteria, ten scientific papers were selected that met the requirements for further analysis and were close to the subject of the research.

All disagreements were resolved through agreement between two researchers or with the help of a third. Two authors (A.N. and B.B.) independently reviewed and selected the searched papers. Selected papers were then cross-checked by the same two authors. The final decision for included papers was made by a third author (H.Đ.).

Methodological quality of studies

Methodological quality assessment of the included studies were performed independently according to the Physical Therapy Database (PEDro) scale, which involves 11 items. These items were displayed and rated as (+ or -), although numbers (1 or 0) can also be used. If the included study has six or more, then the quality of the study is considered high, results of 4-5 mean studies of moderate quality, while results of less than 4 correspond to studies of poor quality (Zhao et al., 2023).

RESULTS

The papers were selected from a ten-year period, taking into account those that could most closely offer solutions to the set topic. The analyzed articles provide an overview of the impact of corrective gymnastics physical exercise programs on postural disorders, with a special emphasis on the deformity of scoliosis. The analysis of the papers included in the review reveals a significant contribution of research in the field of preventive treatment programs for scoliosis. The presented papers focus on various aspects of analysis, rehabilitation and prevention of the development of deformities with a focus on the deformity scoliosis.

A total of 150 articles were identified through the database search. After removing duplicates and screening the articles based on their title, abstract, and other criteria 35 studies remained. Two researchers independently evaluated these 35 studies. Following the final screening, 10 studies met the set criteria and conditions and were included in the systematic review. The procedure for the collection, analysis, and elimination of the papers is shown in Figure 1.

