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Differences in Postural Status of the Spine of Swimmers of the Juvenile and Adolescent Age

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Abstract

The aim of this study was to determine the condition and the difference in postural status of spine in a frontal and sagittal plane in swimmers of juvenile and adolescent age. The sample of respondents, in total, comprised of 53 swimmers of both sexes having at least three-year-long swimming experience, i.e. divided by age: 28 respondents, swimmers of juvenile age, and 25 respondents of adolescent age. `Spinal mouse` was used to assess a postural status of a spine. Based on the obtained results, it may be concluded that there is no statistically significant difference in the number of swimmers of different age groups with postural spinal disorder in the frontal (sig=1.000) and sagittal plane in the thoracic (sig=0.108) and lumbar part (sig=0.237). Statistically significant differences, within each age group of swimmers, have been noticed between the number of children with and without postural disorder: juvenile age frontal plane (sig=0.000), sagittal plane of the thoracic part (sig=0.705), lumbar part (sig=0.001), while with the same statistical analysis, in respondents of adolescent age, was determined: in frontal plane (sig=0.001) and in sagittal plane of the thoracic part (sig=0.028), lumbar part (sig=0.162). Based on the results, it may be concluded that the level of postural disorders of the spine in swimmers of juvenile and adolescent age is high, but that the level of the prevalence of postural disorders is statistically insignificant among the respondents of juvenile and adolescent age.

Keywords: *Scoliosis, Kyphosis, Lordosis, Flat back, Kypholordosis*

Introduction

The modern conditions of living that surround us today represent a highly technologically advanced period due to which there is the development of numerous benefits that affect the facilitation of everyday activities from the earliest age. The benefits, caused by the intense technological development, represent a possibility of a faster and simpler solution to everyday activities at home, school, and work. However, as a side effect of a modern technological development, hectic lifestyle, the phenomenon of hypokinesia, i.e. reduced movement, is increasingly present (Bubanj, Živković, Živković, Milenković, Bubanj, et, al., 2012). Hypokinesia represents a phenomenon that is increasingly present in children of the earliest age, which represents many risk factors. Risk factors of insufficient movement, i.e. physical activity, are reflected primarily in the appearance of the increasingly frequent impaired postural status of children of juvenile and adolescent age. The impaired postural status of children of this age is most noticeable through the appearance of postural disorders on the spinal column as a result of muscle imbalance (Đokić, Međedović, & Smiljanić, 2011).

Postural disorders of the spine can be located in a frontal and sagittal plane. In a frontal plane, scoliosis poor postures of the body can be diagnosed most often due to muscular imbalance of the left and right side of the trunk muscles of the thoracic and lumbar parts, but this imbalance can also occur in a sagittal plane of the spine and then we talk about kyfotically bad posture of the body, i.e. an increased angle of convexity of kyfotic curve and lordotically poor posture of the body, which represents an increase in the concavity of the lordotic curve in a lumbar part of the spine of the sagittal plane (Jorgic, Milenković, Ždrale, Milenković, & Stanković, et al., 2015). Also, due to the appearance of reduced movement, there may be insufficiently formed spinal physiological curves in the sagittal plane, i.e. the appearance of

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flat back in both thoracic and lumbar part (Milenković, 2007, 160). In accordance with the knowledge of insufficient movement of the children of the earliest ages and on the other hand of the high percentage of the postural disorders on the spine in both the sagittal and frontal plane, swimming as a basic sport based on its specificity of movement has the ability to provide the activation of the musculature of the whole body. By activating the musculature of the whole body, and before all muscles of the trunk, both antero-posterior and medially lateral, that represents a possibility to reduce the frequency of the spinal disorders on the spine in relation to the conducted researches whose subjects have not engaged in physical activity.

Accordingly, the aim of this research is to determine the condition and the difference of the postural status of the spine in the frontal and sagittal plane in swimmers of juvenile and adolescent age.

Methods

Sample of respondents

The sample consisted of 25 juvenile swimmers, i.e. aged 6 to 10 years having minimum of 3-year-long experience in swimming and of 25 adolescent swimmers, i.e. aged 11 to 14 years having also minimum of 3-year-long experience in swimming. The participants were the members of the swimming club `Nis 2005` and `Saint Nikola` from Nis.

Because the participants were under the age of 18, the consent for their participation in this study was signed by their coaches.

