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Longitudinal Skeleton Dimensionality in Children With Disturbed Body Posture

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Abstract: *Disturbed body posture in children changes the musculoskeletal system significantly. Muscular disbalance i.e. muscular asymmetry in both the sagittal and the frontal plane can affect the variation level of the longitudinal skeleton dimensionality. The conducted research included a sample of 67 children in the municipality of Subotica, out of which 22 had kyphotic disturbed body posture, 18 had lordotic disturbed body posture while 27 had flat feet. The aim of the research was to determine the differences in longitudinal dimensions in children aged 10 and 11 who have disturbed body posture. The obtained results indicate a statistically significant difference in arms' length (p=0.02).*
Key words: *posture, disturbed body posture, longitudinal dimensionality*

Introduction

The correct postural status is the basis for the proper functioning of the human body throughout life, and also contributes to a good aesthetic appearance (Kendall et al., 1968). Good postural status is reflected in a proportionate anatomical-physiological ratio between all parts of a human motor apparatus (Madić, 2014). A good postural setting of all segments of the human body contributes to the efficiency and persistence of the movement. When the condition of the muscular-skeletal balance is good, it protects from the formation and progressive development of postural disorders of those structures that hold the body in an upright position or in some other position, both in motion or at rest (Madić, 2014). A good postural status is related to the proper activation and maintenance of the locomotor apparatus, especially in critical periods of growth and development of children, and is mainly related to good living habits acquired from the earliest days. Insufficient

Longitudinalna dimenzionalnost skeleta kod dece narušene posture

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Apstrakt: *Pojava narušenog posturalnog statusa dece nosi sa sobom rizik od mogućnosti pojave niza promena na mišićno skeletnom sistemu. Bilo da se radi o narušenim držanjima u sagitalnoj ili frontalnoj ravni, mišićni disbalans tj. mišićne asimetrije mogu da "uslovljavaju " i odstupanja na nivou longitudinalne dimenzionalnsoti skeleta. Istraživanjem je bilo obuhvaćeno ukupno 67 ispitanika sa područja opštine Subotica, od čega je merenjima bilo podvrgnuto 22 ispitanika sa kifotičnim narušenim držanjem tela, 18 ispitanika sa lordotičnim lošim držanjem tela , dok je ispitanika sa ravnim stopalima bilo 27. Cilj studije je bio da se utvrde razlike u longitudinalnim dimenzijama dece uzrasta 10 i 11 godina, čija je postura narušena. Rezultati ukazuju na postojanje statistički značajne razlike u dužini gornjih ekstremiteta (p=0,02).*
Ključne reči: *postura, narušeno držanje, longitudinalna dimenzionalnost.*

Uvod

Pravilan posturalni status predstavlja osnovu za pravilno funkcionisanje čovekovog tela tokom života, a takođe doprinosi i dobrom estetskom izgledu (Kendall i sar., 1968). Dobar posturalni status se ogleda u srazmernom anatomsko fiziološkom odnosu svih delova motornog aparata čoveka (Madić, 2014). Dobra posturalna postavka svih segmenata ljudskog organizma doprinosi efikasnosti i istrajnosti pokreta. Kada je stanje mišićno skeletnog balansa dobro, ono štiti od nastajanja i progresivnog razvoja posturalnih poremećaja onih struktura koje drže telo u uspravnom stavu ili nekom drugom položaju, bilo u kretanju ili pri mirovanju (Madić, 2014). Dobar posturalni status je vezan za pravilnu aktivaciju i održavanje lokomotornog aparata, posebno u kritičnim periodima rasta i razvoja dece, i uglavnom je vezan za dobre životne navike koje se stiču od najranijih dana. Ne-

activation of the musculoskeletal system in children, conditioned by the advancement of modern technology, promotes the appearance of poor and impaired posture of the body (Choo et al., 2010). The forms and habits of human behavior have been adapted to current needs, where less and less time is spent in movement, and more and more in the sedentary regime, which may result in poor health.

