THE IMPACT OF SPORTS ACTIVITIES ON THE OCCURRENCE AND COURSE OF SPINAL DEFORMITY IN PATIENTS WITH IDIOPATHIC SCOLIOSIS: A LITERATURE REVIEW

S.A. Gevorgiz[1], D.A. Glukhov[1], S.O. Ryabykh[1, 3], Yu.A. Fedorova[2], A.V. Gubin[1]
[1]*The Pirogov Clinic of High Medical Technologies at St. Petersburg University, Saint Petersburg, Russia;*
[2]*R.R. Vreden National Medical Research Centre of Traumatology and Orthopaedics, Saint Petersburg, Russia;*
[3]*Yu.E. Veltishchev Research and Clinical Institute for Pediatrics and Pediatric Surgery, Moscow, Russia*

Objective. To analyze current literature data on the relationship between sports and physical activity and the development and course of spinal deformity in adolescents with idiopathic scoliosis.

Material and Methods. A narrative review of 20 publications selected from the PubMed, ScienceDirect, Google Scholar, and eLibrary databases without restrictions on language or publication year was performed. The analysis included studies related to the epidemiology of adolescent idiopathic scoliosis, the prevalence of spinal deformity among adolescents engaged in various sports, and the effects of physical activity on disease course, functional status, and quality of life of patients. Studies focusing on postoperative management and specific methods of scoliosis correction were excluded.

Results. The analysis did not reveal convincing evidence of a causal relationship between sports activities and the development of adolescent idiopathic scoliosis. The increased incidence of idiopathic scoliosis observed in certain aesthetic sports is likely due to biological and anthropometric factors, as well as a selection effect, rather than the impact of sports activities. Most studies demonstrate no negative effect of physical activity on the spinal deformity progression. Regular sports activities are associated with improved physical performance, psycho-emotional state, and quality of life in adolescents with idiopathic scoliosis.

Conclusion. Current data demonstrate the safety of physical activity in adolescent idiopathic scoliosis. Routine restrictions on exercise lack sufficient evidence and may negatively impact patients' overall well-being and quality of life.

Key Words: adolescent idiopathic scoliosis; physical activity; sports; spinal deformity; adolescents; quality of life.

Please cite this paper as: *Gevorgiz SA, Glukhov DA, Ryabykh SO, Fedorova YuA, Gubin AV. The impact of sports activities on the occurrence and course of spinal deformity in patients with idiopathic scoliosis: a literature review. Russian Journal of Spine Surgery (Khirurgiya Pozvonochnika). 2026;23(1):48–55. In Russian. DOI: http://dx.doi.org/10.14531/ss2026.1.48-55*

Adolescent idiopathic scoliosis (IS) is the most common structural spinal deformity in children and adolescents. The prevalence of adolescent IS in the general population fluctuates in the range of 1–3%, reaching 5.2% in large population studies [1]. With progressing deformities, a significant predominance of girls is noted, which is confirmed by a gender ratio of 7:1 at a deformity magnitude according to Cobb of more than 40° [1].

Physical activity is a key component of the normal development of the musculoskeletal system of adolescents. According to the data of the World Health Organization, 81% of adolescents aged 11–17 years do not achieve the minimum recommended level of activity [2]. Physical inactivity is associated with deterioration of metabolic indicators, a decrease in muscle strength, impairments of psycho-emotional state and a deterioration of the quality of life.

The impact of sports activity on the risk of developing adolescent IS remains a subject of discussion. Studies of individual sports demonstrate both potentially unfavorable and protective effects. Tanchev et al. [3] established a tenfold higher prevalence of scoliosis in girls engaged in rhythmic gymnastics (12.0 % vs. 1.1% in the population). Similar data are shown for professional ballerinas, among whom an increased prevalence of scoliosis associated with delayed menarche and a low body mass index was revealed [4]. However, the results of large epidemiological studies show a different picture. In a prospective study by Watanabe et al. [5] (n = 2600) it was noted that the majority of sports are not associated with an increased risk of adolescent IS, and playing basketball and badminton, on the contrary, reduces the probability of the presence of scoliosis [5]. In turn, a systematic review by Mousavi et al. [6] showed a different prevalence of adolescent IS among athletes in various directions, while the heterogeneity of risk factors and methodological approaches was emphasized.