Sample of measuring instruments

"Spinal Mouse"(Idiag, Fehraltdorf, Switzerland, www.idiag.ch) was a measuring instrument for assessing the state of the postural status of the spine in the frontal and sagittal plane of juvenile and adolescent swimmers. This instrument belongs to a group of non-invasive methods of diagnosing the postural status of the spine. Validity and reliability of the instrument was determined by the research conducted by the authors (Mannion, Knecht, Balaban, Dvorak & Grob, 2004; Post & Leferink 2004). "Spinal Mouse" was used earlier with the respondents of the same age (Jorgic, Milenković, Ždrale, Milenković, Stanković et al., 2015; Jorgić, Milenković, Milenković, Stanković, & Bubanj, 2015; Božić, Đorđević, & Nurkić, 2019).

Description of variables

Variables for assessing the state of the postural status of the spine in the frontal plane are represented in Table no. 1. The method of determining of the state of postural status of spine in the frontal plane on the basis of the obtained angles expressed in degrees is taken from the literature (Devedžić, Ćuković, Luković, Luković, Milošević, et al., 2016; Milenković, Stanković, & Đorđević, 2018).

Table no.1. Presentation of variables for assessment of the state of postural status of the spine and their description.

No.	Variable name	Variable description	Abbreviation
1	Normal posture of the body in the frontal plane	Angle with convexities up to 5 degrees in the thoracic ilumbar part of the frontal plane of the spine.	NPBFP
2	Left thoracic scoliotic	Angle with convexity in the thoracic part on the left side greater than five degrees.	LTS
3	Right thoracic scoliotic	Angle with convexity in the thoracic part on the right side greater than five degrees.	RTS
4	Left lumbar scoliotic	Angle with convexity in the lumbar part on the left side greater than five degrees.	LLS
5	Right lumbar scoliotic	Angle with convexity in the lumbar part on the right side greater than five degrees.	RLS
6	Left thoracic and left lumbar scoliotic poor posture, total left scoliotic	Angle with convexity in the thoracic part on the left side greater than five degrees and lumbar left side also greater than five degrees.	LTLLS
7	Right thoracic and right lumbar scoliotic poor posture, total right scoliotic	Angle with convexity in the thoracic part on the right side greater than five degrees and on the lumbar right side also greater than five degrees.	RTRLS
8	Left thoracic and right lumbar scoliotic poor posture, duplex-right scoliotic	Angle with convexity in the thoracic part on the left side greater than five degrees and the lumbar right side also greater than five degrees.	LTRLS
9	Right thoracic and left lumbar scoliotic poor posture, duplex right-left scoliotic	Angle with convexity in the thoracic part on the right side greater than five degrees and the lumbar left side also greater than five degrees.	RTLLS
10	Normal body posture in the sagittal plane of the spine	Represents the angle of the kyphotic curve in the range from 30 ° to 45 ° in the thoracic part and from 20 ° to 40 ° in the lumbar part of the sagittal plane of the spine	NPSP
11	Kyphotic	It represents an angle in the thoracic part of the spine greater than 45 °	KIF
12	Flat back in the thoracic part of the sagittal plane of the spine	Represents an angle in the thoracic part of the spine less than 30 °	FBTSP
13	Lordotic	It represents an angle in the lumbar part of the spine greater than 40 °	LOR
14	Flat back in the lumbar part of the sagittal plane of the spine	It represents an angle in the lumbar part of the spine less than 20 °	FBLSP
15	Kifolordotic poor posture	Represents an angle in the thoracic region greater than 45 ° and in the lumbar spine greater than 40 °	KIFLOR
16	Flat back in the thoracic and lumbar part of the sagittal plane of the spine	Represents the angle of the kyphotic curve less than 30 ° in the thoracic part and less than 20 ° in the lumbar part of the sagittal plane of the spine	FBTLSP

Variables for assessing the state of the postural status of the spine in the sagittal plane are represented in Table no. 1. The method of determining of the state of postural status of spine in the sagittal plane on the basis of the obtained angles expressed in degrees is taken from the literature (Mannion, Knecht, Balaban, Dvorak & Grob, 2004; Post & Leferink 2004; (Milenković, Stanković, & Đorđević, 2018).

Measurement organization

The measurements planned for this research were carried out at the SC `Cair` swimming pool in Nis from 6 till 8 pm. The respondents were minimally dressed; more precisely, they only had on themselves their bathing suits. The diagnosis of the postural status was carried out by graduate professors of sport and physical education with prior education of Professor Sasa Milenkovic.

