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Types of Body Posture and their Characteristics in Boys 10 to 13 Years of Age

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A B S T R A C T

The main goal of the study was to determine the types of body posture of boys (n=273), 10 to13 years of age, by means of the body posture assessment method based on the software Posture Image Analyzer. The results should enable better understanding of postural issues, as well as timely and more precise selection of kinesitherapeutic procedures. Values of 5 front view and 4 sagittal view indicators of standing body posture were measured by means of subjects' photographs and software Image Posture Analyzer. Cluster analysis (K-means method) revealed three types of body posture in both the anterior and sagittal plane. Their characteristics were determined with discriminant analysis. In sagittal indicators three posture types are recognizable: (a) correct sagittal body posture (29.3%), (b) mild impaired sagittal body posture (41.8%), (c) marked impaired sagittal body posture (28.9%). In anterior indicators also three posture types are recognizable: (a) correct anterior body posture (19.4%), (b) mild scoliotic body posture in the lumbar region (47.6%), (c) mild scoliotic body posture with double curvature (33%).

Key words: *posture types, image posture analyzer, school, children*

Introduction

Many research studies have treated so far the issue of body posture assessment by focusing on the selection of the best indicators and by assessing reliability of procedures[1–8], in order to reveal deviations or impairments in body postures of children and adults. Since the problem of poor posture in children, which is among the pronounced issues of modern way of living, occurs in ever earlier years, it is very important to diagnose any posture impairment as soon and as reliable as possible.

Characteristics of good standing posture may be viewed from anterioposterior and sagittal perspective. Good posture implies balance among all segments of the body. From the anterioposterior perspective no asymmetry among body segments must be obvious. The head must be vertically straight up; shoulders, papillas of the pelvis, knees and ankles must be levelled. In the sagittal view all body segments must be in alignment with the gravity line – it must go vertically down through the centres of gravity of each body segment (the centre of scull, the centres of shoulders, hips, knees, and a somewhat in front of the *malleolus lateralis*), and its projection on the floor should form the rectangle with its line. Sagged body posture is a consequence of weak, or not enough strong muscular structure, so body weight overloads certain parts of locomotor system, bones and their connections.

In children deviations from normal body posture are becoming more pronounced and more frequent. In the study conducted by Paušić[7] it was demonstrated that in 51.58% of primary school first formers (6–7 yrs) the indicators of body posture asymmetry were registered. A year later, in the same children, this percentage increased up to 62.1%. Further, in the first form it was obtained that 28.4% of children had rib cavity abnormalities, whereas the next year that percentage was even 51.6%. Flat-foot-disorder was registered in 47.3% and 60.7% of children in the first and the second form, respectively. The presented data illustrate well the growing portion of body posture disorders in school children's health status. Abnormal body posture may assume various forms, which different authors defined as types of body posture[2,9,10]. The main goal of this study was to de-

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termine the types of body posture in boys 10 to 13 years of age by the application of the body posture assessment method based on the software Image Posture Analyzer[11].

Materials and Methods

Subjects

The study was conducted in 2007 on a convenience sample of male students from two elementary schools in Split, Croatia. Prior to the study, sample size requirements had been estimated using Bonett's calculation[15]. To achieve the expected reliability of 0.9 and desired 95% confidence interval of reliability of ±0.02 using 3 items, the required sample size was 251 subjects. To ensure this confidence interval width, 273 subjects were included in the study. All subjects were aged between 10 and 13. The inclusion criterion was that subjects had no structural deformities or aberrations of the locomotor system. The participation of all the examinees was voluntary and students' parents were informed about the procedure and signed the informed consent. The Ethical Commission of the Faculty of Mathematics, Science and Kinesiology, University of Split, Croatia, approved the research design.

Posture parameters

Indicators of body posture were selected according to the already existing knowledge about body referent points in their relation to the gravitational line in sagittal and anterior view[4,10]. Indicators of body posture in anterior or frontal view (Figure 1): FUHO – deviation of the line connecting the top of helices of the left and right ear from the horizontal line; FRAM – deviation of the line connecting the left and the right *acromion* from the horizontal line; FZDJ – deviation of the line connecting the left and the right *spina iliaca anterior superior* from the horizontal line; FKOL – deviation of the line connecting the left and the right *epicondylus medialis* from the horizontal line; FNZG – deviation of the line connecting the left and the right *malleolus medialis* from the horizontal line. Indicators of body posture in sagittal view (Figure 1): SUHO – deviation of the left ear's top of helix from the gravitational line; SRAM – deviation of the left *acromion* from the gravitational line; SZDJ – deviation of the left *spina iliace anterior superior* from the gravitational line; SKOL – deviation of the left *epicondylus lateralis* from the gravitational line.