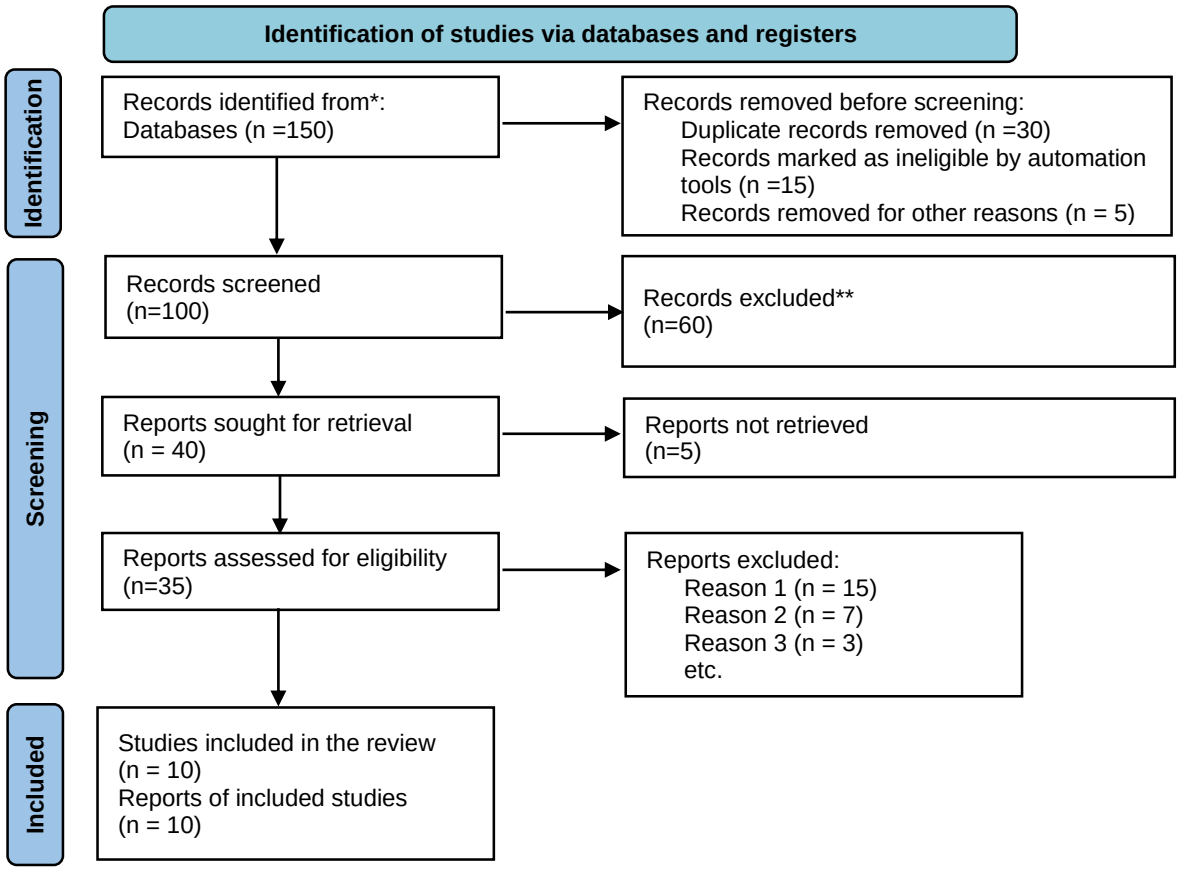

Figure 1 Diagram of included studies (Page et al., 2021)

The data extracted from the selected studies included the following: References, number of respodents, average age, program time, program type, and research results (see Table 1).

Table 1 Systematic review of the impact of preventive programs on spinal deformities with a focus on scoliosis

Authors	Number of respondents	Age	Program time	Program type	Research results
Monticone et al. (2014)	N=110 G1- 55 (control group); G2-55 (stabilization group).	12.45 ± 1.1	12 months	G1- Cobb's angle; TRA, SRS-22	Training in the experimental group led to a significant reduction in radiological deformity (Cobb angle >5), while the control group remained stable.
Kumar et al. (2017)	N= 36 G1- 18 (control group); G2- 18 (postural group for self-correlation).	11.8 ± 1.1	12 months	G1- Cobb's angle, FVC, FEV1, VC; G2-PEF	Post-intervention results showed significantly higher values of FVC (p=0.001), FEV1 (p=0.01) and VC (p=0.002) in the experimental group compared to the control group, with a greater reduction in Cobb angle (p=0.001) in the experimental group.

Zapata et al. (2015)	N= 24 G1- 17 (control group); G2- 17 (uncontrolled stabilization group).	14.9 ± 1.4	8 weeks	G1-NPRS, PSFS; G2- OSW, PDLRT	The supervised group showed significantly greater pain reduction and functional improvements (P < .01), while there were no differences between groups in back muscle endurance, as analyzed by the results of the Oswestry questionnaire or the Global Rating of Change.
Schreiber et al. (2016)	N= 50 G1- 25 (Schroth group); G2- 25 (control group).	13.4 ± 0.7	6 months	G1- Major curve; G2- Sum of curves;	After six months, the Schroth group had a significantly lower maximum angle of curvature (-3.5°, p = 0.006) and a lower Sum of Curves (-0.40°, p = 0.046) compared to the control group, with the difference increasing with the severity of the condition, while the per-protocol analysis showed even larger differences in the maximum angle of curvature (-4.1°, p = 0.002) and Sum of Curves (-0.8° to 0.2°, p = 0.006).
Diab et al. (2012)	N= 76 G1- 25 (control group); G2- 25(postural self-correction group).	13.9 ± 1.3	10 weeks 3 months	G1- Craniovertebral angle, trunk inclination, lordosis, kyphosis, imbalance, lateral deviation, pelvic torsion and rotation, FRI.	After 10 weeks, significant differences were recorded in the study group in several parameters, including craniovertebral angle (p = 0.006), trunk tilt (p = 0.005), lordosis (p = 0.01), kyphosis (p = 0.001), trunk imbalance (p = 0.001), lateral deviation (p = 0.001), pelvic torsion (p = 0.004), and surface rotation (p = 0.013), and these differences remained significant after three months, while there was no significant difference in the functional index after 10 weeks (p = 0.8), but a significant difference was achieved after three months (p = 0.001).
Zheng et al. (2018)	N=53 G1- 24 (control group); G2- 29 (experimental group).	12.4 ± 0.9	52 weeks 1 session 40 minutes	G1- Orthosis; G2-SEAS.	Both interventions, bracing and exercise, showed significant efficacy in the treatment of AIS, with the bracing group achieving better results in correcting spinal curvature (Cobb angle, P = 0.039) as well as improving shoulder balance (P < 0.005), while the exercise group had significantly greater improvements in quality of life, including functional status (P < 0.001), mental health (P < 0.001), and total score (P < 0.001), with significant improvements within both groups in parameters of spinal curvature and body symmetry.
Gao et al. (2019)	N=55 G1- 22 (control group); G2- 23 (experimental group).	12.15±1	24 weeks 7 sessions 10-15 minutes	G1- Orthosis; G2- SEAS + Orthosis.	After 6 months of the program, the group that used the orthosis in combination with exercise showed significantly better correction of the Cobb angle, improved back muscle endurance and lung function, while the group with orthotic intervention recorded a decrease in back muscle endurance and lung function.Significant differences were observed in back muscle endurance time and lung function parameters at the 6-month follow-up.

