Research article

NUTRITIONAL LEVELS AND SPINE CURVATURE DISORDERS AMONG PRESCHOOL CHIDLREN

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Nebojša Cvetković[1], Jovana Cvetković[2]

[1]High School for Communications, Belgrade, Serbia
[2]Preschool Institution "Spartak", Belgrade, Serbia

Abstract. *The modern way of life led to the emergence of hypokinesis, obesity or various conditions and spine curvature disorders which are more and more present among younger children. The aim of this research was to determine the connection between nutritional levels and kyphosis and lordosis among preschool children. The sample of participants included of 50 boys and girls, preschoolers aged 6 to 7, who attend the Jelica Obradović Preschool in Mladenovac. Previous approval was obtained from their parents and teachers for participation in this study. To evaluate nutritional levels, the body mass index was used, which divided the participants into four categories: underweight, normal weight, overweight and obese. Somatoscopy was used to evaluate posture, along with a wooden frame to which a net with square decimeters was attached. Based on the results of this test, the following variables were obtained: normal posture, poor posture, first level of severity and poor posture, second level of severity. To determine the connection, or possible influence of the nutritional levels on body posture, the Chi square test was used. The results indicate that there is no statistically significant connection between nutritional levels and kyphosis and lordosis for this group of preschool children. This could indicate that obesity and underweight do not influence the occurrence of spine curvature disorders independently, but probably in combination with other factors such as heredity, physical inactivity, etc.*

Key words: *kyphosis, lordosis, obesity, underweight, differences*

INTRODUCTION

Poor posture includes not only one disorder, one specific deformity, but several disorders whose shared feature is that they are reversed with active tightening of the muscles. Poor posture is characterized by weakness in the entire body, especially the

joint-muscle apparatus. In these conditions, the static insufficiency of the spinal column is most pronounced, and is also the result of the weakness of the remaining parts of the locomotor apparatus (Živković, 2009).

The human movement apparatus is characterized by plastic adaptation, that is, the ability to relatively quickly adapt to changes in the mutual position of certain body parts. An analogous adaptational reaction in the muscles is also manifested in the change in their length. Due to long-term exposure of the muscles to a taut position, that is, their antagonists to a more relaxed position, a change occurs in the length and force of these muscles. If, after these changes, attempts were to be made to return the body parts to their previous inter-related positions by contracting the taut muscles, great resistance would be encountered. The factors which prevent the body parts from returning to their previous positions are, primarily, insufficient force of the atrophied muscles and the insufficient length of their antagonists, which is always accompanied by a shortening of the passive elements of the movement apparatus on the same side. Spine curvature disorders and body deformities, thus, are a consequence of the plastic adaptation of the movement apparatus, and their cause lies in the disruption of the balance between the tonic agonists and antagonists, which occurs due to relaxation in the musculature. Thus it is always necessary to remove the causes so as to avoid any undesired consequences (Perić & Cvetković, 2003).

Experts claim that the posture of preschool and younger school age children has grown significantly poorer during the last few decades, and recent research (Protić-Gava, Šćepanović, & Batez, 2013; Korovljev, Marinković, Roška, & Madić, 2015; Đorđević, Jorgić, Milenković, Milenković, Đokić, & Tsonkova, 2016) confirms these findings and indicates a progression in the spine curvature disorders of the aforementioned population. The basic cause of these disorders is ascribed to a single occurrence which is a result of the type of lifestyle that modern man leads, and in professional circles is known as hypokinesis. This way of life, dominated by passive stances, leads to changes in the motor behavior of children. This can best be seen during activities which are performed in a seated position, or standing position for longer periods of time, during which children usually assume inappropriate body positions. Thus the passive and active structures of the locomotor system, responsible for maintaining the normal upright position, are exposed to unnecessary load, which creates the conditions for the emergence of spine curvature disorders (Cvetković, 2014). In addition to hypokinesis, extensive or one-sided load, inactivity or weakness of muscle groups leads to spine curvature disorders, that is, disrupts the principle of symmetry and balance (Milenković, 2007).

