

# Postural Status And Kyphosis In School-Age Children

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**Abstract:** *Postural deformity is an irregular and asymmetrical posture that deviates from normal alignment without structural constraints. The human spinal column is in the shape of an elongated letter S, which is very important for his biomechanics. The aim of this study was to determine the deformity of the spine, as well as the possibility of correction and treatment. The method of work is the collection of relevant literature in the period from 2002 to 2020 and their analysis. The research included seventeen original scientific papers, which satisfied the research problems and could provide an answer to the set goal. With the help of the found research, we can freely say that spinal deformity in children is very often manifested through numerous multiple congenital and acquired disorders in childhood. The results showed an increase in deformities primarily due to hypokinesia and lack of physical activity, as well as a sedentary lifestyle and poor childhood habits. We conclude that a systematic clinical examination of children and adults is needed, in order to determine the degree of deformity and monitor their evolution and, in particular, timely resolution.*

**Keywords:** spine, diagnosis, deformities, prevention, corrective exercise

## Introduction

Postural status is very important in the functioning of the human body. The pattern of good posture, if created in early childhood, not only contributes to the proper growth and development of children, but later has a positive effect on their health and quality of life. Movement is one of the basic physiological needs [9,25]. It is an integral part of everyday life. Today's sedentary lifestyle, where children sit in school for 6-7 hours, then for a few hours in front of the TV or computer, can be significantly life-threatening. One of the important determinants of a healthy lifestyle of school-age children through the prevention of deformities is daily movement [30]. Engaging in physical activity is important because physical activity strengthens muscles, bones and joints that prevent various deformities and poor posture [69]. Kyphosis is a deformity that can appear in early childhood, where it can then increase with growth and development. The primary curve of the spine, the so-called the thoracic angle consists of 12 vertebrae [26, 37]. As children grow, the angle of the thoracic spine increases with age and is significantly more pronounced in girls than in boys [32, 37]. Hyperkyphosis or an increase in the thoracic curvature larger than the normal range is one of the most common disorders of the spine. Biomechanical data suggest that an increase in kyphosis could be associated with significantly higher spinal loads and torso muscle strength in an upright position, which could accelerate the degenerative process which in turn leads to further dysfunction and pain in the spine in children [3, 4]. . An increase in kyphosis is also associated with decreased physical function, impaired respiratory function, increased cervical pain, headaches and shoulder problems such as subacromial syndrome. It is an obvious fact that physical activity has a positive impact on the psycho-physical development of children, especially if it is implemented in an early period of childhood, with an adequately trained person [38]. Critical periods taken in the development of deformities, related to the growth and development of active and passive forces in the body are: the period of the first year of life, the period of standing and standing; period 6-7. years of age, period of starting school; period of puberty, a period of pronounced neuro-hormonal influence, with adolescent growth momentum [8, 35]. The treatment of kyphosis in school age is based on the same principles and similar procedures as the treatment of scoliosis [33]. It should be emphasized that kyphotic poor posture is corrected faster with appropriate treatment than scoliosis [27]. But it should also be emphasized that kyphotic bad posture more often turns into kyphosis than scoliotic posture turns into scoliosis. The goals of kinesitherapy procedures in kyphotic posture are: relaxation of the shoulder, neck and back muscles, strengthening of the abdominal and long back muscles (extensors) that strengthen the spine. Procedures begin immediately after diagnosis [11, 21]. Kyphosis can develop due to trauma, developmental anomalies, degenerative disc disease, inflammatory and infectious diseases, as well as iatrogenic [36]. Research has shown that performing exercises in the form of spine extension three times a week for a period of one year significantly reduces the angle of kyphosis and prevents its occurrence [1, 31]. The aim of this paper is to determine the deformity of the spinal column, as well as the possibility of correction and treatment.

## Method

Research data for the purposes of this review were collected through electronic search engines PubMed / Medline, Google Scholar, NCBI, SCI Index, Science Direct, DOAJ and journals in the field of sports sciences as well as relevant literature that could answer the problem. Keywords used for electronic search: spine, posture, diagnosis, deformities, prevention, corrective exercise. A descriptive method was applied in this paper.