de Assis et al. (2021)	N=156 G1-78 (control group); G2- 78 (experimental group).	13±9	261 weeks	Adams test, Life habits, IPAQ, Rebolh questionnaire, postural habits, physical activity, scoliosis.	42.9% of participants were considered to be irregularly active, and only 33.3% practiced physical activity regularly. After bivariate analysis and conditional logistic regression, low physical activity was shown to be a risk factor for scoliosis (p = 0.041; OR: 2.81; 95% CI: 1.04–7.57), while the postural habits assessed in this study did not show a statistical association with scoliosis.
Scaturro et al. (2021)	N=428	11.76	2 school years (80 weeks)	Adams test, Bunnell inclinometer,Pre-intervention questionnaire.	Clinical assessment using the Adams test and Bunnell inclinometer indicated an association between suspected adolescent idiopathic scoliosis (AIS) and high-risk sports ($p < 0.05$), weekly physical activity longer than 3 hours ($p < 0.05$), low back pain ($p < 0.001$), postural disorders ($p < 0.01$), and lack of contact with a doctor ($p < 0.01$). In addition, high-risk sports (adj OR = 1.83; CI 95% 1.11–4.76) and postural disorders (adj OR = 1.67; CI 95% 1.12–3.60) showed a significant association with a confirmed diagnosis of AIS, defined by a Cobb angle ≥ 10° on X-ray.
Kocaman et al. (2021)	N=28G1-14 (schroth group); G2-14 (basic group).	14.14±2.28	10 weeks; 3 days a week	Basic strength training, Schroth exercises/Conventional therapy, Cobb angle.	Patients in the Schroth group showed greater improvement in Cobb angles, thoracic trunk rotation angle, aesthetic trunk deformity, spinal mobility, and quality of life than those in the baseline group ($p<0.05$), except for lumbar trunk rotation angle. Peripheral improvement in muscle strength was greater in the baseline group than in the Schroth.

Legend: group (G), statistical value (p), trunk rotation angle (TRA), Scoliosis Research Society Patient Outcomes questionnaire 22 (SRS-22), forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), vital capacity (VC), peak expiratory flow (PEF), Numeric Pain Rating Scale (NPRS), Global Rating of Change (GROC), Oswestry Low Back Pain Disability Questionnaire (OSW), Patient-Specific Functional Scale (PSFS), Functional Rating Index (FRI), Scientific Exercise Approach to Scoliosis (SEAS), entire simple (N), International Physical Activity Questionnaire (IPAQ).

The methodological quality assessment of the included studies

According to the PEDro scale, seven included studies (n=7) were of high quality, three studies (n=3) were of moderate quality, and no low-quality studies were included in this systematic review (Table 2).

Table 2 Physiotherapy Evidence Database (PEDro) score of the included studies

References	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Monticone et al. (2014)	+	+	+	+	-	-	-	-	-	+	+	6
Kumar et al. (2017)	+	+	-	-	-	-	-	+	-	+	+	5
Zapata et al. (2015)	+	+	-	-	-	-	-	-	+	+	+	5
Schreiber et al. (2016)	+	+	-	+	-	+	-	-	-	+	+	6
Diab et al. (2012)	+	+	-	+	+	-	-	+	-	+	+	7
Zheng et al. (2018)	+	+	+	+	-	-	-	-	-	+	+	6
Gao et al. (2019)	+	+	+	-	-	-	-	+	-	+	+	6
de Assis et al. (2021)	+	+	+	+	-	+	-	-	-	+	+	7
Scaturro et al. (2021)	+	+	-	+	-	-	-	+	-	+	+	6
Kocaman et al. (2021)	+	+	-	-	-	-	-	+	-	-	+	4

Legend: + indicates one point, - indicates no point. (1) Eligibility criteria, (2) Radomization, (3) Concealment of allocation, (4) Between-group homogeneity, (5) Blinded of subjects, (6) Blinded trainers, (7) Blinded testers, (8) Dropout rate < 15%, (9) Intention-to-treat, (10) Statistical between-group comparisons, (11) Point and variability estimates, (12) total scores.