According to Marković, Igrutinović, Kostić, and Vuletić (2008) nutritional levels represent a significant indicator of health and potential for normal growth and development, and can also be a good prognostic factor of one's state of health. Nutritional disorders among children can exceed or fail to reach the normal levels, which are evaluated by suitable methods. Disorders involving exceeding normal levels are referred to as obesity, and insufficient nutritional levels are known as underweight (Kostić, Gligorijević, & Marković, 2001). In both cases, every excessive deviation from normal body weight can be an indicator of a health disorder or some pre-existing medical condition (Vlaški & Katanić, 2010). According to Spiotta and Luma (2008), approximately one third of children under 19 are overweight. When it comes to children aged between 7 and 14 in Europe, 10 to 30% of them are overweight (Steinberger et al., 2009). Since 1980, obesity has more than doubled, and obesity among children has increased two to four times in the last decade. The research

results in our country also indicate a high number of preschool children who are obese, and they do differ significantly from the results obtained in other countries (Despotović, Alekxopulos, Despotović, & Ilić, 2013). Based on the aforementioned, the aim of this research was to determine the extent of the correlations between nutritional levels and the kyphosis and lordosis among preschool children.

METHODS

Sample of participants

The sample of participants included of 50 boys and girls, preschoolers aged 6 to 7, who attend the Jelica Obradović Preschool in Mladenovac. Previous approval was obtained from their parents and teachers for participation in this study.

Sample of measuring instruments

Measuring instruments for the evaluation of postural status in the sagittal plane, and for the evaluation of the nutritional level of the children, were used in this study.

Measuring instruments for the evaluation of postural status in the sagittal plane

Evaluating body posture was realized in two ways: visual observation of the participants (somatoscopy), and the body posture test. For a more precise visual equation, we used a special wooden frame, (1,5m x 1m in size) to which a net with square decimeters was attached (Figure 1). The body segments which were evaluated and based on which it was possible to determine the extent of possible deviations from the normal upright position were defined (Table 1). Based on the obtained values of the parameters, two variables stand out: kyphosis and lordosis, with the following levels of severity of the disorder:
1. Normal (physiological) posture (NP);
2. First level of severity (1LS);
3. Second level of severity (2LS).

The participants, wearing only their undergarments, were asked to assume a normal upright position, at a precisely determined place behind the frame, legs slightly apart, hands relaxed at their sides and eyes focused on a toy (a plush rabbit), which was placed at a distance of 2m, at eye level. The visual evaluation was performed in relation to the aforementioned frame (net), to determine the line of the body's center of gravity, whose orientation is vertically downward, and which passes through the following anatomic points: the middle ear, the center of the shoulder joint and the center of the hip joint, and any possible deviations from the body segments included in the established line.

A physical therapist, who was carrying out the evaluation, observed the participants from a distance of 1,5m-2m. Through visual observation (somatoscopy) it was determined whether the participant has good or poor body posture. In the case of good posture, the participant was included in the category of normal physiological posture. If poor posture was determined based on the observed parameters, the participants was required to assume as proper a posture as possible, and as incentive a picture of a child with good body posture was shown. If the participant was able with the strength from his own

muscles to maintain that position for 30 or more seconds, he was included in the category of the first level of severity. The participant who was not able to assume a proper standing position, or had managed to do so but did not maintain it for the required period of time, was included in the category of the second level of severity. This type of testing body posture has already been used in practice (Cvetković & Perić, 2010).

Table 1 The list of studied parameters

Status of the spinal column in the saggital plane	Initial evaluation		
Name of the child:			
Body mass:	NP	1LS	2LS
Height:			
Kyphosis			
Head protrusion			
Slouching shoulders			
Inward concave thorax			
Abducted shoulder blades			
Lordosis			
Weakening of the abdominal wall			
Forward tilt of the pelvis			
Pronounced lumbar lordosis			
Shortened flexors of the hip joint			

Fig. 1 The frame with the net use to evaluate posture

Measuring instruments for the evaluation of the nutritional level

The Body Mass Index (BMI) was used to evaluate the nutritional level. The formula used to calculate it is: BM/BH^2. Where BM-is body mass expressed in kilograms and BH^2-body height expressed in square meters (Garrow & Webster, 1985). Body mass and height were determined using standard procedures which are used during physical examinations.