The engagement in regular physical activity results in functional adaptation of the entire musculoskeletal system, and thus achieves its positive effects. Engagement in physical activity causes a number of changes in all physiological systems in the body, primarily musculoskeletal (Moreira et al., 2014; Gunter et al., 2012; Baxter et al., 2008). In addition to all the consequences that cause an impaired postural status, one of the leading consequences is reflected in changes in motor function. Insufficient muscular involvement can eventually lead to muscular imbalances, which not only have negative effects on motor skills in children, but can in the long run also cause changes in the musculoskeletal system. In order to maintain the correct postural status, it is necessary that all the links in the kinetic chain of the body function well and be in balance. The parts primarily at risk of the occurrence of postural deviations are spinal column and feet, especially in critical periods, especially affecting younger school age (Protić-Gava, 2015). According to the available data in the territory of Serbia, there is relatively large number of children of both sexes, of younger school age, with impaired postural status (Radisavljević et al., 1997). The most common deviations are seen in winged shoulder blades (21%), lordotic poor posture (44% boys and even 57% of girls) and flat feet (79%).

Reduced physical activity and sedentary lifestyle, which is increasingly present in the younger population, can consequently lead to muscular asymmetries in some segments, for example, the deviation of the shoulder blade region, or the appearance of an inferior angle of the scapula (Burkhart et al., 2003; Kibler, 2003 Kibler et al., 2002), which could later affect the formation of a impaired spinal column position. All forms of impaired posture carry certain anthropometric-morphological specificities. Muscular imbalances in the spinal column, regardless of the observed plane, when reviewing the clinical picture, may have an effect on the length of the upper extremities. Poor and insufficient musculature affects the harmonious relationship of the left and right sides of the body, and therefore can affect the dimensionality of the skeleton.

Accordingly, the aim of the study was to determine whether there are differences in the selected parameters of dimensionality (body height, sitting height, forearm

dovoljna aktivacija mišićno-skeletnog sistema kod dece, uslovljena napretkom savremene tehnologije, promoviše pojavu lošeg narušenog držanja tela (Choo i sar., 2010). Oblik i navike čovekovog ponašanja su se prilagodile aktuelnim potrebama, gde se sve manje vremena provodi u kretanju, a sve više u sedentarnom režimu, što za posledicu može da ima narušeno zdravlje.

Primena redovne fizičke aktivnosti rezultira funkcionalnim prilagođavanjem i adaptacijom celog mišićno skeletnog sistema, i na taj način ostvaruje svoje pozitivne efekte. Telo angažovano fizičkom aktivnošću uzrokuje niz promena u svim fiziološkim sistemima, u prvom redu mišićno-koštanom (Moreira i sar., 2014; Gunter i sar., 2012; Baxter i sar., 2008). Pored svih posledica koje uzrokuje narušen posturalni status, jedna od vodećih posledica se ogleda u promenama u motoričkom funkcionisanju. Nedovoljna mišićna angažovanost može vremenom dovesti do mišićnih disbalansa, koji ne samo da imaju negativne efekte na motoriku dece već u dužem vremenskom periodu mogu da uzrokuju promene na koštano-mišićnom sistemu. Da bi se održao pravilan posturalni status, neophodno je da sve karike u kinetičkom lancu organizma dobro funkcionišu i budu u balansu. Prvenstveno su podložni kičmeni stub i stopala riziku nastanka posturalnih odstupanja, pogotovu u kritičnim periodima, od kojih je jedan i mlađi školski uzrast (Protić-Gava, 2015). Prema dostupnim podacima, na području Srbije, relativno je veliki broj dece oba pola mlađeg školskog uzrasta koji imaju narušen posturalni status (Radisavljević i sar., 1997). Najčešća odstupanja se ogledaju u krilastim lopaticama (21%), lordotično lošem držanju (44% dečaci i čak 57% devojčice) i ravnom stopalu (79%).

Usled smanjene fizičke aktivnosti i sedentarnog načina života, koji je sve prisutniji u mlađoj populaciji, posledično može dovesti do mišićnih asimetrija u nekim segmentima npr., odstupanja rameno lopatične regije, odnosno pojave slabijeg skapularnog ugla (Burkhart i sar., 2003; Kibler, 2003; Kibler i sar, 2002), koje bi kasnije moglo uticati na formiranje narušene posture kičmenog stuba. Svi oblici narušene posture nose sa sobom određene antropometrijske-morfološke specifičnosti. Mišićni disbalansi u kičmenom delu, bez obzira na posmatranu ravan, kada se posmatra klinička slika, mogu imati uticaj na dužinu gornjih ekstremiteta. Slaba i insuficijentna muskulatura utiče na skladan odnos leve i desne strane tela, a samim tim može da utiče i na dimenzionalnost skeleta.