DISCUSSION

The primary purpose of the study was to determine the effects of various corrective and preventive programs on scoliosis, one of the most common postural disorders in children and young people. The results obtained clearly indicate significant differences between the experimental and control groups, with the interventions implemented in the experimental groups leading to significant improvements (de Assis et al. 2021; Scaturro et al., 2021; Kocaman et al., 2021) in multiple dimensions, including reduction of radiological deformities (Cobb angle >5°) and improvements in physiological functions. The reduction in Cobb angle in the experimental groups, while the condition in the control groups remained stable, suggests that targeted interventions are crucial for modifying structural spinal deformities. This study is in line with previous research highlighting that conservative therapies, such as specific corrective exercises, can reduce the progression of scoliosis (Monticone et al., 2014).

Post-intervention data further indicate the benefits of interventions in the experimental groups, which showed significant improvements in pulmonary functions, including FVC ($p=0.001$), FEV1 ($p=0.01$) and VC ($p=0.002$). These results suggest that the increase in lung capacity is likely associated with the correction of thoracic spine deformities, which allows for a larger lung volume and improved ventilation. On the other hand, the control group did not show such changes, which emphasizes the importance of an active therapeutic approach, rather than relying on passive methods or lack of intervention. Analysis of long-term effects shows that significant improvements were maintained after six months. The Schroth group, which focuses on a three-dimensional corrective approach, showed a significant reduction in the maximum angle of curvature (-3.5°, $p=0.006$) and the Sum of Curves (-0.40°, $p=0.046$) compared to the control group. These results are even more pronounced when considering the per-protocol analysis, which showed an additional reduction in the maximum angle of curvature (-4.1°, $p=0.002$). These findings indicate the key role of precisely structured and supervised exercises in the treatment of adolescent idiopathic scoliosis, especially in patients with more severe deformities. Interestingly, the supervised group showed a significant reduction in pain and functional improvements ($p < 0.001$), while there were no differences in back muscle endurance between the groups. This study opens up a discussion about how interventions primarily affect subjective factors (such as pain), while objective factors, such as muscle endurance, require a longer period to achieve visible changes.

These results are consistent with research by Čuk et al. (2020), who state that pain reduction can be an early indicator of the effectiveness of interventions, while changes in muscle strength are a longer-term process. A particularly significant aspect of this study is the comparative analysis of different approaches. The group using orthoses showed better results in Cobb angle correction ($p=0.039$) and shoulder balance ($p<0.005$), while the exercise group showed greater improvement in quality of life, including mental health and functional status ($p<0.001$). These results highlight the different goals and effects of interventions – while orthoses may provide faster correction of deformities, exercise brings broader benefits to the overall health and quality of life of patients. The combination of orthosis and exercise produced significantly positive results and led to significant improvements in Cobb angle correction, back muscle endurance, and lung function. On the other hand, the isolated use of orthosis was associated with a decline in muscle endurance and lung function, indicating the potential negative effects of lack of physical activity.

These findings are in line with the literature that emphasizes the need for a holistic approach to the treatment of AIS (Negrini et al., 2018). When we analyze the broader aspects of these results, it is clear that targeted therapeutic exercises, such as the Schroth method, have significant potential for long-term reduction of deformity and improvement of functional capacity. These programs not only affect physiological parameters, but also psychological aspects, improving the quality of life of patients. Given that AIS often affects adolescents, timely and effective intervention can have lasting effects on their physical and mental health, reducing the risk of further complications in adulthood.