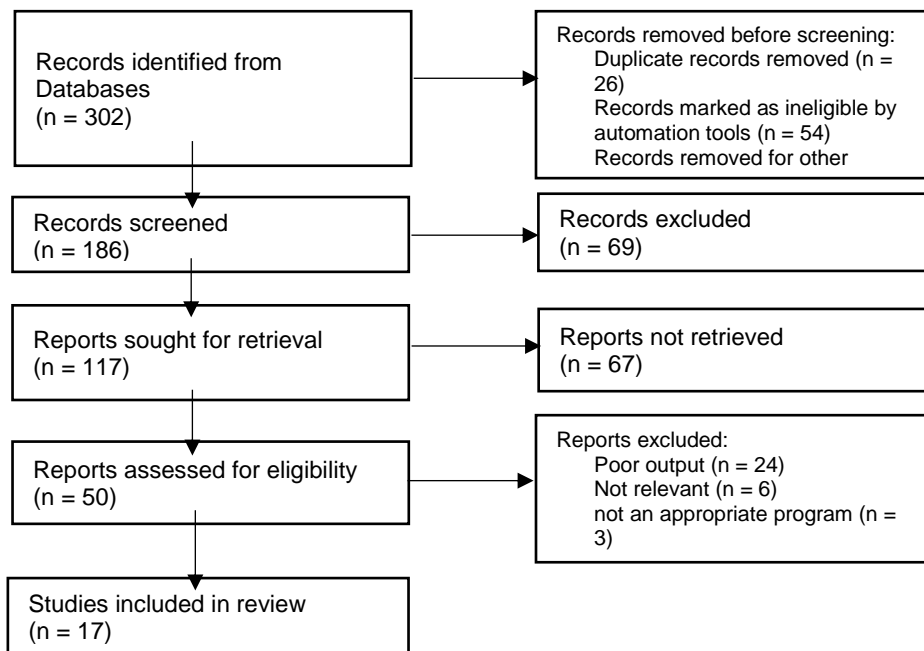
The selection of papers is determined on the basis of titles and keywords. Two selection criteria have been set. The first criterion refers to the problem of spinal deformity, more precisely kyphosis. The second criterion was the implementation of the analysis of works in the period from 2002 to 2019. Seventeen original scientific papers were selected from the mentioned time period, which were close to the subject of research and met all the criteria for further consideration. Studies in English, Serbian and other available languages are included.

In Table 1, the papers are presented and analyzed, the content information on the authorship is given, the holder of the paper and the year of publication are listed, and the co-authors are listed in the references. Basic information on the number of respondents, age categories and gender within the sample, the type of deformity and research results are provided. In the column marked as types of deformities, the key words from the title, ie the problem of work, are extracted. The research results section presents the results of the authors and partial conclusions from which we have drawn a personal conclusion in further considerations.

**Results**

The search identified 302 potentially relevant studies. After removing the duplicates and reviewing the title and abstract, 50 papers remained. After reviewing the entire texts according to the inclusion criteria, 17 papers remained, which were included in the detailed analysis and tabular presentation. (Figure 1).

*Figure 1.* Identification of studies via databases and registers



The analysis of the table shows that the papers were presented and analyzed through the following parameters: reference, age of respondents, number of respondents and groups of respondents, as well as results. Participants ranged in age from 5 years [28] to 18 years [18]. The total number of respondents of both sexes included in the papers presented was 14,354 the least number of respondents, 22 respondents, were in the paper [29], while the largest number of 8142 respondents was in the research conducted by [34].

*Table 1.* Studies showing the prevalence of kyphosis in school-age children

First author and year of publication	Sample of respondents			Types of deformities	Research results
	NUMBER	AGE	POL		