Shodno navedenom, cilj rada je bio da se utvrdi da li postoje razlike u odabranim parametrima dimenzionalnosti (telesna visina, sedeća visina, dužina podlaktice,

length, upper arm length, total arm length) in children with already established impaired posture of body segments.

Method

The sample of respondents consisted of 67 children of 10 and 11 years (± 6 months) of age, from Subotica. The sample was divided into three subsamples with an existing diagnosis given by a physician (22 respondents with a kyphotic, 18 respondents with lordotic posture, and 27 respondents with flat feet). For the estimation of the longitudinal dimensionality of the skeleton, the following parameters were measured: body height (mm), sitting height (mm), upper arm and forearm lengths and total arm length (mm). When measuring the longitudinal parameters, the standards according to the International Biological Program (IBP) have been respected in order to obtain the most relevant data. Martin anthropometer with a measurement accuracy of 0.1cm was used for all measurements of longitudinal skeleton and its segments.

Longitudinal parameters are shown through descriptive statistics (AS, S, MIN, MAX), while the univariate variance analysis (ANOVA) and the LSD Post Hock test (a series of independent t tests) were applied for determining the existence of differences between the groups of subjects for all the analyzed variables. Statistical significance was set to $p<0.05$.

Results

The study covered a total of 67 respondents from the municipality of Subotica, of which 22 respondents with kyphotic impaired body posture (32.8%), 18 respondents with lordotic poor body posture (26.9%), and 27 respondents with flat feet (40.3%). Table 1 shows the results of descriptive parameter statistics for the observed groups of respondents: with kyphotic impaired posture (K), with lordotic poor posture (L) and with flat feet (FF).

dužina nadlaktice, ukupna dužina ruke) kod dece sa već utvrđenom narušenom posturom segmenata tela.

Metod

Uzorak ispitanika je činio 67 dece uzrasta 10 i 11 godina (±6 meseci) iz Subotice. Uzorak je podeljen na tri subuzorka sa već postojećom dijagnozom datom od strane lekara (22 ispitanika sa kifotičnim, 18 ispitanika sa lordotičnim, i 27 ispitanika sa ravnim stopalima). Za procenu longitudinalne dimenzionalnosti skeleta mereni su sledeći parametri: telesna visina (mm), sedeća visina (mm), dužina nadlaktice i dužina podlaktice i ukupna dužine ruke (mm). Prilikom merenja longitudinalnih parametara ispoštovani su standardi prema Internacionalnom biološkom programu (IBP) kako bi se dobili što relevantniji podaci. Za sve mere longitudinalnosti skeleta i njegovih segmenata korišten je antropometar po Martinu, sa preciznošću merenja od 0,1cm

Longitudinalni parametri su prikazani kroz deskriptivne statistike (AS, S, MIN, MAX), dok su za utvrđivanje postojanja razlika između grupa ispitanika za sve analizirane varijable primenjeni univarijatna analiza varijanse (ANOVA) i LSD Post Hok test (serije nezavisnih t- testova). Statistička značajnost je postavljena na $p<0,05$.

Rezultati

Istraživanjem je bilo obuhvaćeno ukupno 67 ispitanika sa područja opštine Subotice, od čega je merenjima bilo podvrgnuto 22 ispitanika sa kifotičnim narušenim držanjem tela (32,8%), 18 ispitanika sa lordotičnim lošim držanjem tela (26,9%), dok je ispitanika sa ravnim stopalima bilo 27 (40,3%). U Tabeli 1. su prikazani rezultati deskriptivnih statistika parametara za posmatrane grupe ispitanika: sa kifotičnim narušenim držanjem (K), ispitanika sa lordotičnim narušenim držanjem (L) i ispitanika sa ravnim stopalima (RS).