The measurements included in this research conducted in accordance with the ethical principles of human research according to the Helsinki Declaration of 2008 (World Medical Association, 2011).

Statistical data processing

The data obtained were processed in the programme for statistical data processing SPSS `version 20` after the measurement.

The state of postural status in the frontal and sagittal plane in juvenile and adolescent swimmers is presented through the parametres of the descriptive statistics: frequency and percentages.

To determine differences in the prevalence of deformities and normal body posture within each individual group of respondents, the Hi quality test was used to determine the quality of matching, while for determining the differences in the prevalence of deformities between juvenile and adolescent swimmers, Hi square test was used to test independence.

Results

Based on the table no.2, that is, the presentation of basic parametres of the descriptive statistics on the numerical and percentage prevalence of deformities in the frontal plane of the spine in juvenile and adolescent swimmers, indicate that normal body posture in the frontal plane is present in 8 respondents (15,1%), while right thoracic scoliosis poor body posture diagnosed in 4 respondents (7,5%), left lumbar scoliosis poor body posture diagnosed in 2 respondents (3,8%), total right scoliosis poor body posture diagnosed in 33 respondents (62,3%) and duplex right-left scoliosis poor body posture diagnosed in 6 respondents (11,3%).

Based on the presentation of the results in the Table no.2, on the numerical and percentage prevalence of deformities in the sagittal plane of the spine in juvenile and adolescent swimmers indicate that the normal body posture in the sagittal plane is present in 22 respondents (41,5%), kyfotic poor body posture diagnosed in 4 respondents (7,5), while flat back in a thoracic part of the sagittal plane present in 13 respondents (24,5%), lordosis poor body posture diagnosed in 8 respondents (15,1). Only 1 respondent (1,9%) was diagnosed with the postural disorder of flat back in lumbar part of the sagittal plane. Diagnosed postural disorder in the sagittal plane in thoracic and lumbar part in terms of increased convexity or concavity of physiological curves was diagnosed in 4 respondents (7,5%) and in only 1 respondent the lack of physiological curves in thoracic and lumbar part of the sagittal plane of the spine was diagnosed.

Based on the presentation of the results in the Table no. 2, on the numerical and percentage prevalence of deformities in the frontal plane of the spine in juvenile swimmers indicate that the normal body posture in the frontal plane is present in 4 respondents (14,3%), kyfotic poor body posture diagnosed in 4 respondents (7,5), left lumbar scoliosis bad posture diagnosed in 2 respondents (7,1%), total right scoliosis poor posture diagnosed

Table no. 2. Postural status of the spine in juvenile and adolescent swimmers

Postural status of the spinal column in the frontal and sagittal plane of juvenile and adolescent swimmers									
Fontal plane									
	Juvenile and adolescent swimmers			Juvenile swimmers			Adolescent swimmers		
	F	P	CP	F	P	CP	F	P	CP
NPBFP	8	15.1	15.1	4	14.3	14.3	4	16.0	16.0
RTS	4	7.5	22.6				4	16.0	32.0
LLS	2	3.8	26.4	2	7.1	21.4			
RTRLS	33	62.3	88.7	18	64.3	85.7	15	60.0	92.0
RTLLS	6	11.3	100.0	4	14.3	100.0	2	8.0	100.0
In total	53	100.0		28	100.0		25	100.0	
Sagittal plane									
NPSP	22	41.5	41.5	10	35.7	35.7	12	48.0	48.0
KIF	4	7.5	49.1	1	3.6	39.3	3	12.0	60.0
FBTSP	13	24.5	73.6	12	42.9	82.1	1	4.0	64.0
LOR	8	15.1	88.7	2	7.1	89.3	6	24.0	88.0
FBLSP	1	1.9	90.6	1	3.6	92.9			
KIFLOR	4	7.5	98.1	2	7.1	100.0	2	8.0	96.0
FBTLSP	1	1.9	100.0				1	4.0	100.0
In total	53	100.0		28	100.0		25	100.0	

F-Frequency; P-Percentage; CP-Cumulative percentage; NPBFP - Normal posture of the body in the frontal plane; RTS - Right thoracic scoliotic; LLS - Left lumbar scoliotic; RTRLS - Right thoracic and right lumbar scoliotic, total right scoliotic; RTLLS - Right thoracic and left lumbar scoliotic, duplex right-left scoliotic; NPSP - Normal body posture in the sagittal plane of the spine; KIF - Kyphotic; FBTSP - Flat back in the thoracic part of the sagittal plane of the spine; LOR - Lordotic; FBLSP - Flat back in the lumbar part of the sagittal plane of the spine; KIFLOR - Kifolordotic; FBTLSP - Flat back in the thoracic and lumbar part of the sagittal plane of the spine.

in 18 respondents (64,3%) and duplex right-left scoliosis poor posture diagnosed in 4 respondents (14,3%).