Thus, the available data are characterized by significant variability due to differences in age groups, training regimens, level of sports specialization, duration of activities and initial predisposition (hypermobility of joints and spine, low body mass index, delayed puberty).

The objective of the current review is to summarize the data of modern literature devoted to the epidemiology of adolescent IS and the impact of engaging in various sports on the risk of its

occurrence, progression and functional outcomes.

Taking into account the deficit of cohort studies and the absence of data identity, we intentionally abandoned a systematic review in favor of a narrative one.

Material and Methods

A narrative review of 20 domestic and foreign publications selected in the databases PubMed, ScienceDirect, Google Scholar and eLibrary without language and time restrictions was conducted. The analysis included studies dedicated to the prevalence of IS in adolescents engaged in various sports, as well as evaluating the impact of physical activity on the functional state and quality of life of patients. In the analysis, the level of sports training (amateur/professional) was taken into account if there was data in the studies; in their absence, the level was regarded as unspecified. Works dedicated to the postoperative period and specific methods of scoliosis correction were excluded.

Results and Discussion

Prevalence and demographic features of adolescent idiopathic scoliosis

Adolescent IS is registered in approximately 0.5–5.0% of clinically healthy adolescents, while in the majority of population studies the frequency of curvatures of 10° and more according to Cobb constitutes 2–3% [1, 6]. The prevalence of adolescent IS varies depending on age, the threshold value of the Cobb angle, screening methods and ethnic characteristics of the studied population [1].

The peak of IS manifestation falls on the period of rapid pubertal growth (girls aged 10–14, boys aged 12–16), which reflects the dependence of deformity progression on somatic growth rates [1]. At the same time, pronounced gender dimorphism is revealed: the ratio of girls and boys in small curves is close to 1:1, but in deformities greater than 30° it reaches 7–10:1 [1, 7]. In the majority of observational studies it is indicated that only a part of the identified scoliotic curves has a clinically significant progression potential. According to epidemiological series, the proportion of patients reaching angles of 30 degrees and more according to Cobb and requiring active orthopedic or surgical treatment is less than 10–15% of all cases of IS [1]. This emphasizes the need for differentiation between mild scoliotic deformities, including scoliotic posture, and true IS with a high risk of progression.

General physical activity of children and adolescents

According to the updated recommendations of the World Health Organization, children and adolescents aged 5–17 are recommended to have at least 60 minutes of moderate or vigorous aerobic physical activity daily with the inclusion of muscle and bone-strengthening exercises at least three times a week [2].

A global analysis including data from more than 1.6 mln. schoolchildren from 146 countries showed that about 81% of adolescents (85% of girls and 78% of boys) do not reach the recommended level of activity [8]. In many countries, there is no improvement in these indicators over the last decade, which reflects a steady trend towards adolescent physical inactivity [8].

Insufficient physical activity is associated with deterioration of both somatic and mental health. A systematic review by Wu et al. [9] demonstrated a stable positive link between overall physical activity and indicators of quality of life, self-esteem and mental well-being of children and adolescents. A similar review by Rodriguez-Ayllon et al. [10] showed that a higher level of physical activity is associated with lesser severity of depression, anxiety, stress reactions and better psychological adaptation.

Thus, the overwhelming majority of adolescents, including potential patients with IS, live in conditions of a chronic deficit of general physical activity relative to international recommendations [2, 8]. This must be taken into account when interpreting data on the role of sports and physical activity in the occurrence and course of IS.

Physical activity in patients with adolescent idiopathic scoliosis

Studies assessing the level of physical activity in adolescents with IS demonstrate mixed results and significant methodological heterogeneity. In a large Japanese case-control comparative study Watanabe et al. [5] showed that long-term intensive practices of certain sports (primarily rhythmic gymnastics and ballet) were associated with increased odds of identifying IS, whereas playing basketball and badminton was accompanied by a lower risk. At the same time, the authors emphasized the impossibility of uniquely identifying a causal link, considering the possible pre-selection of children with an already existing, not yet diagnosed deformity.

In contrast to this data, Kenanidis et al. [11] in a cross-sectional study of 99 adolescents with IS and a control group did not reveal a connection between systematic sports activities and the development of IS, and also did not find an impact of continuing sports activity on the progression of an already formed deformity.

Meyer et al. [12] showed that adolescents with IS more often engage in gymnastics compared to healthy peers, which may reflect both selective engagement into aesthetic sports and features of physique and motor skills in these patients. At the same time, the type and localization of the scoliotic curve impact the structure of sports activity: for example, in thoracic curves, a restriction on engaging in sports with pronounced axial loading is more often noted.

