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The Prevalence of Spine Deformities and Flat Feet among 10–12 Year Old Children Who Train Basketball – Cross-Sectional Study

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ABSTRACT

The aim of this study is to estimate the prevalence of spine and feet deformities among children who are regularly involved in basketball trainings, as well as finding differences in the prevalence of those deformities between children of different gender and age. The study included a total of 64 children, of which 43 were boys and 21 were girls, ages 10–12. All subjects have been regularly participating in basketball trainings for at least one year. Postural disorder is defined as an irregularity in posture of the spine and feet, and it is assessed by visual methods from the front, side and rear side of the body. The prevalence of spinal deformities in our group was 53.13%. The boys had a significantly higher prevalence than girls, 65.1% compared to 28.57% (p=0.006). There was no significant difference in prevalence of spine deformities between children of different ages. The prevalence of feet deformities was 64.06%. There was a statistically significant difference between the sexes, where boys had a significantly greater prevalence of the feet deformities than girls, 83.7% compared to 23.81% (p=0.001). Flat feet were the most common in 10 year old children (85.71%). In conclusion, it can be said that despite regular participation in basketball training, subjects in this study have high prevalence of deformities; especially boys who stand out with the high prevalence of flat feet.

Key words: *basketball, children, flat feet, kyphosis, lordosis, scoliosis*

Introduction

Body deformities in schoolchildren and adolescents are on the rise mainly due to external factors. These external factors such as prolonged inadequate positions, inadequate school furniture, physical inactivity and overweight school bags lead to muscle imbalances and weakness, which are considered to be the main causes of postural deformities. Modern life style encourages children to spend a large amount of time sitting at the computer instead in playground from an early age[1]. Physical activity in the modern age generations is decreasing every year, and it is often reduced only to mandatory physical education classes at school, which is not enough to prevent the occurrence of deformities or affect their correction. There has been an increased percentage of posture deformities in schoolchildren over the past 15 years[2].

The position of the spine is characterized by spinal curves[3,4], two of which are kyphotic: thoracic and sacral; and the remaining two are lordotic: cervical and lumbar. These four curves are essential for balance, amortization and distribution of stress and forces, as well as for the elasticity and range of motion of the spine. The decrease or increase of those curves beyond the normal physiological range adversely affects the motor skills. When these values are drastically disturbed, deformities may tamper the work of some organs (e.g. heart and lungs)[5–7] and they can cause bigger problems in the locomotor activities, create an aesthetic problem and may impair the quality of life[8]. Posture variations in schoolchildren, such as lateral

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asymmetry, have been regarded as potential risk factors for low back pain, while hyperkyphotic posture according to some studies does not present a risk factor[9–11]. The most common spinal deformities are: increased kyphotic thoracic curve – kyphosis, which often results in increasing cervical and lumbar lordotic curvature – cervical or lumbar hyperlordosis, and the third most common spine deformity is a lateral bending of the spine – scoliosis. Spine deformities, depending on their degree, lead to an improper position of shoulders and shoulder blades, as well as to deformation of the rib cage.

Flat feet (*pes planus*) are common disorder of posture in younger schoolchildren[12–15]. It is clinically easily recognizable deformity, which is characterized by the lowering of the arch of the foot which increases the contact area of the foot with the ground[16]. Flat feet in children are usually classified as physiological (flexible) and pathological (rigid) flat feet[12,14,16].

During standing, walking or running, feet transfers entire weight to the surface. Structure of the arch of the foot and biomechanics of the lower leg are in functional relationship. The arch ensures an elastic connection between the forefoot and the hindfoot, and it can demonstrate two extremes of anatomical structural positions. Those two positions are the high arch of pes cavus and the flat arch of pes planus. Proper anatomical position of the arch of the foot ensure that forces incurred throughout standing, walking or running are dissipated, before they reaches the long bones of the lower leg.

Pes planus is characterized by lower or flat arch of the foot, and with talus bone head displaced medially and distally in regard to navicular bone. Consequently, the spring ligament, which is the main support of the medial longitudinal arch (MLA), and tibialis posterior muscle tendon are stretched. Excessive stretching of those two elements causes the absent of MLA function in individuals with pes planus. Foot is in everted position. In individuals with flatfeet, the foot position should be distinguished on »rigid« and »flexible«. Individuals with »rigid« flatfeet have absent or dysfunctional MLA in both seated and standing positions. In »flexible« flatfeet MLA is present while individual is sitting or standing up on their toes, and this flatfeet condition can be corrected with arch supports, which are added within the footwear.