Based on the presentation of the results in the Table no. 2, on the numerical and percentage prevalence of deformities in the sagittal plane of the spine in juvenile swimmers indicate that the normal body posture in the sagittal plane diagnosed in 10 respondents (35,7%), kyfotic poor body posture was diagnosed in 1 respondent (3,6%), while flat back in a thoracic part of the sagittal plane present in 12 respondents (42,9%), lordosis poor body posture diagnosed in 2 respondents (7,1%). Only 1 respondent (1,9%) was diagnosed with the postural disorder of flat back in lumbar part of the sagittal plane. Diagnosed postural disorder in the sagittal plane in thoracic and lumbar part in terms of increased convexity or concavity of physiological curves was diagnosed in 2 respondents (7,1%).

Based on the presentation of the results in the Table no. 2, on the numerical and percentage prevalence of deformities in the frontal plane of the spine in adolescent swimmers indicate that the normal body posture in the frontal plane is present in 4 respondents (16 %), right thoracic scoliosis poor posture diagnosed in 4 respondents (16 %), total right scoliosis poor posture diagnosed in 15 respondents (60%) and duplex right-left scoliosis poor posture diagnosed in 2 respondents (8 %).

Based on the presentation of the results in the Table no. 2, on the numerical and percentage prevalence of deformities in the sagittal plane of the spine in adolescent swimmers indicate that the normal body posture in the sagittal plane was diagnosed in 12 respondents (48%), kyfotic poor body posture diagnosed in 3 respondents (12%), while flat back in a thoracic part of the sagittal plane present in 1 respondent (4%), lordosis poor body posture diagnosed in 6 respondents (24,4%). Only 1 respondent (1,9%) was diagnosed with the lack of physiological curves in thoracic and lumbar part of the sagittal plane of the spine. Diagnosed postural disorder in the sagittal plane in thoracic and lumbar part in terms of increased convexity or concavity of physiological curves was diagnosed in 2 respondents (8%).

Table no. 3. Difference in state of the postural status of the spine in juvenile swimmers

Difference in state of the postural status of the spine in juvenile swimmers			
Difference in the state of postural status of the spinal column in the frontal plane in juvenile swimmers			
	Frequency	Hi square test	
NPBFP	4	Chi-Square	14.286a
DFP	24	df	1
In total	28	Asymp. Sig.	.000
NPBFP - Normal body posture in the frontal plane of the spine; DFP - Deviation from normal posture in the frontal plane of the spine.		a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 14.0.	
Difference in the state of postural status of the spine in the sagittal plane in juvenile swimmers			
Difference in the state of postural status of the spine in the thoracis part of the sagittal plane in juvenile swimmers		**Test Statistics**	
	Frequency	Hi square test	
NPTPSP	13	Chi-Square	.143a
DPTPSP	15	df	1
In total	28	Asymp. Sig.	.705
NPTPSP - Normal body posture in the thoracic part of the sagittal plane of the spine; DPTPSP - Deviation from normal posture in the thoracic part of the sagittal plane of the spine		a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 14.0.	
Difference in the state of postural status of the spine in the lumbal part of the sagittal plane in juvenile swimmers		**Test Statistics**	
	Frequency	Hi square test	
NPLPSP	23	Chi-Square	11.571a
DPLPSP	5	df	1
In total	28	Asymp. Sig.	.001
NPLPSP - Normal body posture in the lumbal part of the sagittal plane of the spine; DPLPSP - Deviation from normal posture in the lumbal part of the sagittal plane of the spine.		a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 14.0.	

Results presented in the table no.3 indicate that there is a statistically significant difference (sig=0.000) in number of juvenile swimmers with and without postural disorders of the spine in the frontal plane.

Results presented in the table no.3 indicate that there is no statistically significant difference (sig=0.705) in number of juvenile swimmers with and without postural disorders of the spine in thoracic part of the sagittal plane. In lumbar part of the sagittal plane of the spine in juvenile swimmers, statistically significant difference between the number of respondents with normal posture and with diagnosed disorder was noticed.