Systematic reviews and summarizing publications show that existing studies on the relationship between overall physical activity and IS are characterized by significant heterogeneity in design, selection criteria and activity assessment methods, which does not allow drawing a conclusion about physical activity as an independent risk factor or a method of prevention [6, 11].

In the majority of works, the level of overall activity in patients with IS was comparable or only slightly differed from population values, while the main differ-

ence concerned specific sports – gymnastics, ballet, figure skating, etc. [5, 6].

A separate line of studies is related to the impact of physical activity on the functional state and quality of life of patients with IS. A number of works have shown that aerobic training (walking, running, cycle ergometry, swimming) improves exercise tolerance, lung function indicators and subjective well-being in adolescents with moderate IS [13, 14].

In a retrospective comparative study by Segreto et al. [7], engaging of adolescents with IS in «non-contact» sports (athletics, swimming, cyclic types, dancing, etc.) was not accompanied by an increase in the Cobb angle compared to inactive patients, but was associated with higher indicators of function, self-esteem and overall satisfaction according to the SRS-30 questionnaire, as well as a more favorable perception of the deformity by parents.

In aggregation, the presented data indicate the absence of a negative impact of overall physical activity and most sports on the course of IS and emphasize their potentially favorable role in maintaining the functional state and quality of life of patients [8, 10, 11].

International recommendations on physical activity in adolescent idiopathic scoliosis

The consensus documents of the SOSORT and their updated versions indicate that overall physical activity and sports are not contraindicated for patients with IS and should be encouraged in accordance with the age recommendations of the World Health Organization [13, 14]. Restrictions may apply only to certain types of activities with a high risk of injury or extreme axial loading and are determined individually.

Systematic reviews and population studies have not revealed convincing data that sports or a high level of physical activity accelerate the progression of IS; conversely, the majority of works demonstrate a neutral or favorable impact of physical activity on functional and psycho-emotional outcomes [15–17]. In this regard, modern recommendations consider maintaining physical activity as an important component of the comprehensive management of patients with IS along with observation, orthotic treatment and therapeutic physical training [13].

Biomechanical and biological factors associated with sports, and their role in the development of adolescent idiopathic scoliosis

Some biomechanical and biological characteristics more frequently encountered in athletes of aesthetic and coordinationally complex sports are considered as possible factors capable of explaining the observed association between sports and IS. Such factors include generalized joint hypermobility, which is more often identified in female rhythmic gymnastics and ballet athletes and can create biomechanical prerequisites for increased spinal mobility during the growth period [3, 4]. Furthermore, adolescents systematically engaged in intensive training often note a low body mass index and delayed puberty, which are associated with a prolongation of the period of active spinal growth and increased susceptibility to mechanical impacts [4, 5].

The role of asymmetrical training loads is also discussed; however epidemiological studies do not confirm a causal link between asymmetrical sports activity and the development of structural scoliotic deformities. In studies controlling for anthropometric and biological factors, asymmetrical sports were not associated with an increased risk of IS, and in a number of cases demonstrated neutral or even protective effects [5, 16].

Thus, the listed factors most likely reflect the initial constitutional and biological features of adolescents, predisposing them both to the choice of certain sports and to the detection of IS, rather than a direct impact of sports activity on the formation of spinal deformity.

Prevalence of adolescent idiopathic scoliosis in various sports

The question of a possible connection between certain sports and the development of IS has been a subject of discussion for many years. Modern data indicate the absence of evidence that sports activity can be a direct cause of the formation of a structural scoliotic deformity. Historically, rhythmic gymnastics has attracted the most attention, since Tanchev et al. [3] revealed a higher frequency of IS among female gymnasts compared to the general adolescent population. However, the interpretation of these data is limited by the lack of information about the condition of the spine prior to beginning activities, the pronounced hypermobility and low body mass index in the athletes, as well as the peculiarity of anthropometric selection into this sport. Subsequent larger studies did not confirm the role of gymnastics as a factor in the formation of IS, and the systematic review by Mousavi et al. [6] emphasizes that the observed association more likely reflects a combination of biological characteristics of the athletes themselves rather than the impact of the training process.