Although sports activities positively affect the reduction of the deformity, the majority of the researchers came to the conclusion that a large number of repeated movements in sports and muscle imbalances affect the incidence and development of certain disorders in posture[17]. Also, long retaining of unnatural positions could lead to the development of deformities, which is usually found among professional cyclists[18]. A properly dosed physical activity will have a favorable effect on the development of posture, but irregularities in its application and dosage, as well as poor conditions in which it is done, can have negative effects[19]. Although the previous studies examined the association of certain sports activities and deformities, there has been, to the best of our knowledge, no literature regarding the incidence of spinal deformities and flat feet in Serbian children who regularly train basketball. Besides, as far as we know, very few studies on this topic have been done so far; therefore, this paper makes a significant contribution to the overall knowledge in this field.

The aim of this study is to estimate the prevalence of spine and feet deformities among the 10–12 year old schoolchildren who are regularly involved in basketball trainings, as well as finding differences in the prevalence of those disorders among children of different gender and age.

Materials and Methods

Subjects

This descriptive study was conducted during a medical examination and motor testing of young basketball players at the International basketball camp »Aleksandar Nikolic« Zlatibor, Serbia. This study included all examined 10–12 year old children who participated in basketball trainings during at least 12 months before examination, with minimum 3 training sessions per week. Children included in the study were not involved in any other regular sport trainings with an exception of mandatory physical education classes in school. Except for the summer break of 3 weeks, they didn't have longer breaks in training than 2 weeks, and the total break in trainings was not longer than 7 weeks in the last 12 months. Those data were obtained from training attendance records which were noted by the coaches. Out of all the children in the basketball camp, 64 were included in the study, 43 boys and 21 girls.

Deformity examination

Posture was assessed by visual methods from the front, side and rear side of the body[20]. The deviation from the normal posture was reflected in the leaning posture of the head to one side, asymmetry of the chest, shoulder and shoulder blades asymmetric position, imparity of Lorentz triangles, increasing or decreasing of the normal physiological spinal curves and the asymmetry of the pelvic bone position. The deviation from a normal feet posture was reflected in the ankle *valgus* position, as well as in an abnormal position of Achilles tendon and the arch of the foot.

Anthropometric measurement

Height measurement was performed using the Martin's anthropometer[21], while weight measurement was performed by digital bioelectrical impedance using the Tanita BC-1500 Ironman. Respondents were divided into three categories of nutritional status (underweight, normal and obese) based on body mass index (BMI), and their age taken into account[22].

Statistical analysis

Statistical analysis was performed using the statistical package PASW 18.

For the description of the parameters of interest we used the methods of descriptive statistics: measures of central tendency (mean value), measures of variability (standard deviation), percentages and tabulation. When comparing dichotomous categorical data, we used the non-parametric Chi-Squared test.

Results

The study included 64 children (43 boys, 21 girls). The prevalence of different types of spine and foot deformities is shown in groups defined by gender, age and nutritional status (Table 1). The sum of subjects with spine deformities and with flat feet was greater than the total number of subjects with deformities, because some subjects had both spine and feet deformities.

In Table 1, it can be seen that prevalence of spine deformities in male subjects was 65.1% (N=28), while the prevalence in female subjects was 28.57% (N=6). The Chi-square tests showed statistically significant difference in the prevalence of spine deformities between those two groups (p=0.006). Table 1 also shows prevalence of spine deformities among age groups, but Chi-square test didn't show significant difference between them (p=0.211). Prevalence of flat feet in boys was 83.7% (N=36) and in girls 23.81% (N=5). Boys had significantly higher prevalence of flat feet, which was assessed by Chi-square test (p=0.001). Table 1 shows that flat feet were the most common in 10-year-old children, in which 10 out of 12 subjects (85.71%) possess that deformity and Chi square test shows that there was significant difference in prevalence of children of different age (p=0.036).