However, the results obtained should be interpreted with certain limitations. This systematic review analyzed only ten studies. Another limitation of the study is that the authors made general conclusions without examining whether scoliosis is more common in children or adolescents, or in boys or girls. Therefore, a recommendation for future researchers would be to examine whether there are differences in the incidence of scoliosis in boys and girls, or whether scoliosis is more common in children or

adolescents. It would also be interesting to conduct a meta-analysis in order to fully interpret the results obtained. It would also be interesting to further investigate individual factors that may influence the success of interventions, as well as to develop standardized protocols that will enable wider application of these methods in clinical practice.

CONCLUSION

The results of this study clearly indicate the importance of well-structured and targeted interventions in the treatment of adolescent idiopathic scoliosis. Experimental groups that applied specific therapeutic exercises, including the Schroth method, showed significant improvements in Cobb angle reduction, functional lung capacity, as well as subjective factors such as pain reduction and improved quality of life. In contrast, control groups did not record similar positive changes, which further confirms the effectiveness of the active therapeutic approach. Comparison between different treatment methods showed that orthoses were effective in correcting spinal deformities and balancing the shoulders, while exercises provided broader benefits, including significant improvements in functional status, mental health and quality of life. The combination of orthoses and exercise stood out as the most effective approach, ensuring comprehensive improvements in both structural deformities and functional abilities and general health of patients. Long-term analysis confirms the sustainability of these results, with the improvements achieved with the Schroth method and combined therapies remaining significant even after six months. At the same time, the negative effects of isolated orthosis use on functional parameters, such as muscle endurance and pulmonary function, emphasize the need for a multidisciplinary approach that also includes physical activity.

In conclusion, the results of this study confirm the importance of integrated therapeutic approaches in the treatment of adolescent idiopathic scoliosis. While isolated methods, such as orthosis, provide certain advantages in deformity correction, combined therapies provide much broader benefits, including functional and psychological improvements.

REFERENCES

1. Abdelaal, A., Munigangaiah, S., Trivedi, J., & Davidson, N. (2020). Magnetically controlled growing rods in the treatment of early onset scoliosis: a single centre experience of 44 patients with mean follow-up of 4.1 years. *Bone & Joint Open, 1*(7), 405–414.
2. Adam, C., & Dougherty, G. (2011). Applications of medical image processing in the diagnosis and treatment of spinal deformity. In Medical Image Processing: Techniques and Applications (pp. 227-248). New York, NY: Springer New York.
3. Aebi, M. (2005). The adult scoliosis. *European Spine Journal, 14,* 925-948.
4. Ailon, T., Smith, J. S., Shaffrey, C. I., Lenke, L. G., Brodke, D., Harrop, J. S., ... & Ames, C. P. (2015). Degenerative spinal deformity. *Neurosurgery, 77*, S75-S91.
5. Altaf, F., Gibson, A., Dannawi, Z., & Noordeen, H. (2013). Adolescent idiopathic scoliosis. *Bmj,* 346.
6. Berdishevsky, H., Lebel, V. A., Bettany-Saltikov, J., Rigo, M., Lebel, A., Hennes, A., ... & Durmala, J. (2016). Physiotherapy scoliosis-specific exercises–a comprehensive review of seven major schools. *Scoliosis and Spinal Disorders, 11,* 1-52.
7. Bogdanovic, Z. (2005), The impact of a programmed corrective gymnastics on postural status of primary school students. *PhD Thesis*, Nis. In Serbian
8. Bogdanovic, Z. (2008). [Spinal deformities in the sagital plane - prevention and correction]. *Monografija,* State University of Novi Pazar, Novi Pazar. In Serbian
9. Boos, N. (2008). *Spinal disorders: fundamentals of diagnosis and treatment* (Vol. 1165). M. Aebi (Ed.). Berlin: Springer.
10. Bunnell W. P. (1986). Spinal deformity. *Pediatric Clinics of North America, 33*(6), 1475–1487.
11. de Assis, S. J. C., Sanchis, G. J. B., de Souza, C. G., & Roncalli, A. G. (2021). Influence of physical activity and postural habits in schoolchildren with scoliosis. *Archives of Public Health*, *79*(1), 63.
12. Diab A. A. (2012). The role of forward head correction in management of adolescent idiopathic scoliotic patients: a randomized controlled trial. *Clinical Rehabilitation, 26*(12), 1123–1132.
13. Diebo, B. G., Shah, N. V., Boachie-Adjei, O., Zhu, F., Rothenfluh, D. A., Paulino, C. B., ... & Lafage, V. (2019). Adult spinal deformity. *The Lancet, 394*(10193), 160-172.