A similar situation is observed in classical ballet. Warren et al. [4] note somewhat higher prevalence of scoliosis among ballerinas, however, as in gymnastics, data on the presence of deformity prior to admission to professional schools were absent, and the athletes themselves had a low body mass, delayed puberty and joint hypermobility. A large epidemiological study by Watanabe et al. [5], conducted among 2600 Japanese schoolgirls, revealed only a moderate association between engaging in ballet and the presence of IS without confirmation of causal links, which was also regarded as a possible result of biased selection, and not a consequence of the training load.

Of particular interest are sports traditionally considered symmetrical, primarily swimming. In a number of publications of the past decade, a possible relationship between swimming and posture disorders was suggested, however, modern studies, including the works of Zaina et al. [16, 17], did not find an increase in the risk of IS in swimmers and synchronized swimming athletes. A clinical observation of monozygotic twins with IS engaged in synchronized swimming, presented by Potoupnis et al. [18], demonstrated a different severity of scoliosis in them, which focuses greater attention on the leading role of individual predisposition, rather than sports load as a direct risk factor for the formation of deformity.

Regarding team sports, literature data demonstrate a predominantly neutral or even potentially protective impact. According to the data of Watanabe et al. [5], engaging in basketball and badminton was associated with a decrease in the probability of identifying IS. The authors emphasize that these sports are characterized by a high variability of motor actions, symmetrical involvement of muscle groups and the absence of extreme statodynamic regimes, which biomechanically reduces the load on the growing spinal column of the adolescent.

Asymmetrical sports, such as tennis, badminton, fencing, in which the dominance of one side and repetitive movements of the same type could be considered as potentially unfavorable, require separate discussion. Accumulated data convincingly show that asymmetrical sports loads do not increase the risk of IS formation. Thus, in the studies mentioned above, tennis and badminton did not demonstrate an increase in the frequency of scoliosis [5], the distribution of scoliotic curves among athletes of various disciplines did not reveal statistically significant differences compared to the control group [16]. Kenanidis et al. [11] also did not find a connection between systematic sports activities and the presence of IS in adolescents.

A summary analysis of data on various disciplines shows that moderate and even specialized sports activity in childhood is not the cause of IS formation, and the observed differences in the frequency of scoliosis between individual groups of athletes are explained predominantly by biological characteristics and selection mechanisms in specific sports. The majority of modern studies of a high methodological level demonstrate either a neutral or a potentially favorable impact of sports on the state of the spine, which confirms the safety of engaging children and adolescents with IS in various forms of physical activity.

Sports, functional state and quality of life of adolescents with idiopathic scoliosis

The functional state and quality of life of patients with IS are key parameters when assessing the impact of physical activity and sports activities. Modern data convincingly testify that the physical activity of adolescents with IS, including regular sports, does not lead to an increase in the severity of the deformity, does not worsen clinical indicators and, conversely, can be accompanied by significant improvements in both physical and psycho-emotional state.

One of the most informative studies in this direction is the work of Segreto et al. [7], which demonstrated that adolescents with IS participating in sports activities are characterized by higher indicators of quality of life according to the SRS-30 questionnaire, including the scales of physical function, activity, self-esteem and satisfaction with appearance, compared to inactive peers. A more favorable perception of the disease by parents was also noted, which emphasizes the socio-psychological effect of regular physical activity. An important observation was the absence of statistically significant differences in the dynamics of the Cobb angle between the active and inactive groups, which confirms the safety of the participation of adolescents with IS in sports activities.

A number of studies devoted to the impact of aerobic loads and cyclic activity showed an improvement in functional characteristics in patients with IS. In the review by Wu et al. [9], a stable positive connection between overall physical activity and the level of mental well-being, self-esteem and indicators of social adaptation of adolescents was demonstrated. Similar conclusions are presented by Rodriguez-Ayllon et al. [10], who emphasize the positive impact of regular physical loads on the reduction of the level of anxiety, depressive symptoms and improvement of the overall psychological state of adolescents. These works confirm that physical activity exerts not only a favorable somatic, but also a pronounced therapeutic effect on the psycho-emotional status of adolescents with chronic diseases, including IS.

A significant contribution to the understanding of the functional aspects of the condition of patients with adolescent IS was made by the study of Diarbakerli et al. [19], which demonstrated a decrease in quality-of-life indicators in adolescents with IS compared to age norms, especially in the domains of self-esteem and perception of appearance. These data emphasize the importance of preserving and stimulating physical activity as a way of improving self-perception, social integration and overall psycho-emotional well-being of adolescents with spinal deformities. Moreover, Segreto et al. [7] testify that physical activity helps to level out some of the negative psychosocial consequences of IS, without exerting a negative impact on the course of the disease.