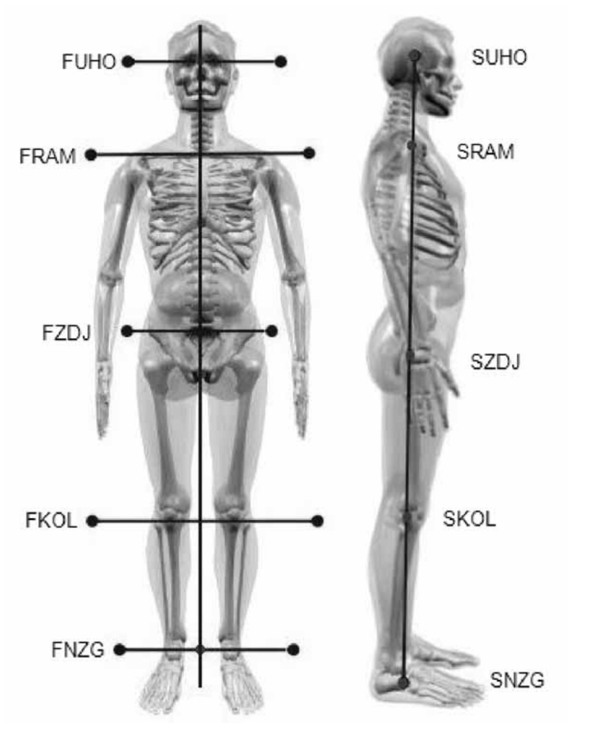

Fig. 1. Indicators of body posture in anterior or frontal view.

Testing procedure

In the preparation phase for this research we programmed software Image Posture Analyzer using Visual Basic. The main task of the software was to determine values of individual standing body posture indicators using two photographic pictures of each subject, taken by a digital photo-camera. The photo session was conducted in the gymnasium of the Elementary School Skalice in Split. The space for photographs taking was large enough and well light flooded (at least 5x2 metres), which were key criteria for the location selection. Tripod for the digital photo-camera was set 3.1 m apart from the line of the subject which was marked on the floor with the 30 cm long tape. Centrally and perpendicular to that line the other tape, 15 cm long, was put on the floor in order to regulate proper positioning of a subject in front of the photo-camera in his anterior and lateral (sagittal) stance. The camera tripod was duck-taped to the floor after its proper positioning was ensured by a spirit-level utensil, which was positioned on the top of the photo-camera during the whole procedure of picture taking. The Kodak Esyshare digital photo-camera of 5 Mpx was utilized, and photographs were saved into the software Image Posture Analyzer aimed at assessing body posture.

The procedure of photographs taking commenced with the subject assuming the position facing the camera with the tips of his longest toes touching the 30 cm long tape on the floor. His feet should be on both sides of the perpendicular, shorter tape. One measurer was responsible for the application of adhesive reflective markers on all the subjects. The markers were placed from above downwards, from the head to the feet on the particular, by the research protocol determined points of the body (Figure 1). After the adhesive markers had been fixed on the particular points, the measurer asked the subject to assume his usual, comfortable erect posture. Then the measurer took the first picture in the front view. Between each photo taking the subject was asked to make a few steps around, then to return and to assume the position for photograph taking again. Each time the position of the reflective markers was checked and corrected if it was