14. Forssberg, H., & Nashner, L. M. (1982). Ontogenetic development of postural control in man: adaptation to altered support and visual conditions during stance. *Journal of Neuroscience*, *2*(5), 545-552.
15. Fusco, C., Zaina, F., Atanasio, S., Romano, M., Negrini, A., & Negrini, S. (2011). Physical exercises in the treatment of adolescent idiopathic scoliosis: an updated systematic review. *Physiotherapy Theory and Practice, 27*(1), 80-114.
16. Gámiz-Bermúdez, F., Obrero-Gaitán, E., Zagalaz-Anula, N., & Lomas-Vega, R. (2022). Corrective exercise-based therapy for adolescent idiopathic scoliosis: Systematic review and meta-analysis. *Clinical Rehabilitation, 36*(5), 597-608.
17. Gao, C., Zheng, Y., Fan, C., Yang, Y., He, C., & Wong, M. (2019). Could the Clinical Effectiveness Be Improved Under the Integration of Orthotic Intervention and Scoliosis-Specific Exercise in Managing Adolescent Idiopathic Scoliosis?: A Randomized Controlled Trial Study. *American Journal of Physical Medicine & Rehabilitation, 98*(8), 642–648.
18. Goldberg, C. J., Moore, D. P., Fogarty, E. E., & Dowling, F. E. (2008). Scoliosis: a review. *Pediatric Surgery International, 24,* 129-144.
19. Ha, Y., Oh, J. K., Smith, J. S., Ailon, T., Fehlings, M. G., Shaffrey, C. I., & Ames, C. P. (2015). Impact of Movement Disorders on Management of Spinal Deformity in the Elderly. *Neurosurgery, 77* Suppl 4, S173–S185.
20. Hajder, D. (2023). Nutrition And Lifestyle Habits. *International Journal of Academic and Applied Research, 7*(2), 95-101.
21. Janicki, J. A., & Alman, B. (2007). Scoliosis: Review of diagnosis and treatment. *Pediatrics & Child Health, 12*(9), 771-776.
22. Kocaman, H., Bek, N., Kaya, M. H., Büyükturan, B., Yetiş, M., & Büyükturan, Ö. (2021). The effectiveness of two different exercise approaches in adolescent idiopathic scoliosis: A single-blind, randomized-controlled trial. *PloS One, 16*(4), e0249492.
23. Kumar, A., Kumar, S., Sharma, V., Srivastava, R. N., Gupta, A. K., Parihar, A., Verma, V., & Kumar, D. (2017). Efficacy of Task Oriented Exercise Program Based on Ergonomics on Cobb's Angle and Pulmonary Function Improvement in Adolescent Idiopathic Scoliosis- A Randomized Control Trial. *Journal of Clinical and Diagnostic Research 11*(8), YC01–YC04.
24. Monticone, M., Ambrosini, E., Cazzaniga, D., Rocca, B., & Ferrante, S. (2014). Active self-correction and task-oriented exercises reduce spinal deformity and improve quality of life in subjects with mild adolescent idiopathic scoliosis. Results of a randomised controlled trial. *European Spine Journal*, *23*, 1204-1214.
25. Scaturro, D., Costantino, C., Terrana, P., Vitagliani, F., Falco, V., Cuntrera, D., ... & Letizia Mauro, G. (2021). Risk factors, lifestyle and prevention among adolescents with idiopathic juvenile scoliosis: a cross sectional study in eleven first-grade secondary schools of Palermo province, Italy. *International Journal of Environmental Research and Public Health, 18*(23), 12335.
26. Schlenk, R. P., Kowalski, R. J., & Benzel, E. C. (2003). Biomechanics of spinal deformity. *Neurosurgical Focus, 14*(1), 1-15.
27. Schreiber, S., Parent, E. C., Khodayari Moez, E., Hedden, D. M., Hill, D. L., Moreau, M., Lou, E., Watkins, E. M., & Southon, S. C. (2016). Schroth Physiotherapeutic Scoliosis-Specific Exercises Added to the Standard of Care Lead to Better Cobb Angle Outcomes in Adolescents with Idiopathic Scoliosis - an Assessor and Statistician Blinded Randomized Controlled Trial. *PloS One, 11*(12), e0168746.
28. Shumway-Cook, A., & Woollacott, M. H. (1985). The growth of stability: postural control from a developmental perspective. *Journal of Motor Behavior*, *17*(2), 131-147.
29. Shumway-Cook, A. (2001). Motor control. *Theory and practical applications*.
30. Wiggins, G. C., Shaffrey, C. I., Abel, M. F., & Menezes, A. H. (2003). Pediatric spinal deformities. *Neurosurgical Focus, 14*(1), e3.
31. Wojtys EM, (1987), Section of Orthopaedic Surgery, University of Michigan, Ann Arbor. *The Orthopedic Clinics of North America,18*(4),689-708.
32. Woollacott, M., Inglin, B., & Manchester, D. (1988). Response preparation and posture control. Neuromuscular changes in the older adult. *Annals of the New York Academy of Sciences*, *515*, 42-53.
33. Youssef, J. A., Orndorff, D. O., Patty, C. A., Scott, M. A., Price, H. L., Hamlin, L. F., ... & Deviren, V. (2013). Current status of adult spinal deformity. *Global Spine Journal, 3*(1), 051-062.
34. Zapata, K. A., Wang-Price, S. S., Sucato, D. J., Thompson, M., Trudelle-Jackson, E., & Lovelace-Chandler, V. (2015). Spinal stabilization exercise effectiveness for low back pain in adolescent idiopathic scoliosis: a randomized trial. *Pediatric Physical Therapy*, *27*(4), 396-402.
35. Zhao, H., Teng, J., Song, G., Fu, X., Pan, X., Shen, S., ... & Liu, C. (2023). The optimal exercise parameters of Tai Chi on the effect of glucose and lipid metabolism in patients with type 2 diabetes mellitus: A meta-analysis. *Complementary Therapies in Medicine,* 102995.