Table 2 shows the prevalence of different spine deformities in association with flat feet in groups defined by gender, age and nutritional status. The Chi-square test shows that there was not a statistically significant difference (p=0.946) in frequency of flat feet deformity between children with and without scoliosis, while in children with kyphosis there was a significantly higher frequency of flat feet than in children without that spine deformity (p=0.006). In this study there were 4 children with lumbar hyperlordosis, and 3 of them had flat feet. The sample size of children with hyperlordosis was too small, so we considered that no statistically relevant data could be calculated. In children without spine deformity, there were 15 children with and 15 children without flat feet.

TABLE 2
PREVALENCE OF DIFFERENT SPINE DEFORMITIES ASSOCIATED WITH FLAT FEET, IN THE GROUPS DEFINED BY GENDER, AGE AND NUTRITIONAL STATUS

Variable	SC + FF	KY + FF	HY + FF
Gender			
Male (N=43)	7 (16.28%)	13 (30.23%)	3 (6.98%)
Female (N=21)	2 (9.52%)	1 (4.76%)	0
Age			
10 years old (N=14)	0	7 (50%)	0
11 years old (N=15)	1 (6.67%)	1 (6.67%)	1 (6.67%)
12 years old (N=35)	8 (22.86%)	6 (17.14%)	2 (5.71%)
Nutritional status			
Underweight (N=0)	0	0	0
Normal weight (N=59)	8 (13.56%)	13 (22.03%)	3 (5.08%)
Overweight (N=5)	1 (20%)	1 (20%)	1 (20%)
Total (N=64)	9 (14.06%)	14 (21.88%)	3 (4.69%)

HY + FF – Hyperlordosis and Flat Feet, SC + FF – Scoliosis and Flat Feet, KY + FF – Kyphosis and Flat Feet

TABLE 1
PREVALENCE OF SPINE AND FOOT DEFORMITIES, IN THE GROUPS DEFINED BY GENDER, AGE AND NUTRITIONAL STATUS

Variable	SC	KY	HY	TSD	FF	TD
Gender						
Male (N=43)	10 (23.26%)	14 (32.56%)	4 (9.3%)	28 (65.1%)	36 (83.7%)	41 (95.3%)
Female (N=21)	5 (23.81%)	1 (4.76%)	0	6 (28.57%)	5 (23.81%)	8 (38.1%)
Age						
10 years old (N=14)	0	8 (57.14%)	0	8 (57.14%)	12 (85.71%)	13 (92.86%)
11 years old (N=15)	3 (20%)	1 (6.67%)	1 (6.67%)	5 (33.33%)	6 (40%)	8 (53.33%)
12 years old (N=35)	12 (34.29%)	6 (17.14%)	3 (8.57%)	21 (60%)	23 (65.71%)	28 (80%)
Nutritional status						
Underweight (N=0)	0	0	0	0	0	0
Normal weight (N=59)	14 (23.73%)	14 (23.73%)	3 (5.1%)	31 (52.54%)	36 (61.02%)	44 (74.58%)
Overweight (N=5)	1 (20%)	1 (20%)	1 (20%)	3 (60%)	5 (100%)	5 (100%)
Total (N=64)	15 (23.44%)	15 (23.44%)	4 (6.25%)	34 (53.13%)	41 (64.06%)	49 (76.56%)

SC – Scoliosis, KY – Kyphosis, HY – Hyperlordosis, TSD – Total Spine Deformities, FF – Flat Feet, TD – Total Deformities

Discussion

The prevalence of spinal deformities in our study was 53.13%. The boys had a significantly higher prevalence than girls, 65.1% compared to 28.57% (p=0.006). Other researchers also found high prevalence of spinal deformities; Bogdanovic[23] reported kyphosis in 43.14% in 11 year old pupils, while Milenkovic et al.[24] found it in 51.4% in children 7–10 years old. In our study, subjects were involved in basketball training three times a week for at least one year, although there is a lack of studies examining the influence of regular basketball training on postural deformities, the prevalence of those deformities are lower than in studies of some other authors[23,24].

In this study we found that 23.44% subjects had one or more signs that can indicate scoliosis deformity, such as an improper position of shoulders and shoulder blades, Lorentz triangle imparity and etc. Other authors who examined children from this region who are not involved in sports activities reported various prevalence of scoliosis in their studies[25–27]. It is hard to say that basketball and exercise training can have positive effect on scoliosis deformity, because there is very little evidence supporting that exercise and physiotherapy is beneficial in the treatment of patients with scoliosis[28]. In contrast to treatment of scoliosis, exercising and physical treatment of patients with kyphosis deformity appears to be accepted widely[29].