Table 1 *Descriptive statistics of longitudinal parameters*

Tabela 1. *Deskriptivni statistici longitudinalnih parametara*

	Grupa / *Group*	AS	S	MIN	MAX
Telesna visina (mm) / *Body height (mm)*	K	1543.86	63.28	1390	1630
	L	1556.11	84.32	1375	1705
	RS	1511.67	77.78	1370	1660
Sedeća visina (mm) / *Sitting height (mm)*	K	702.23	41.71	625	790
	L	708.33	70.79	560	815
	RS	695.15	66.74	565	820
Dužina nadlaktice (mm) / *Upper arm length (mm)*	K	221.55	10.23	200	241
	L	221.67	10.91	204	250
	RS	217.41	7.92	202	232
Dužina podlaktice (mm) / *Forearm lenght (mm)*	K	206.05	12.94	184	236
	L	210.00	13.81	190	240
	RS	203.96	8.60	190	219
Dužina ruke (mm) / *Arm length (mm)*	K	595.05	21.31	535	636
	L	598.00	28.15	551	666
	RS	577.41	28.96	521	629

Legend: *AM - arithmetic mean; S – standard deviation; MIN – minimum result; MAX – maximum result*

Legenda: *AS – aritmetička sredina; S – standardna devijacija; MIN – minimalni rezultat; MAX – maksimalni rezultat*

Table 2 shows the results of quantitative differences in the longitudinal dimensionality of the skeleton at the univariate level. Based on the results of the F ratio, it can be concluded that there was a statistically significant difference only for the variable *Arm length* (p = 0.02). In other analyzed variables, statistically significant differences were not observed (p> 0.05).

U Tabeli 2. prikazani su rezultati kvantitativnih razlika longitudinalne dimenzionalnosti skeleta na univarijatnom nivou. Na osnovu rezultata F odnosa, može se zaključiti da je postojala statistički značajna razlika samo u varijabli *Dužina ruke* (p=0,02). U ostalim analiziranim varijablama statistički značajne razlike nisu uočene (p>0,05).

Table 2 *Differences between groups of respondents (ANOVA)*

Tabela 2. *Razlike između grupa ispitanika (ANOVA)*

Varijabla / *Variable*	F	p
Telesna visina (mm) / *Body height (mm)*	2,16	0,12
Sedeća visina (mm) / *Sitting height (mm)*	0,26	0,77
Dužina nadlaktice (mm) / *Upper arm length (mm)*	1,48	0,24
Dužina podlaktice (mm) / *Forearm lenght (mm)*	1,46	0,24
Dužina ruke (mm) / *Arm length (mm)*	4,21	0,02

Legend: *F – F test; p – level of statistical significance of the F test*

Legenda: *F – F test; p – nivo statističke značajnosti za F test*

In order to gain a clearer insight between which groups there were accurately statistically significant differences, a t - test for independent samples was applied. The values are presented through differences between arithmetic means using the LSD Post Hock test (Table 3). Statistically significant differences occurred between the groups with kyphotic poor posture and flat feet (p = 0.02) in favor of respondents with kyphotic poor posture, and there was also a difference between respondents with lordotic poor posture and flat-footed respondents (p = 0.02) in favor of

Da bi se dobio jasniji uvid između kojih grupa tačno su postojale statistički značajne razlike primenjen je t – test za nezavisne uzorke. Vrednosti su predstavljene kroz razlike aritmetičkih sredina uz primenu LSD Post Hock testa (Tabela 3.). Statistički značajne razlike su se pojavile između grupa sa kifotično lošim držanjem i ravnim stopalima (p=0,02) u korist ispitanika sa kifotičnim lošim držanjem, a takođe se javila razlika između ispitanika sa lordotičnim lošim držanjem i ispitanika sa ravnim stopalima (p=0,02) u korist ispitanika sa lordotičnim lo-

respondents with lordotic poor posture. In both groups of respondents, values were observed pointing to longer upper extremities compared to the group with flat feet.