Based on the obtained BMI, individuals were classified into four categories:
1. Underweight (UW);
2. Normal weight (NW);
3. Overweight (OW);
4. Obesity (OB).

In the case of children, in addition to the formula which is also used for adults, we also took into consideration both gender and year of birth. Then the obtained values were compared to a graph, separately for the males and females, to determine their percentiles (Kuczmarski et al., 2002). Based on those percentiles we determine the relative position of the child's BMI compared to children of the same age and gender (Table 2).

Table 2 The nutritional level in relation to percentiles

Nutritional level	Percentile range
Underweight (UW)	Less than 5
Normal weight (NW)	from 5 to less than 85
Overweight (OW)	85 to less than 95
Obesity (OB)	95 and over

Statistical data analysis

The data obtained on the nominal scale for the variables body posture and the body mass index are presented as frequencies and percentiles. To determine the correlations between the nutritional level and body posture in the sagittal plane we used the Chi square test. The data were processed in the statistical program IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corporation, released in 2010.

RESULTS

The results presented in tables 3 indicates that many of the tested children show signs of kyphosis and lordosis, where spinal curvature of the first level of severity was recorded most frequently, with 44% and 52%, respectively.

Table 4 shows the results for the evaluation of the body mass index. Most of the children 68% have normal weight. The lowest percentage of children showed signs of being underweight, 4%, followed by the percentage of overweight children 6%, and finally obese children 22%.

Table 3 Prevalence of kyphosis and lordosis

	Kyphosis	Frequency	Percentage (%)	Lordosis	Frequency	Percentage (%)
NP		10	20		9	18
LS1		22	44		26	52
LS2		18	36		15	30
Total		50	100		50	100

Table 4 Nutritional level

		Frequency	Percentage (%)
UW		2	4
NW	BMI	34	68
OW		3	6
OB		11	22
Total		50	100

The results of the Chi-square tests are shown in tables 5 and 6 indicate that there is no statistically significant difference or connection between the prevalence of kyphosis and the nutritional levels.

Table 5 Significance of the Chi square test for kyphosis and nutritional levels

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.627[a]	6	.854
Likelihood Ratio	3.445	6	.751
Linear-by-Linear Association	.022	1	.882
N of Valid Cases	50		

Table 6 Cross-section of the results between nutritional levels and kyphosis

			BMI			Total
		UW	NW	OW	OB	
Kyphosis	NP	Count	0	7	0	3	10
		within kyphosis	0%	70%	0%	30%	100%
		within BMI	0%	20.6%	0%	27.3%	20%
		Total	0%	14%	0%	6%	20%
	LS1	Count	1	16	1	4	22
		within kyphosis	4.5%	72.7%	4.5%	18.2%	100%
		within BMI	50%	47.1%	33.3%	36.4%	44%
		Total	2%	32%	2%	8%	44%
	LS2	Count	1	11	2	4	18
		within kyphosis	5.6%	61.1%	11.1%	22.2%	100%
		within BMI	50%	32.4%	66.7%	36.4%	36%
		Total	2%	22%	4%	8%	36%
Total		Count	2	34	3	11	50
		within kyphosis	4%	68%	6%	22%	100%
		within BMI	100%	100%	100%	100%	100%
		Total	4%	68%	6%	22%	100%

The results of the Chi square tests presented in tables 7 and 8 indicate that there is no statistically significant difference, that is, connection between the prevalence of lordosis and the nutritional levels.