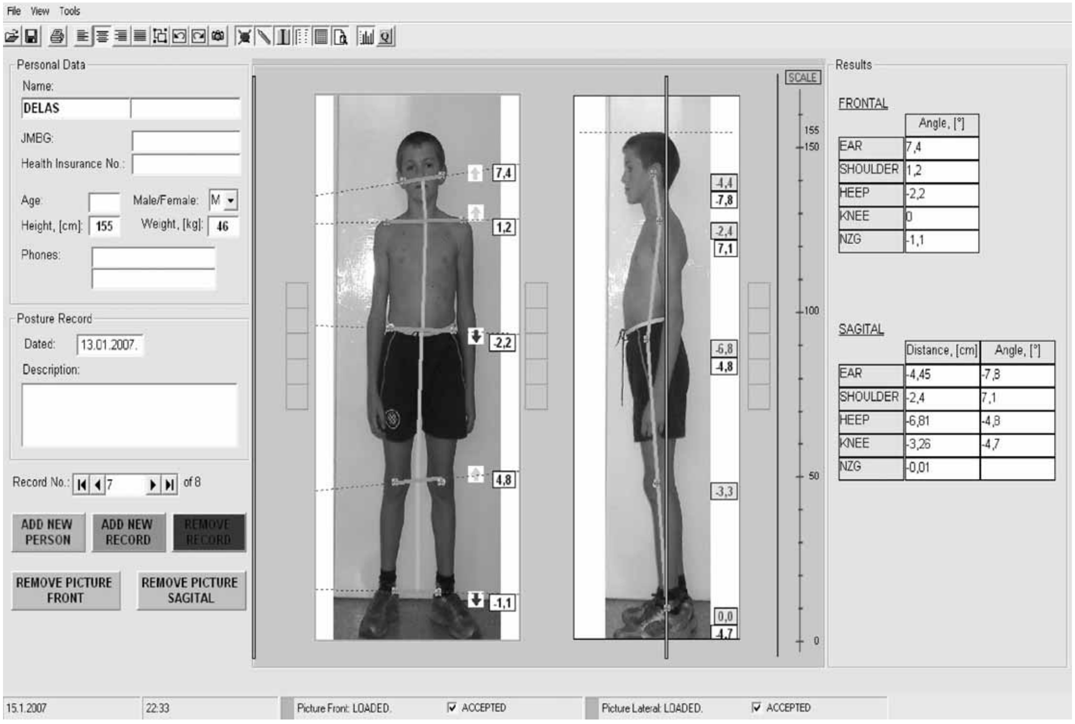

Fig. 2. The photograph entered into a body posture assessing software (Posture Image Analyzer, Paušić J, 2006).

necessary. Altogether, six photographs of each subject were taken – three in the anterior view, and three in the sagittal view of standing posture.

The photographs were entered into a body posture assessing software (Figure 2) subject by subject. The software was designed so as to automatically recognize the markers and to replace them by its own signs, which could be subjected to corrections. Afterwards, only one click was needed to compute the values of indicators. All the obtained results were directly saved in the Microsoft Excel folder and were used in the further statistical data processing.

Data analysis

The total score of subjects in each indicator was expressed as arithmetic mean and reliability was established by means of Cronbach's coefficient. K-means method of cluster analysis[12] was utilized to determine basic types of body posture. The following was computed: arithmetic mean ($\overline{X}$), standard deviation (SD), indicators of analysis of variance (F-value, p-level of significance), and the number of the subjects in each cluster. Discriminant analysis was used to determine the differences between the groups of boys and indicators of their body posture types obtained by cluster analysis. Statistical significance of the obtained discriminant functions was tested with Burttlet χ^2-test (on the 0.05 level of signification), so the following was computed: eigenvalues of discriminant functions (λ), canonical correlation coefficients (Rc), and Wilks' lambdas (Wλ) of discriminant functions, the correlation of the variables with the discriminant functions (matrix of structure), and centroids of the groups on the discriminant functions. The statistical processing was performed using the statistical software package Statistica 7.0 (StatSoft, USA).

Results

Reliability coefficients of the sagittal indicators ranged from 0.87 to 0.92, whereas these coefficients were of somewhat lower values in the anterior indicators and they ranged from 0.81 to 0.90[14].