A separate line of research concerns the impact of physical activity on respiratory function in patients with IS. The classic work of Kesten et al. [20] demonstrated that aerobic loads improve pulmonary function indicators and exercise tolerance in adolescents with moderate scoliotic curves, which is an important aspect of their overall physical performance and quality of life. The presence of mild or moderate scoliosis, thus, is not an obstacle to aerobic training and can be considered as a functionally significant direction of correction of the adolescents' condition.

The totality of data shows that the participation of patients with IS in sports activities is not only safe, but also possesses a pronounced potential for improving functional state and quality of life. The absence of a negative impact of sports on the progression of deformity is confirmed in studies of various designs, and the demonstrated positive changes in physical and psychological state allow considering physical activity as an important component of the comprehensive management of adolescents with IS [7, 9, 19].

Thus, modern literature data testify that regular physical activity and participation in sports activities are safe for adolescents with IS and can exert a protective impact on the functional state, emotional well-being and quality of life of patients.

Modern contradictions and unresolved issues

Despite a significant number of publications devoted to the relationship

between physical activity and IS, the interpretation of available data remains difficult due to methodological limitations. One of the key factors is the lack of prospective studies allowing for a clear differentiation between the initial biological characteristics of adolescents and the possible impact of sports load. In many works, spinal deformity was registered already after the start of sports activities, which does not allow excluding an initial predisposition to the formation of IS.

A significant role is played by systematic selection bias. Aesthetic sports traditionally attract adolescents with certain anthropometric and biological characteristics, such as joint hypermobility, low body mass index and delayed puberty [3, 4], which in themselves are associated with an increased risk of IS. In large epidemiological studies, adjusting for these factors significantly weakened or completely eliminated the identified associations between the type of sport and the presence of IS [5].

Additional contradictions are associated with the heterogeneity of methods for assessing physical activity and criteria for diagnosing scoliosis, including differences in threshold values of the Cobb angle, which leads to pronounced statistical heterogeneity and complicates the formation of unified conclusions [6].

The presence of an association between individual sports and the frequency of IS does not testify to a causal link. The absence of data on the state of the spine prior to the start of activities and the results of observations of monozygotic twins engaged in the same sport with varying severity of deformity emphasize the leading role of genetic and biological factors compared to the impact of sports load [18].

Despite ongoing assumptions about a possible negative impact of asymmetrical sports, modern epidemiological studies do not confirm their connection with the risk of IS formation [11, 16].

In aggregate, the indicated limitations testify to the lack of reliable data in favor of a causal link between sports activity and the formation of IS.

Conclusion

Analysis of modern data shows that sports activity is not a factor initiating the formation of IS. Despite historically ingrained notions about the potentially unfavorable impact of sports, including aesthetic and asymmetrical disciplines, available studies do not confirm a causal link between training load and the development of structural scoliotic deformities. The increased frequency of IS observed in certain sports is largely due to the biological characteristics of adolescents and the effect of systematic selection bias, rather than the impact of sports activity itself.

Large epidemiological studies demonstrate the absence of an unfavorable impact of most sports on the risk of IS formation, and in a number of cases – a neutral or potentially protective impact, especially regarding team disciplines. Data on asymmetrical sports also do not confirm an increase in the risk of scoliotic deformity in adolescents systematically engaged in physical activity.

Along with this, physical activity exerts a favorable impact on the functional state and quality of life of adolescents with IS, contributing to the improvement of physical performance, psycho-emotional well-being and perception of the disease, without a negative impact on the magnitude of deformity.

Thus, rational physical activity is safe and clinically justified for adolescents both without scoliosis and in the presence of IS. Quitting sports amid IS has no evidence base, and recommendations on limiting physical activity should be formed individually, taking into account the clinical picture and features of a specific type of activity.

The obtained data can be used in the formation of clinical guidelines for the management of adolescents with IS and in counseling patients and their parents.