The prevalence of flat feet deformity among subjects in this study was 64.06%; In flat feet prevalence there was a statistically significant difference between the sexes, and among children of different age. Male subjects had a significantly greater prevalence than female, 83.7% compared with 23.81% (p=0.001), also the largest prevalence was in children 10 years old, 85.71%. It is believed that the first critical period for developing flat feet in children is the righting period and the period of learning bipedal walking. During the next 4–6 years feet are developing, so at the age of 6 child's feet have features of an adult[30]. Almost all newborns have flat feet, and then the prevalence of this deformity decreases with age[31,32] the children examined in this study should be distinguished having rigid and flexible flat feet[31,32].

In this research there was only 5 (7.81%) overweight subjects, which is less than the number of overweight subjects in general population[33,34]. Although it is a small number for a proper statistical analysis, it should be noticed that all 5 overweight subjects had flat feet. In the data from the literature overweight is considered one of the main risk factors for the development of flat feet[35]. The lack of overweight subjects in this study is probably under direct influence of regular trainings, which are dominantly aerobic in basketball sport. In this study, there were no underweight subjects; it might be influenced by regular sports trainings and activities, which improve appetite and are beneficial for metabolism.

Conclusion

Early diagnosis of spine and feet deformities in children is crucial indication for referral to orthopedic assessment and medical treatment. Therefore, current study investigated the prevalence of postural deformities among children, 10–12 years old, who regularly train basketball for at least 12 months. We believe that this study, which included 64 children, is a representative research sample of children population who attend in this type of sport training. To the best of the authors' knowledge, no data on this topic has been previously published in academic journals. However, the determination of degree and level of deformities require further investigation.

In present research, we observed high prevalence of postural deformities among the participating subjects, especially boys, who have been mostly diagnosed with flat feet deformity. The prevention of postural deformities is of great importance. This study showed that participation in basketball training is not enough, so specific physical activity and corrective exercises are advised regardless. The cooperation between parents, physicians, physical education teachers and sports coaches is playing essential role in this. Consequently, the prevention and early diagnosis of these deformities may be the most effective treatment of these disorders. Especially, having in mind that they could significantly compromise aesthetics and quality of life, these disorders reduce motor skills and adversely affect the work of some internal organs.

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PREVALENCIJA DEFORMITETA KRALJEŽNICE I RAVNIH STOPALA MEĐU DJECOM STAROM 10–12 GODINA KOJA TRENIRAJU KOŠARKU – POPREČNO PRESJEČNO ISTRAŽIVANJE

S A Ž E T A K

Cilj ovog istraživanja je ustanoviti prevalenciju deformiteta kralježnice i nogu među djecom koja su redovito uključena u košarkaške treninge, kao i pronalaženje razlike u učestalosti tih deformiteta između djece različitog spola i dobi. U istraživanju je sudjelovalo ukupno 64 djece, od kojih su 43 bili dječaci i 21 djevojčica, svi u dobi od 10–12. Svi ispitanici su redovito sudjelovali u košarkaškim treninzima unazad najmanje godinu dana. Posturalni poremećaj se definira kao nepravilnost u držanju kralježnice i nogu, a procjenjuje se vizualnim metodama s prednje stranetijela, stražnje strane tijela i sa strane tijela. Prevalencija deformacije kralježnice u našoj skupini bio je 53.13%. Dečki su imali značajno višu prevalenciju od djevojčica, 65,1% u odnosu na 28,57% (p = 0.006). Nije bilo značajne razlike u prevalenciji deformiteta kralježnice između djece različitih uzrasta. Prevalencija stope deformiteta bila je 64.06%. Postoji statistički značajna razlika između spolova, gdje dječaci imaju značajno veću prevalenciju deformiteta stopala nego djevojčice, 83,7% u odnosu na 23.81% (p = 0.001). Ravna stopala su najčešća u djece stare 10 godina (85,71%). Zaključno, može se reći da, unatoč redovitom sudjelovanju u košarkaškim treninzima, ispitanici u ovom istraživanju imaju visoku prevalenciju deformiteta; posebno dječaci koji se posebno ističu visokom učestalosti ravnih stopala.