Table 3. *Results of the analysis of the series of t-tests (LSD) and differences between AMs*

Varijabla / *Variable*	(I) Grupa / *Group*	(J) Grupa / *Group*	Razlika AS / *Difference between AMs* (I-J)	p
Telesna visina (mm) / *Body height (mm)*	K	L	-12,25	0,61
		RS	32,20	0,14
	L	K	12,25	0,61
		RS	44,44	0,06
	RS	K	-32,20	0,14
		L	-44,44	0,06
Sedeća visina (mm) / *Sitting height (mm)*	K	L	-5,61	0,77
		RS	7,58	0,67
	L	K	5,61	0,77
		RS	13,19	0,48
	RS	K	-7,58	0,67
		L	-13,19	0,48
Dužina nadlaktice (mm) / *Upper arm length (mm)*	K	L	-0,12	0,97
		RS	4,14	0,15
	L	K	0,12	0,97
		RS	4,26	0,16
	RS	K	-4,14	0,15
		L	-4,26	0,16

Legend: p *– level of statistical significance of the t- test*

Table 3 (continued). Results of the analysis of the series of t-tests (LSD) and differences between AMs

Dužina podlaktice (mm) / *Forearm lenght (mm)*	K	L	-3,96	0,29
		RS	2,08	0,54
	L	K	3,96	0,29
		RS	6,04	0,09
	RS	K	-2,08	0,54
		L	-6,04	0,09
Dužina ruke (mm) / *Arm length (mm)*	K	L	-2,91	0,73
		RS	17,68	0,02
	L	K	2,91	0,73
		RS	20,59	0,01
	RS	K	-17,68	0,02
		L	-20,59	0,01

Legend: *p – level of statistical significance of the t test*

Discussion

The aim of this paper is to determine whether there are differences in the selected parameters of skeletal di-

šim držanjem. U obe grupe ispitanika su uočene vrednosti koje upućuju na duže gornje ekstremitete u odnosu na grupu sa ravnim stopalima.

Tabela 3. *Rezultati analize serija t-testova (LSD) i razlike AS*

Legenda: *p – nivo statističke značajnosti t- testa*

Nastavak tabele 3. Rezultati analize serije t-testova (LSD) i razlike AS

Legenda: *p – nivo statističke značajnosti t testa*

Diskusija

Cilj rada je bio da se utvrdi da li postoje razlike u odabranim parametrima dimenzionalnosti skeleta kod

mensionality in children with already established impaired posture. The obtained data indicate that subjects with impaired posture of the spinal column at sagittal level (kyphotic and lordotic) had longer upper extremities. Due to developmental specifics, pre-puberty period is characterized by rapid growth and development, which can lead to weaker ligament connections, due to the inability of the muscles to cope with rapid bone growth. The results obtained by the research (Weinstein et al., 2008; Yilikoski, 2005; Yilikoski, 2003) have shown that children with an impaired posture of spinal column are generally higher than the standard population of the same age, which could be related to the observed difference between the groups of respondents in our study. Some studies (Ylikoski et al., 2005; Cheung et al., 2003; Escalada., 2005; Yrjonen et al., 2006) also emphasize the importance of the pre-puberty period in terms of impaired posture. The relation between the measures of longitudinality and disturbed posture is also indicated by studies (Bogdanović and Milenković, 2009), where they pointed out the correlation between body height and muscle imbalances. Considering the age of the sample examined in this study, a correlation could be created between the developmental specificities and the obtained values of the longitudinality of the upper extremities. The increased longitudinality of the skeleton is one of the prerequisites for creating an impaired posture. Studies carried out (Trajković and Nikolić, 2008; Bogdanović and Milenković, 2009) also pointed to the significant correlation between the increased longitudinality of the skeleton with muscular imbalances on the spinal column.

The intense growth of long tubular bones accompanying the pre-puberty and puberty period can affect the body's muscularity that is not able to follow such changes, which can lead to impaired body posture. Changes in observed longitudinality of extremities in respondents with kyphotic poor posture compared to the group of flat-footed respondents could be attributed to changes occurring in a typically pronounced kyphotic posture. A typical kypothic body posture the result of a change in the length of the muscles, specifically shortened deep muscles of chest cavity, such as the external and internal intercostal muscles (*mm. intercostalis externi etinterni*) and transverse chest muscle (*m. transversus thoracis*) that lead to characteristic forward-rounded shoulder. On the other hand, weak and elongated musculature of the muscles of the back, especially the muscles of upper third (superficial and deep muscles) can also lead to the forward-roundness of the shoulder, which could be associated with increased longitudinality of the upper extremities.