References

1. **Konieczny MR, Senyurt H, Krauspe R.** Epidemiology of adolescent idiopathic scoliosis. *J Child Orthop*. 2013;7:3–9. DOI: 10.1007/s11832-012-0457-4
2. **Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, Carty C, Chaput JP, Chastin S, Chou R, Dempsey PC, DiPietro L, Ekelund U, Firth J, Friedenreich CM, Garcia L, Gichu M, Jago R, Katzmarzyk PT, Lambert E, Leitzmann M, Milton K, Ortega FB, Ranasinghe C, Stamatakis E, Tiedemann A, Troiano RP, van der Ploeg HP, Wari V, Willumsen JF.** World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med.* 2020;54:1451–1462. DOI: 10.1136/bjsports-2020-102955
3. **Tanchev PI, Dzherov AD, Parushev AD, Dikov DM, Todorov MB.** Scoliosis in rhythmic gymnasts. *Spine (Phila Pa 1976)*. 2000;25:1367–1372. DOI: 10.1097/00007632-200006010-00008
4. **Warren MP, Brooks-Gunn J, Hamilton LH, Warren LF, Hamilton WG.** Scoliosis and fractures in young ballet dancers. Relation to delayed menarche and secondary amenorrhea. *N Engl J Med.* 1986;314:1348–1353. DOI: 10.1056/NEJM198605223142104
5. **Watanabe K, Michikawa T, Yonezawa I, Takaso M, Minami S, Soshi S, Tsuji T, Okada E, Abe K, Takahashi M, Asakura K, Nishiwaki Y, Matsumoto M.** Physical activities and lifestyle factors related to adolescent idiopathic scoliosis. *J Bone Joint Surg Am.* 2017;99:284–294. DOI: 10.2106/JBJS.16.00459
6. **Mousavi SJ, Seidi F, Minoonejad H, Nikouei F.** Prevalence of idiopathic scoliosis in athletes: a systematic review and meta-analysis. *BMJ Open Sport Exerc Med.* 2022;8:e001312. DOI: 10.1136/bmjsem-2022-001312
7. **Segreto FA, Messina JC, Doran JP, Walker SE, Aylyarov A, Shah NV, Mixa PJ, Ahmed N, Paltoo K, Opare-Sem K, Kaur H, Day LM, Naziri Q, Paulino CB, Scott CB, Hesham K, Urban WP, Diebo BG.** Noncontact sports participation in adolescent idiopathic scoliosis: effects on parent-reported and patient-reported outcomes. *J Pediatr Orthop B.* 2019;28:356–361. DOI: 10.1097/BPB.0000000000000574
8. **Guthold R, Stevens GA, Riley LM, Bull FC.** Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based survey with 1.6 million participants. *Lancet Child Adolesc Health.* 2020;4:23–35. DOI: 10.1016/S2352-4642(19)30323-2
9. **Wu XY, Han LH, Zhang JH, Luo S, Hu JW, Sun K.** The influence of physical activity, sedentary behavior on health-related quality of life among the general population of children and adolescents: A systematic review. *PLoS One*. 2017;12:e0187668. DOI: 10.1371/journal.pone.0187668
10. **Rodriguez-Ayllon M, Cadenas-S nchez C, Est vez-L pez F, Mu oz NE, Mora-Gonzalez J, Migueles JH, Molina-Garc a P, Henriksson H, Mena-Molina A, Mart nez-Vizca no V, Catena A, L f M, Erickson KI, Lubans DR, Ortega FB, Esteban-Cornejo I.** Role of physical activity and sedentary behavior in mental health of preschoolers,children and adolescents: a systematic review and meta-analysis. *Sports Medicine*. 2019;49:1383–1410. DOI: 10.1007/s40279-019-01099-5
11. **Kenanidis E, Potoupnis M, Papavasiliou K, Sayegh FE, Kapetanos GA.** Adolescent idiopathic scoliosis and exercising: is there truly a correlation? *Spine (Phila Pa 1976)*. 2008;33:2160–2165. DOI: 10.1097/BRS.0b013e31817d6db3
12. **Meyer C, Haumont T, Gauchard GC, Leheup B, Lascombes P, Perrin PP.** The practice of physical and sporting activity in teenagers with idiopathic scoliosis is related to the curve type. *Scand J Med Sci Sports*. 2008;18:751–755. DOI: 10.1111/j.1600-0838.2007.00750.x
13. **Negrini S, Donzelli S, Aulisa AG, Czaprowski D, Schreiber S, de Mauroy JC, Diers H, Grivas TB, Knott P, Kotwicki T, Lebel A, Marti C, Maruyama T, O'Brien J, Price N, Parent E, Rigo M, Romano M, Stikeleather L, Wynne J, Zaina F.** 2016 SOSORT guidelines: orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth. *Scoliosis Spinal Disord.* 2018;13:3. DOI: 10.1186/s13013-017-0145-8
14. **Negrini S, Fusco C, Minozzi S, Atanasio S, Zaina F, Romano M.** Exercises reduce the progression rate of adolescent idiopathic scoliosis: results of a comprehensive systematic review of the literature. *Disabil Rehabil.* 2008;30:772–785. DOI: 10.1080/09638280801889568
15. **Green BN, Johnson CD, Moreau W.** Is physical activity contraindicated for adolescents with idiopathic scoliosis? A systematic literature review. *J Chiropr Med.* 2009;8:25–37. DOI: 10.1016/j.jcm.2008.11.001
16. **Zaina F, Donzelli S, Lusini M, Minnella S, Negrini S.** Swimming and spinal deformities: a cross-sectional study. *J Pediatr*. 2015;166:163–167. DOI: 10.1016/j.jpeds.2014.09.024
17. **Zaina F, Donzelli S, Lusini M, Fusco C, Minnella S, Negrini S.** Tennis is not dangerous for the spine during growth: results of a cross-sectional study. *Eur Spine J*. 2016;25:2938–2944. DOI: 10.1007/s00586-016-4452-1
18. **Potoupnis ME, Kenanidis E, Papavasiliou KA, Kapetanos GA.** The role of exercising in a pair of female monozygotic (high-class athletes) twins discordant for adolescent idiopathic scoliosis. *Spine (Phila Pa 1976)*. 2008;33:E607–E610. DOI: 10.1097/BRS.0b013e31817c4ef3
19. **Toren S, Diarbakerli E.** Health-related quality of life in adolescents with idiopathic scoliosis: a cross-sectional study including healthy controls. *Eur Spine J.* 2022;31:3512–3518. DOI: 10.1007/s00586-022-07428-z
20. **Kesten S, Garfinkel SK, Wright T, Rebuck AS.** Impaired exercise capacity in adults with moderate scoliosis. *Chest.* 1991;99:663–666. DOI: 10.1378/chest.99.3.663