TABLE 1
ANALYSIS OF VARIANCE WITH THE RESULTS OF ARITHMETIC MEANS AND STANDARD DEVIATIONS OF THE OBTAINED CLUSTERS (TYPES OF SAGITTAL AND FRONTAL BODY POSTURE)

	$\overline{X}$			SD			p
	Type 1	Type 2	Type 3	Type 1	Type 2	Type 3	
SUHO	–3.88	–1.95	–7.14	1.38	2.16	1.38	0.00
SRAM	–3.60	–0.30	–5.80	1.74	1.65	1.26	0.00
SZDJ	–5.11	–3.21	–7.38	1.32	1.91	1.91	0.00
SKOL	–2.36	–0.32	–3.44	1.46	1.60	1.48	0.00
FUHO	–0.16	–1.81	2.05	2.10	1.02	1.29	0.00
FRAM	–0.14	–0.08	0.58	1.89	2.01	1.55	0.02
FZDJ	–0.65	–1.82	–1.43	1.70	1.48	1.44	0.00
FKOL	1.70	–1.34	–1.87	0.67	1.20	1.20	0.00
FNZG	1.71	–1.84	–1.46	1.00	1.10	0.97	0.00

TABLE 2
STRUCTURE OF THE DISCRIMINANT FUNCTIONS AND CENTROIDS OF THE OBTAINED CLUSTERS
(SAGITTAL BODY POSTURE TYPES AND FRONTAL BODY POSTURE TYPES)

	DF_1	DF_2		DF_1	DF_2
SUHO	–0.49	–0.74	FUHO	0.03	0.98
SRAM	–0.54	0.48	FRAM	0.04	0.13
SZDJ	–0.39	–0.27	FZDJ	–0.13	0.11
SKOL	–0.33	0.46	FKOL	–0.59	–0.09
			FNZG	–0.67	0.21
Type1 – mild impairedtype of body posture	0.07	–0.36	Type 1 – correct type of body posture	–3.91	0.15
Type2 – correct typeof body posture	–3.21	0.25	Type 2 – mild scoliotic posture in lumbar region	0.84	–1.19
Type3 – marked impaired type of body posture	3.15	0.26	Type 3 – mild scoliotic posture with bilateral impairment	1.09	1.63
λ	5.96	0.09	λ	3.74	1.56
Rc	0.93	0.29	Rc	0.89	0.78
χ^2	544	24	χ^2	669.33	252.29
df	8	3	df	10	4
p	0.00	0.00	p	0.00	0.00

Sagittal plane standing posture types

In the process of defining the best maximal number of different groups in *K-means* method of cluster analysis, we tried out the variations with two, three, four and five possible groups. The variations were tested by comparing the results of ANOVA between the obtained groups in each indicator (Table 1).

In the end the best was the variation with three groups of subjects and their scores on the indicators of body posture in the sagittal view. These were: type 1, embracing 114 subjects (41.8%), type 2 with 80 (29.3%), and type 3 with 79 subjects (28.9%). Two discriminant functions were obtained (Table 2) which significantly (p?0.05) discriminated three body posture types in the sagittal view. The first function was considerably more powerful in the discrimination of sagittal posture types (Rc_1=0.93) than the second one (Rc_2=0.29). According to the values of the centroids of the obtained groups on the discriminant functions it is obvious that type 2 and type 3 significantly differ among themselves according to the first discriminant function, and that types 2 and 3 differ less from type 1 according to the second discriminant function. Correlations of indicators of sagittal posture with the first discriminant function indicate that position of shoulders (SRAM –0.54) contributed mostly to the differences between the obtained clusters. The other indicators also contributed to these differences in the following descended order: position of the head (SUHO –0.49), position of the pelvis (SZDJ –0.39), and position of knees (SKOL –0.33). The structure of the second discriminant function revealed that the indicator of head position (SUHO –0.74) contributed mostly to the difference between the aforementioned types of sagittal body postures. The other indicators also significantly contributed to their discrimination in the following (descending) order: position of shoulders (SRAM 0.48) and knees (SKOL 0.46), with the positive signs, and position of the pelvis (SZDJ –0.27), with the negative sign.

Anterior plane posture types

Cluster analysis of the anterior standing posture indicators extracted three clusters (types) of subjects: type 1 – contains 53 (19.4%), type 2 – contains 130 (47.6%), and type 3 – contains 90 (32.9%) subjects. Analysis of variance (Table 2) indicated that there were statistically significant differences between the obtained types (clusters) in all the frontal indicators of body posture at the significance level lower than 0.01. Two discriminant functions were obtained (Table 2) which described the differences between the types of anterior standing posture. Coefficients of canonical discrimination (R_C) in both discriminant functions are statistically significant and considerably high. However, the first discriminant function is slightly more powerful in the discrimination of frontal body posture types. According to the position of the centroids of subject groups (anterior types of posture) in the coordinate system of two discriminant functions, it is obvious that types 2 and 3 significantly differ from type 1 by the first discriminant function, as well as that type 2 significantly differs from type 3 by the second discriminant function. The structure of the discriminant functions and the positions of the centroids of the established frontal posture types are presented in Table 2. The structure of the first discriminant function indicates that the indicators position of knees (FKOL=–0.59) and position of ankles (FNZG=–0.67) contributed mostly to the differences between the mentioned types of frontal body posture, whereas position of the head (SUHO=0.98) determined maximally the second discriminant function. The rest of the indicators did not contribute substan-