The weakened musculature of the abdominal region

dece sa već utvrđenom narušenom posturom. Dobijeni podaci ukazuju na to da su ispitanici sa narušenim držanjem kičmenog stuba u sagitalnoj ravni (kifotično i lordotično) imali duže gornje ekstremitete. Predpubertetski period, zbog razvojnih specifičnosti, karakteriše nagli rast i razvoj, koji može dovesti do slabijih ligamentarnih veza, usled nemogućnosti mišića da proprate ubrzan rast kostiju. Rezultati dobijeni istraživanjima (Weinstein i sar., 2008; Yilikoski, 2005; Yilikoski, 2003) su pokazala da su deca sa narušenom posturom kičmenog stuba generalno viša u odnosu na standardnu populaciju istog uzrasta, što bi se moglo dovesti u vezu sa dobijenom razlikom unutar grupa ispitanika u našem istraživanju. Pojedine studije (Ylikoski i sar., 2005; Cheung i sar., 2003; Escalada., 2005; Yrjonen i sar., 2006), takođe ističu značaj predpubertetskog perioda kada su u pitanju narušena držanja. Da postoji veza između mera longitudinalnosti i narušenih držanja ukazuju i istraživanja (Bogdanović i Milenković, 2009), gde su ukazali na povezanost telesne visine i mišićnih disbalansa. Obzirom na uzrast ispitivanog uzorka u ovom istraživanju, mogle bi da se dovedu u vezu razvojne specifičnosti sa dobijenim vrednostima longitudinalnosti gornjih ekstremiteta. Povećana longitudinalnost skeleta je jedan od preduslova za stvaranje narušenog držanja. Istraživanja koje su sprovedena (Trajković i Nikolić, 2008; Bogdanović i Milenković, 2009) su takođe ukazala na značajnu povezanost povećane longitudinalnosti skeleta sa mišićnim disbalansima na kičmenom stubu.

Intenzivan rast dugih cevastih kostiju koji prati predpubertetski i pubertetski period može da utiče na muskulaturu tela koja nije u stanju da prati takve promene, što može da dovode do narušenih držanja tela. Promene primećene u longitudinalnosti ekstremiteta kod ispitanika sa kifotično lošim držanjem u odnosu na grupu ispitanika sa ravnim stopalima bi se mogle pripisati promenama koje nastaju kod tipično izraženog kifotičnog držanja. Tipična slika kifotičnog držanja tela je rezultat promena u dužini mišića, gde kod skraćenih dubokih mišića grudnog koša, kao što su spoljni i unutrašnji međurebarni mišići (*mm. intercostales externi et interni*) i poprečni grudni mišić (*m. transversus thoracis*) koji daju karakterističnu zaobljenost u ramenom delu ka napred. Sa druge strane, slaba i izdužena muskulatura mišića leđa, pogotovo mišića gornje trećine (površinskih i dubokih) takođe može da utiče na povlačenje ramena prema napred što bi se moglo dovesti u vezu sa povećanom longitudinalošću gornjih ekstremiteta.

Oslabljena muskulatura abdominalne regije dodatno može da ima uticaja na narušena držanja u sagitalnoj i

can additionally have an effect on disturbed postures in the sagittal and frontal plane. The insufficiency of the abdominal region can lead to the abdominal wall protrusion (Ishida & Kuwajima, 2001; Penha et al., 2005) and lowering followed by pulling the shoulder belt which can result in higher longitudinal dimensions of the upper extremities.

Another aspect of interpreting the results obtained could be related to functional asymmetries caused by hemispheric brain domination. Voluntary interactions with the environment and life habits can cause functional adjustment. This can be observed from the aspect of a long sitting in front of the computer. Biomechanical adaptation to the characteristic position can cause the strengthening of motor paths which may result in the pushing of the shoulder-blade region forwards. Interaction with the environment and the influence of certain motor stimulants can result in functional lateralization, or dominance of certain muscle groups (Mostoflei and Banica., 2010).

In addition to the results obtained, the research also has some disadvantages. First of all, the fact that a sample of respondents is composed of children at the pre-puberty stage, which additionally makes it difficult to make conclusions. In order to obtain objective data when it comes to impaired posture and the values of longitudinal dimensionality it would be desirable to look at these changes in the period of completed growth and development, or in early childhood. This way, one could obtain the results that "eliminate" the phase of intense growth and development, and some other factors of influence could be correlated. In addition, a relatively small number of respondents per group limits a more certain conclusion. There is also an issue of further research by expanding and comparing results with a group of respondents without determined postural deviations and obtaining a clearer insight into mechanisms related to the growth and development of children of this age.