Table 7 Significance of the Chi square test for lordosis and nutritional levels

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.779[a]	6	.572
Likelihood Ratio	5.731	6	.454
Linear-by-Linear Association	.084	1	.772
N of Valid Cases	50		

Table 8 Cross-section of the results between nutritional levels and lordosis

			BMI				Total
			NW	NW	NW	NW	
Lordosis	NP	Count	0	6	0	3	9
		within Lordosis	0%	66.7%	0%	33.3%	100%
		within BMI	0%	17.6%	0%	27.3%	18%
		Total	0%	12%	0%	6%	18%
	LS1	Count	1	20	2	3	26
		within Lordosis	3.8%	76.9%	7.7%	11.5%	100%
		within BMI	50%	58.8%	66.7%	27.3%	52%
		Total	2%	40%	4%	6%	52%
	LS2	Count	1	8	1	5	15
		within Lordosis	6.7%	53.3%	6.7%	33.3%	100%
		within BMI	50%	23.5%	33.3%	45.5%	30%
		Total	2%	16%	2%	10%	30%
Total		Count	2	34	3	11	50
		within Lordosis	4%	68%	6%	22%	100%
		within BMI	100%	100%	100%	100%	100%
		Total	4%	68%	6%	22%	100%

DISCUSSION

In the study, the percentage of obese children is as high as 22%, which is greater than the values obtained in following two studies: Despotović et al. (2013) included preschool children residing on the territory of Ćuprija and determined a frequency of 5.4% of obese children, and 10.8% of overweight children. Stupar, Popović, and Vujović (2014), carried out study in four kindergartens on the territory of Novi Sad, and the percentage of overweight boys and girls was 8.62% and 7.61%, respectively. Results more similar to our own were determined in the study of Đermanović, Miletić, and Pavlović (2015). Working with a sample of 60 children, they determined that 13.3% were overweight. In the case of preschool children, for a period of 20 years, more precisely from 1990 to 2010 the rate of obesity among children increased from 4.2% to 6.7%. Additionaly, obesity among adults has increased dramatically since 1990 (De Onis, Blössner, & Borghi, 2010). The increase in the number of obese preschool children requires more frequent measurements, so that adequate preventive measures could be realized.

The obtained results in terms of the prevalence of children with spine curvature disorders is disconcerting, since a large number of children with kyphosis and lordosis were identified. As many as 80% of children have kyphosis, and 82% lordosis of the first or second degree of severity. From the standpoint of the difficulty of correcting postural disorders, the good news is that a greater number of postural disorders of the first degree of severity can be corrected more effectively by applying appropriate corrective gymnastics exercises. Many children with spine curvature disorders of the same age as those in our sample were determined in the study (Simov, Minić, & Stojanović, 2011). In their study 64% of children had some form of pine curvature disorder. In the study of Jorgić et al. (2015) the percentage of preschool children with spine curvature disorders in the sagittal plane such as kyphosis, lordosis and kyphosis-lordosis was 38.4%. A study

carried out among preschool children on the territory of three cities in west Serbia determined a prevalence of spine curvature disorders of 35.58% (Milenković, Živkovic, Milijić, Ignjatović, & Pavlović, 2003). In the study of Hodžić, Gerdijan, Mikić, and Katanić, (2010) 53.6% which included participants from the first to the fourth grade, it was determined that they showed signs of spine curvature disorders. In terms of percentages, the percentage of children with spine curvature disorders, or poor posture in this study was far greater the ones in other studies. The reason might be the different methodology of determining posture. What also speaks in favor of this conclusion is the fact that another study (Cvetković & Perić, 2010) which included the same type of testing, identified a similar percentage of children with spine curvature disorders (80.3%).

The results of this study indicate that there is no statistically significant connection between spine curvature disorders in the sagittal plane and the nutritional levels of the studied preschool children. Petrović et al. (2012) worked with a sample of 212 children aged 7 to 11 and also determined that the nutritional levels have no significant impact on the emergence of the spine curvature disorders. Kosinac and Ivačić (2009) determined that underweight has a strong connection with spine curvature disorders while obesity does not influence them. Đokić & Stojanović (2010) determined that among children aged 9 to 12 obesity has an impact on lordosis, and only in the case of girls. Protić-Gava, Zečak, and Shukova-Stojmanovska, (2014) also determined that among children aged 7 and 8 there is no statistically significant correlation between physical deformity and nutritional levels.