[13] Ljubic et al., (2002)	1363	7-18 years	M / F	Kyphosis , idiopathic scoliosis	Kyphosis was found in 0.80% of cases. The relationship between the sexes was: 1) in students with scoliotic posture almost the same; 2) in idiopathic scoliosis 5 to 2 in favor of girls; 3) in kyphosis 7 to 4 in favor of the boy.
[2] Jovovic (2003)	511	13 ± 6 months	M / F	Kyphosis , Lordoza,	The study showed that round back, as a specific form of kyphotic disorders, is present in the examined population. The total percentage of kyphosis and round back is close to the total percentage of lordotic disorders, which is the result of the compensatory action of active and passive forces on the spinal column. It has been shown that the largest percentage of round backs are milder forms of functional condition, which can be successfully remedied by applying certain corrective measures.
[35] Zivkovic et al., (2004)	8142	7-10 years	M / F	Kyphotic and Lordotic posture	A high percentage of postural disorders was observed, which is 47.5% in boys and 32.6% in girls in the first grade. In the association class, it is 45.4% for boys and 56.2% for girls. In the third grade, 64.7% of boys have postural disorders, while 72.2% of girls have impaired posture. In the fourth grade, the percentage of boys with postural disorders is 71.9%, while for girls it is 55.8%. Out of the total number of respondents, 51.4% have kyphotic bad posture and 33.5% have lordotic bad posture.
[16] Milenković & Bogdanović (2008)	299	12 years	M / F	Kyphosis	Indicators indicate a greater presence of kyphotic poor posture than is the case with lordotic poor posture. Also, we notice a more pronounced presence of kyphotic bad posture in the group of indecisive subjects, both in male and female subjects. Kyphotic poor posture in both boys and girls is most pronounced in the group of answers where the respondents declared themselves indecisive. Kyphotic poor posture is more pronounced in male subjects than in the female population.
[28] Stankovic-Babic & Despotovic (2009)	30	5-16 years	M / F	Kyphosis and scoliosis	Scoliotic posture and scoliosis were dominant and 3 × more common in girls (n = 16, 12F: 4M), followed by kyphoscoliosis (n = 8, 4F: 4M) and kyphosis (n = 6, 2F: 4M).
[7] Djokic et al., (2010)	810	9-12 years	M / F	Kyphosis , scoliosis and lordosis	. Only 38.1% of school-age children from the third to the sixth grade have the correct postural status. The most common disorder of postural status is foot deformity - flat feet with 26.6%, more in boys. Of the disorders of the spinal column, the most common is scoliosis - 19.6%, followed by kyphosis - 7.6% and lordosis - 1.0%.
[17] Markovic (2011)	299	12 years + - 6 months	M / F	Kyphotic bad posture, lordosis	Kyphotic poor posture is significantly more present in male subjects (62.02%) than in female subjects (37.98%). As for the indicators of good posture, we see a far higher percentage (67.06%) of respondents in the female population than in the case of men (32.94%). In male respondents, kyphotic poor posture is more present in those who do not have a computer at home (57.5%) than in those who do (39.71%). Kyphotic poor posture is much more present (87.76%) in those female respondents who do not own a computer at home than in those who do (12.24%).
[2] Bogdanovic & Colovic					The highest kyphotic poor posture was in the group of obese students (60.87%), followed by the group prone to obesity with 48.98% and 43.90% of normal weight, and