36. Zheng, Y., Dang, Y., Yang, Y., Li, H., Zhang, L., Lou, E. H. M., He, C., & Wong, M. (2018). Whether Orthotic Management and Exercise are Equally Effective to the Patients With Adolescent Idiopathic Scoliosis in Mainland China?: A Randomized Controlled Trial Study. *Spine, 43*(9), E494–E503.

UTICAJ PREVENTIVNIH PROGRAMA VJEŽBANJA NA SKOLIOZU

Veselinović Zorana, Hajder Đorđe, Bjelica Bojan, Pržulj Radomir, Aksović Nikola, Dobrescu Tatiana, Bubanj Saša

Sažetak: *Cilj istraživanja bio je da se utvrdi efekat različitih korektivnih i preventivnih programa na skoliozu, kao jedan od najčešćih posturalnih poremećaja kod djece i mladih. U pregledu literature korištene su elektronske baze podataka kao što su PubMed, Web of Science, Scopus, MEDLINE, ERIC i Google Scholar. Na osnovu unaprijed definisanih kriterijuma, analizirano je sedam studija koje su zadovoljile standarde kvaliteta. Rezultati istraživanja ukazuju na to da preventivni programi koji uključuju specijalizovane vježbe, korektivnu gimnastiku i individualno prilagođene intervencije značajno doprinose smanjenju ugla iskrivljenja kičme i poboljšanju posturalnog stanja. Takođe, pokazano je da redovna primjena ovakvih programa pozitivno utiče na funkcionalne sposobnosti i psihofizičko zdravlje učesnika. Naredna istraživanja trebala bi staviti fokus na dugoročne efekte preventivnih programa, uključujući njihovu primjenu u različitim uzrasnim grupama i stepenima skolioze. Takođe, preporučuje se ispitivanje efikasnosti programa koji kombinuju korektivne vježbe sa modernim tehnološkim rješenjima, kao što su senzori za praćenje držanja i virtuelna stvarnost. Pored toga, važno je proširiti uzorke na populacije iz različitih okruženja kako bi se rezultati mogli generalizovati i primjeniti u širem kontekstu.*
Ključne riječi: *Korektivna gimnastika, vježbe, rehabilitacija, posturalni poremećaji.*