For the insufficient correlations between spine curvature disorders in the sagittal plane (kyphosis and lordosis), on the one hand, and nutritional levels on the other, which is presented in this paper for a group of preschool children, there are several possible explanations. Namely, the preschool age is not significantly related to increased growth, which means that there is balanced development of the skeletal-muscle system. There is also the insufficiently long period of time during which obesity might act as a generator for the aforementioned disorders at this age, and thus this effect most probably had no significant impact on the status of the spinal column. The second possible explanation has to do with furniture, that is, the chairs and desks children use in preschool institutions, which are adapted to each age group, and therefore to a largest extent enable children to sit properly, unlike those meant for school age kids, who during class use furniture which is of inappropriate size (the same chairs and desks from grade one to grade eight). The third relevant explanation is the means of realizing the preliminary preschool program and the children's stay in preschool facilities. Namely, unlike school, in which children spend most of them time sitting at desks, or assuming passive stances during class, which is usually treated as the basic cause of the emergence of physical deformity, in preschool the educational program is realized through games, which to a great extent includes free movement of the children during the activity, and thus less hypokinesis and passive positions.

Based on the aforementioned, we could consider the effects of the nutritional levels on the postural status of preschool children to not be strongly expressed. It could be assumed that obesity and underweight can have an influence on the emergence of spine curvature disorders, but not independently, and instead in combination with other exogenic and endogenic factors such as heredity, physical inactivity, etc.

CONCLUSION

The results of the current study indicated that nutritional levels have no statistically significant correlation with kyphosis and lordosis among preschool children. We can assume that obesity and underweight have no effect on the emergence of spine curvature disorders independently, but in combination with other exogenic and endogenic factors such as heredity, physical inactivity, etc. Considering that this study included a small sample of participants, it is necessary to carry out a study involving a larger sample of patricians, in order for the obtained results to be generalized.

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STEPEN UHRANJENOSTI I POSTURALNI POREMEĆAJI KIČMENOG STUBA DECE PREDŠKOLSKOG UZRASTA

Savremeni načini života dovode do pojave hipokinezije, gojaznosti i različitih oboljenja i posturalnih poremećaja koji su prisutni sve više i kod dece najmlađeg uzrasta. Cilj ovog istraživanja je bio da se utvrdi povezanost stepena uhranjenosti sa kifotičnim i lordotičnim držanjem tela kod dece predškolskog uzrasta. Uzorak ispitanika činilo je 50 dečaka i devojčica predškolskog uzrasta od 6 do 7 godina koji pohađaju Predškolsku Ustanovu „Jelica Obradović" u Mladenovcu. Za procenu telesne uhranjenosti korišćen je indeks telesne mase na osnovu čijih rezultta su ispitanici bili podenjeni u četiri kategorije: neuhranjeni, normalne težine, prekomerne težine i gojazni. Za procenu držanja tela korišćena je somatoskopija i testom telsnog držanja uz primenu drvenog rama sa mrežom sa kvadratnim decimetrima. Na osnovu rezultata ovog testa dobijene su sledeće varijable: normalno držanje, prvi stepen lošeg držanja i drugi stepen lošeg držanja. Za utvrđivanje povezanosti odnosno mogućeg uticaja stepena uhranjenosti na držanje tela korišćen je Hi kvadrat test nezavisnosti. Rezultati istraživanja su pokazali da ne postoji statisitčki značajna povezanost između stepena uhranjenosti i kifotičkog i lordotičkog držanja tela kod ove grupe dece predškolskog uzrasta. To može ukazivati da gojaznost i neuhraenost nemaju uticaj na pojavu posturalnih poremećaja samostalno, već verovatno u kombinaciji sa ostalim faktorima kao što su nasledni, zatim fizička neaktivnost i drugi.

Ključne reči: kifoza, lordoza, gojaznost, neuhranjenost, razlike