Conclusion

On the basis of the obtained results it can be said, as a general conclusion, that the longitudinality of the skeleton is in direct correlation with the occurrence of impaired body posture. Based on the analysis, the existence of differences in the length of the long tubular bones of the upper extremities is observed. The intense growth of long tubular bones and the fact that the body's muscularity does not accompany such a change can lead to various manifestations of body deformities characterized as poor body postures in children, which further leads to weakness of the ligament apparatus and reduced tone. More detailed control and early detection of impaired conditions is needed in order to reduce the number of children with changes that may lead to other musculoskeletal changes.

frontalnoj ravni. Insuficijencija abdominalne regije utiče na protruziju trbušnog zida (Ishida & Kuwajima., 2001; Penha i sar.,2005) i spuštanje praćeno povlačenjem ramenog pojasa što za rezultat može da ima povišene longitudinalne mere gornjih ekstremiteta.

Još jedan aspekt tumačenja dobijenih rezultata mogao bi da se odnosi na funkcionalne asimetrije uzrokovane hemisfernom dominacijom mozga. Dobrovoljne interakcije sa okolinom i životnim navikama mogu da uzrokuju funkcionalno prilagođavanje. To se može posmatrati iz ugla dugotrajnog sedenje za računarom. Biomehaničko prilagođavanje karakterističnom položaju može da uzrokuje jačanje motornih puteva koji za posledicu mogu da imaju povlačenje rameno-lopatične regije prema napred. Interakcija sa okolinom i uticajem određenih motoričkih stimulansa može da dovede do funkcionalne lateralizovanosti, odnosno dominacije određenih mišićnih grupa (Mostoflei i Banica., 2010).

Pored navedenih dobijenih rezultata, istraživanje ima i određene nedostatke. Kao prvo, činjenica je da je uzorak ispitanika sastavljen od dece u fazi predpuberteta, što dodatno otežava izvođenje zaključaka. Kako bi se došlo do objektivnih podataka kada su u pitanju narušena držanja i vrednosti longitudinalne dimenzionalnosti poželjno bi bilo sagledati upravo te promene u periodu završenog rasta i razvoja, ili pak u ranom detinjstvu. Na taj način bi se dobili rezultati koji "eliminišu" fazu intenzivnog rasta i razvoja pa bi se u vezu mogli dovesti i neki drugu faktori uticaja. Pored ovoga, relativno mali broj ispitanika po grupama limitira konkretnije zaključivanje. Otvara se i pitanje daljeg istraživanja u ovoj problematici proširivanjem i poređenjem rezultata sa grupom ispitanika bez utvrđenih posturalnih odstupanja i dobijanja jasnije slike o mehanizmima vezanim za rast i razvoj dece ovog uzrasta.

Zaključak

Na osnovu dobijenih rezultata kao generalni zaključak se može reći da je longitudinalnost skeleta u direktnoj vezi sa nastankom narušenih držanja. Na osnovu analize, konstatuje se postojanje razlika u dužini dugih cevastih kostiju gornjih ekstremiteta. Intenzivan rast dugih cevastih kostiju i činjenice da muskulatura tela ne prati takve promene, može da dovede do raznih pojava u vidu telesnih deformiteta okarakterisanih kao loša držanja tela kod dece, što dalje dovodi do slabosti ligamentarnog aparata i smanjenog tonusa. Potrebna je detaljnija kontrola i rana detekcija narušenih stanja kako bi se smanjio broj dece sa promenama koje mogu da budu okosnica za stvaranje drugih mišićno-koštanih promena.

Families, sports clubs and schools have to deal more with this problem. Prevention and early detection of impaired body posture are the key to success in their elimination. The ability to recognize the impaired body posture by a pedagogue of physical education is one of the important links in the problem-solving chain.

Porodica, sportski klubovi i škole moraju se više pozabaviti ovim problemom. Prevencija i rana detekcija kada su u pitanju narušena držanja su ključ uspeha u otklanjanju istih. Mogućnost prepoznavanja narušenih držanja tela od strane pedagoga fizičke kulture jedna je od značajnih karika u lancu rešavanja problema.

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