(2011)	428	11 ± 6 months	M / F	Kyphosis	finally the group of malnourished students with 28.57%. The kyphotic poor posture of the male population is mostly in the group of obese (80%), followed by malnourished subjects with 71.43%, subjects prone to obesity with 66.67%, and finally the subjects with normal weight with 56.91%. Among female subjects, the most kyphotic poor posture is also found in the group of obese (46.15%), followed by the group prone to obesity, while the least poor posture is in the group of malnourished subjects (14.29%).
[20] Protić et al., (2011)	55	10-13 years	M / F	Kyphosis , lordosis and flat back	The results of the research show that 67.3% of children have the following forms of poor posture: lordosis, 40% kypho-lordosis and 32.8% kyphosis. Decreased neck lordosis was recorded in 30.9%, while increased in 37.3% of children. Straight backs were found in 5.5%. A higher frequency of deviating segments of the spine in the sagittal plane was found in girls, but these differences are not statistically significant. In the case of these deformities, it is a question of the functional stage, so that they can be successfully removed with proper physical exercises.
[22] Petrovic et al., (2012)	229	7-11	M / F	Kyphosis , lordosis, scoliosis	The study included a total of 229 children (mean height 138.4 ± 9.6 cm, weight 33.9 ± 8.5 kg, body mass index 17.5 ± 2.6 kg / m <sup>2</sup> ). The prevalence of different types of spinal deformities in the examined population was: without deformities 76.9% (n = 176) and with deformities 23.1% (n = 53). The prevalence of different types of spinal deformities was as follows: torticollis 0.4% (n = 1), kyphosis 10.5% (n = 24), scoliosis 5.2% (n = 12), hyperlordosis 9.2% = 21).
[24] Romanov, R. et al (2014)	423	6-7	M / F	Kyphosis , scoliosis, lordosis, assessment of the feet	Assessment of the postural status of the spine was performed with a Spine Scan portable device. Data were processed according to the frequency of occurrence to assess spinal status, foot status, or by gender. The significance of the difference in relation to gender was determined by the Chi-square test. The results indicate a significant deviation from the normal status of the feet in girls and boys and spinal deformities that occur in the frontal and sagittal planes. Quantitative research results indicate the need for the application of corrective gymnastics in order to correct but also prevent postural disorders by introducing the same as daily focused activity of the preschool population.
Jovović, V. et al (2014)	155	13.6	Ž	Kyphosis , lordosis	The overall frequency of lordotic disorders is more prevalent in girls from urban areas, at a statistically significant level. The overall frequency of kyphotic disorders is approximately equally represented in both subsamples. By far the largest percentage of deviations are functional disorders that can be successfully corrected by applying adequate physical treatment.
[18] Mohammad et al., (2014)	572	13-18 years	M	Kyphosis , thoracic kyphosis	In nine reported studies in boys aged 10 to 20, the value and range of thoracic kyphosis ranged from 25.1 ° to 53.3 °. The mean thoracic kyphosis for the entire population was 35.49 ° SD 7.83, and the plus-minus two standard deviations ranged from 19.83 ° to 51.15 °. It gradually increased from 13 to 16, and then there was a small decrease to 18 years.

[19] Milic et al., (2018)	74	13.02 ± 0.89 years	M / F	Kyphotic , scoliotic and lordotic posture	The obtained results of the chi-square test indicate that there are no statistically significant differences between the analyzed groups of subjects in terms of the presence of scoliotic (p = 0.85), kyphotic (p = 0.77) and lordotic poor posture (p = 0.82) between the defined groups. . It is assumed that boys are involved in sports activities due to postural disorders in adolescence, in order to prevent further progression and the emergence of new ones.
[39] Wilczynski et al., (2020)	257	11-12 years	M / F	Kyphosis , lordosis	The correct curvature of the spine was determined in 106 subjects (41.08%). Other types were included: decreased kyphosis and correct lordosis -40 participants (15.50%), correct kyphosis and reduced lordosis -24 persons (9.30%), increased kyphosis and correct lordosis -17 subjects (6.59%), correct kyphosis and increased lordosis -22 children (8.53%), decreased kyphosis and decreased lordosis -32 persons (12.40%), decreased kyphosis and increased lordosis - four subjects (1.55%) increased kyphosis and lordosis - 13 persons (5.04%). In addition, 134 (51.94%) showed scoliotic posture and eighth (3.10%) scoliosis.
[10] Jankowicz et al., (2020)	685	10-12 years	M / F	Thoracic kyphosis, lumbar lordosis, valgus and knee varus	The girls surveyed were heavier than the boys and had a higher BMI. Spinal deformities and incorrect knee position are common among children aged 10-12. Girls and boys differed significantly in the shape of the spine in the sagittal plane and intermaleolar distance. Round lumbar lordosis is more characteristic for girls, and round thoracic kyphosis for boys. For both sexes, knee valgus occurs more often than knee varus and coexists with reduced thoracic kyphosis. The more rounded the thoracic kyphosis, the greater the distance between the knees and the smaller the distance between the joints.
[29] Stojanovic et al., (2020)	22	16	M / F	Kyphosis , thoracic and lumbar scoliosis, and lordosis	The postural status of the spine was assessed in the sagittal and frontal planes (thoracic and lumbar scoliosis, kyphosis, and lordosis) with the Spinal mouse instrument (Quantum Health and Wellness Ltd, Wallasay, England). until a significant improvement in thoracic scoliosis (p = 0.003) and kyphosis (p = 0.006), while in lumbar scoliosis and lordosis there were no significant changes.