Results presented in the table no.4 indicate that there is a statistically significant difference (sig=0.001) in number of adolescent swimmers with and without postural disorders of the spine in the frontal plane. Results presented in the table no.4 indicate that there is statistically significant difference (sig=0.028) in number of adolescent swimmers with and without postural disorders of the spine in thoracic part of the sagittal plane. In lumbar part of the sagittal plane of the spine in adolescent swimmers, statistically significant difference (sig=0.162) between the number of respondents with

Table no 4. Difference in state of the postural status of the spine in adolescent swimmers

Difference in state of the postural status of the spine in adolescent swimmers			
Difference in the state of postural status of the spinal column in the frontal plane in adolescent swimmers			
	Frequency	Hi square test	
NPBFP	4	Chi-Square	11.560a
DFP	21	df	1
In total	25	Asymp. Sig.	.001
NPBFP - Normal body posture in the frontal plane of the spine; DFP - Deviation from normal posture in the frontal plane of the spine.		a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 12.5.	
Difference in the state of postural status of the spine in the sagittal plane in adolescent swimmers			
Difference in the state of postural status of the spine in the thoracis part of the sagittal plane in adolescent swimmers		**Test Statistics**	
	Frequency	Hi square test	
NPTPSP	18	Chi-Square	4.840a
DPTPSP	7	df	1
In total	25	Asymp. Sig.	.028
NPTPSP - Normal body posture in the thoracic part of the sagittal plane of the spine; DPTPSP - Deviation from normal posture in the thoracic part of the sagittal plane of the spine		a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 14.0.	
Difference in the state of postural status of the spine in the lumbal part of the sagittal plane in adolescent swimmers		**Test Statistics**	
	Frequency	Hi square test	
NPLPSP	16	Chi-Square	1.960a
DPLPSP	9	df	1
In total	25	Asymp. Sig.	.162
NPLPSP - Normal body posture in the lumbal part of the sagittal plane of the spine; DPLPSP - Deviation from normal posture in the lumbal part of the sagittal plane of the spine.		a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 14.0.	

normal posture and with diagnosed disorder was not noticed.

Based on the results obtained from Table no. 5, it may be observed that the proportion of the respondents, juvenile swimmers who do not have postural disorder in the frontal plane, does not differ statistically significantly (sig=1.000) from the proportion of the respondents, adolescent swimmers.

Results presented in the table no.5 indicate that there is no statistically significant difference (sig=0.108) between respondents - adolescent and juvenile swimmers in the proportion of the postural disorders in the thoracic part of the sagittal plane of the spine. Also, it can be observed that the proportion of the respondents, juvenile swimmers who do not have postural disorders in the frontal plane, does not differ statistically significantly (sig=1,000) from the proportion of the respondents, adolescent swimmers.

Based on the results presented in the table no 5, it can be observed that the proportion of the respondents, juvenile swimmers without postural disorders in the lumbar part of the sagittal plane of the spine, does not differ statistically significantly (sig=0,237) from the proportion of the respondents, adolescent swimmers.

Table no. 5. Difference in state of the postural status of the spine in the frontal and sagittal plane in juvenile and adolescent swimmers

Difference in state of the postural status of the spine in the frontal and sagittal plane in juvenile and adolescent swimmers								
Difference in state of the postural status of the spine in the frontal plane in juvenile and adolescent swimmers								
	Value	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Value	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.030a	.862						
Continuity Correctionb	.000	1.000						
Likelihood Ratio	.030	.862						
Fisher's Exact Test			1.000	.581				
Linear-by-Linear Association	.030	.863						
N of Valid Cases	53							
a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 3.77.								
b. Computed only for a 2x2 table								

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Table no. 5. Difference in state of the postural status of the spine in the frontal and sagittal plane in juvenile and adolescent swimmers

Difference in state of the postural status of the spine in the sagittal plane in juvenile and adolescent swimmers								
	Thoracic part				Lumbal part			
	Value	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Value	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.557a	.059			2.237a	.135		
Continuity Correctionb	2.582	.108			1.401	.237		
Likelihood Ratio	3.617	.057			2.252	.133		
Fisher's Exact Test			.094	.053			.212	.118
Linear-by-Linear Association	3.490	.062			2.194	.139		
N of Valid Cases	53				53			
	a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.38.				a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.60.			
	b. Computed only for a 2x2 table				b. Computed only for a 2x2 table			