Received 16.01.2026
Review completed 03.02.2026
Passed for printing 18.02.2026

Additional information

Author contributions. S.A. Gevorgiz – concept and design of the study, literature analysis, writing the main text of the article, formulation of conclusions, coordination of the work of the author team, duties of the corresponding author; D.A. Glukhov – scientific supervision, critical analysis of literature, editing of the manuscript; S.O. Ryabykh – analysis and interpretation of data, participation in the preparation of the «Discussion» and «Conclusion» sections, scientific editing of the text; Yu.A. Fedorova – analysis and interpretation of data, scientific editing of the text; A.V. Gubin – general scientific supervision, expert evaluation of the content, approval of the final version of the article. All authors approved the manuscript (the version for publication), and also agreed to bear responsibility for all aspects of the work, guaranteeing proper consideration and resolution of issues related to the accuracy and integrity of any part of it.

Funding sources. None.

Disclosure of interests. The authors declare no conflict of interest.

Authors' Info

✉Sofia Aleksandrovna Gevorgiz; 13–15 Kadetskaya Line, Vasilyevsky Island, Saint Petersburg, 199004, Russia; eLibrary SPIN: 1337-7254; ORCID: 0000-0002-3489-3658; sofiagevorgiz@gmail.com

Dmitrii Aleksandrovich Glukhov, MD, Cand. Sci. (Medicine); eLibrary SPIN: 3376-2569; ORCID: 0000-0002-6880-8562; dmitriy.a.glukhov@gmail.com

Sergey Olegovich Riabykh, MD, Dr. Sci. (Medicine); eLibrary SPIN: 6382-1107; ORCID: 0000-0002-8293-0521; rso_@mail.ru

Yulia Andreevna Fedorova, MD, Cand. Sci. (Medicine); eLibrary SPIN: 3911-4108; ORCID: 0000-0003-3842-2113; julsigareva@gmail.com

Alexander Vadimovich Gubin, MD, Dr. Sci. (Medicine), Professor; eLibrary SPIN: 2014-6518; ORCID: 0000-0003-3234-8936; shugu19@gubin.spb.ru