Based on the analyzed works from Table 1. poor posture and kyphosis are significantly more present in boys than in girls, and we can freely say that kyphosis is more pronounced in persons with increased body mass index and sedentary lifestyle. Studies indicate that modern children spend most of the day in a sitting position, where they do homework, look at the phone, tablet and computer, playing games with fast food consumption, which leads to an enormous amount of obesity among the school population.

The formation of proper posture, in addition to various other known factors, depends largely on the involvement of teachers, professors and parents, but also the level of physical activity [23]. Due to poor posture in children, health problems can occur at a later age, which also affects their quality of life.

Scientists suggest that early diagnosis and adequate and professionally programmed exercise programs can have a positive and corrective effect on the angle and curvature of kyphosis, and that strengthening, rather than stretching, could be more important for kyphosis. All the presented studies dealt to a greater or lesser extent with the examination of the state of postural status and the structure of the resulting changes in it. According to almost all the obtained results, the postural status is significantly endangered and disturbed in a large number of children, which gives us the right to characterize this issue as alarming. The most important role in the formation and maintenance of proper posture is played by muscles, as an active part of the locomotor system.

Most of the presented studies dealt with, among other things, differences in posture between male and female students. One study was typical of just that [15]. In essence, it turned out that there were no differences in the level of statistical significance, except in the periods of children entering puberty, when due to intense hormonal activity and overall changes in the functioning of the organism, there was an increase in longitudinal skeletal dimensionality, which caused negative changes to move on a larger scale. As in the case of the sexes, these periods of maturation differ in terms of onset, they also record differences in the state and structure of changes in most cases on the spinal column itself. Most studies, when assessing postural status, included taking certain anthropometric parameters, so the cause-and-effect relations of the same with the resulting changes in the locomotor system were examined. In general, as in the research of Bogdanović and Milenković from 2008 [5], a connection was established with the longitudinal dimensionality of the skeleton (body height and sitting height). The association was particularly pronounced with changes in the thoracic spine, mostly in the sagittal plane. The results obtained in this way are understandable, considering the age of the examined children, which mainly referred to the critical periods for the occurrence of some types of deformity.

Diseases of the respiratory system cause shortening of muscle groups and change in posture. Lopes, et al. (2007) [12] in 60 boys aged 7–12 years, proved that a group of boys with frequent asthmatic attacks have a significantly impaired posture caused by muscle contraction, decreased level, and chest mobility. The clinical appearance of kyphosis is characterized by increased prominence of the posterior vertebral processes (processus spinosus), especially at the apex of the curve, usually between Th6 and Th11, and most often in the part from Th7 to Th8. The paravertebral musculature is hypotrophic, and so are the muscles of the back of the chest. Depending on the size of the kyphosis, lumbar lordosis is often increased, and the roundness of the back is visible in the lateral view and anterior prone position [11]. Based on everything presented in this paper, we can conclude that physical activity leads to one of the key roles in preventing the occurrence of many postural problems. Raising awareness of declining physical activity, educating the youngest, national strategies for involving young people in sports and recreational projects and strategies at the local level can create a good basis for future generations to prevent not only postural problems but also various cardiovascular diseases. Educating school staff, especially physical education and health teachers, about recognizing certain postural problems, about the further course of procedures to be taken is very important if we want to diagnose and solve some things as soon as possible

## Conclusion

During the school period, more and more children face improper posture, and various deformities of the spine that affect their further physical development. This paper presents postural disorders, and deals in more detail with the problem of kyphosis as a leading segment of postural anomalies today. The results showed an increase in deformities primarily due to hypokinesia and lack of physical activity, as well as a sedentary lifestyle and poor childhood habits. One of the leading problems is the constant use of mobile devices, which leads to more and more frequent irregular sitting and unconscious positions during growing up. We conclude that a systematic clinical examination of children and adults is needed to determine the degree of deformity and monitor their evolution. Only concretely, timely resolution, involvement of children in a certain type of physical activities and awakening the awareness of their parents as a leading factor of correction during childhood can be a positive turning point in healthy growing up and personality formation.

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