Discussion

Obtained results in the conducted research indicate generally a high level of prevalence of postural disorders of the spine in the frontal and sagittal plane in juvenile and adolescent swimmers. The results obtained show that even 85.7% of the juvenile respondents have some of the deformities in the frontal plane, while in adolescent swimmers 84%. In the sagittal plane, the prevalence of the postural disorders is 64,3% and in adolescent swimmers 52%. In accordance with the obtained results of this research and with the recent researches in respondents of this age and who are not trained swimmers, the results significantly differ in favour of the respondents exposed to the testing of this research (Jorgić, Milenkovič, Ždrele, Milenković, Stanković, & Bubanj, 2015; Jorgić, Milenković, Milenković, Stanković, & Bubanj, 2015; Radaković, Madić, Radaković, Protić-Gava, Radanović, & Marković, 2016; Vukićević, Čokorilo, Lukić, Miličković, & Bjelica, 2018; Vukićević, Pajić, Čokorilo, Lukić, Miličković, & Bjelica, 2018). Recent researches, where the diagnostics of the postural status of the spine in swimmers of this age was done, significantly greater presence of the postural disorders of the spine was observed (Milenković, Živković, Bubanj, Bogdanović, Živković, & Stošić, 2012).

By statistical analysis, the Hi square test, which is used to examine the quality of matching within groups, i.e. to determine the existence of statistically significant differences between the respondents with normal postural status and those where a deviation from the normal postural status of the spine in the frontal and sagittal plane was diagnosed in both juvenile and adolescent respondents. This analysis determined the existence of statistically significant differences in the frontal plane in juvenile (sig=0,000) but also in adolescent (sig=0,001) respondents in the level of the prevalence of the postural disorders and normal body posture. The same results can be noticed in earlier researches with the same age groups (Jorgić, Milenkovič, Ždrele, Milenković, Stanković, & Bubanj, 2015; Vukićević, Čokorilo, Lukić, Miličković, & Bjelica, 2018). Also, it was observed that in the sagittal plane in respondents of the juvenile age in the thoracic part there are no statistically significant differences in the level of the prevalence of the respondents, swimmers with diagnosed normal posture and those who have deviation (sig=0.705), In lumbar part of the sagittal plane of this group of respondents, a statistically significant difference in favour of the respondents who have normal posture was observed (sig=0.001). In adolescent respondents, statistical analysis revealed the existence of statistically significant differences in the thoracic part of the sagittal plane in favour of the respondents with normal postural status (sig=0.028) while in lumbar part such statistical difference was not observed (sig=0.162). Such results are not consistent with the previous researches (Jorgić, et al., 2015; Jorgić, et al., 2015; Radaković, et al., 2016; Vukićević, et al., 2018; Vukićević, et al., 2018) whose results are with a worsened postural status but whose respondents are children of juvenile and adolescent age who do not train.

The results obtained by determining the differences in the level of the prevalence of postural disorders of the spine in the frontal and sagittal plane between juvenile and adolescent respondents indicated that there are no statistically significant differences in frontal plane (sig=1.000), in thoracic (sig=0.108) and lumbar part (sig=0.237) of the sagittal plane. The results of the earlier researches (Milenković, et al., 2012; Jorgić, et al., 2015; Vukićević, et al., 2018) are not consistent with the obtained results of this research. Also, an earlier research (Đokić, Međedović, & Smiljanić, 2011) found the existence of an increase in the number of postural disorders in the spine in adolescent children compared to juvenile children. According to the results of this research, it can be indicated that swimming as a form of physical activity is one of the active forms of prevention of postural disorders in children of the most susceptible age for the occurrence of muscle imbalance located on the spine and the occurrence of the postural disorders. The absence of statistical differences between juvenile and adolescent respondents in the level of the prevalence of postural disorders represent an important indicator for health institutions and also for teachers of physical education in elementary schools as well as trainers and parents of children who have been diagnosed with postural changes on the spine.

Conclusion

In accordance with the obtained results on the state of postural status on the spine in the frontal and sagittal plane in juvenile and adolescent swimmers, it can be concluded that the level of postural disorders on the spine in juvenile and adolescent swimmers is high. Also, the level of difference in prevalence of postural disorders is statistically insignificant in juvenile and adolescent respondents, indicating a very significant factor that due to intensive growth and development in adolescent period, swimming as a sport had an impact on establishment of normal muscle balance and not an increase in the number of swimmers with postural disorders on the spine.

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Conflict of Interest
The author declares that there is no conflict of interest.

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