TABLE 3
CONTINGENCY TABLE WITH ALL THE OBTAINED BODY POSTURE TYPES

	Sagittal body posture	$Type_1$ – mild impaired type of body posture	$Type_2$ – correct type of body posture	$Type_3$ – marked impaired type of body posture	
Frontal body posture		F	F	F	Total
Type 1 – correct type of body posture	F	19	11	23	53
	%	6.9	4.03	8.42	19.41
Type 2 – mild scoliotic posture in lumbar region	F	61	41	28	130
	%	22.34	15.02	10.26	47.62
Type 3 – mild scoliotic posture with bilateral impairment	F	34	28	28	90
	%	12.45	10.26	10.26	32.97
TOTAL	F	114	80	79	273
	%	41.76	29.30	28.94	100.00

tially to the definition of the second discriminant function.

Relations among all the obtained types of body posture

In order to establish relations among the obtained types of body posture in both views a contingency table was designed (Table 3) to obtain an insight into the existence of various combinations of body posture types. The largest percentage of boys in the sample has a mild impaired sagittal body posture in the combination with a mild scoliotic impaired posture (22.34%). Then comes a group of boys with correct sagittal body posture in combination with small deviations in frontal body posture (mild scoliotic body posture) (15.02%). It is also important to notice a low percentage of boys with correct posture in both views (4.03%). Other combinations are present in almost equal portions, ranging from 6.9% (correct frontal and mild impaired sagittal body posture) do 12.45% (mild impaired sagittal with double scoliotic body posture).

Discussion and Conclusion

The obtained reliability coefficients for the sagittal indicators of body posture indicate satisfactory reliability whereas the coefficients for the anterior indicators show somewhat lower values[14]. Therefore, it is advisable to enlarge the number of items to 4 in the indicators with not so high reliability, and to pay more attention to the precision of markers' placement on the referent points. Similar results were obtained by Dunk, Lalonde and Callaghan[13], who used photographs in the sagittal and the posterior view of standing posture to measure angles in three indicators with five items and obtained excellent reliability of the indicators in the sagittal plane, whereas moderate reliability coefficients were obtained in the indicators from the rear view. In all the indicators of the sagittal view McEvoy i Grimmer[8] obtained reliability higher that 0.93, and Paušić[7] in her research also obtained relatively high reliability coefficients (0.89 and above) for the measuring instrument Skoliozometar (Scoliosysmeter)[3]. Therefore, it is viable to conclude that the new method, presented here, although somewhat less reliable than the posture assessing method using Scoliosysmeter, has a competitive edge over it due to its simplicity and applicability in practice.

Sagittal plane posture types

Based on the results obtained by cluster and discriminant analyses it was viable to describe the obtained sagittal plane posture types as follows:

Type 1 – mild impaired type of body posture: Arithmetic means (Table 1) of the first sagittal posture type (first cluster) range between –2.36 and –5.11 centimetres. All the indicators are of the negative sign which indicates that all four indicators are positioned in front of the gravitational, vertical reference line of the sagittal body posture. The largest distance from the gravitational line was registered for the position of the pelvis, followed by the position indicators of the head, shoulders and knees. This type of posture in the sagittal view was obtained in 41.8% of subjects. It can be described as follows: the head is slightly protruded, the lower part of the abdomen musculature is lightly relaxed and the whole body is slightly inclined to the front. This type of posture corresponds to the type many authors[2,9,10] named body posture type B. The mentioned authors regard this type of posture as good or just slightly incorrect body posture.

Type 2 – correct type of body posture: Arithmetic means (Table 1) of the second type of sagittal posture (second cluster) range in the interval between –0.030 and –0.21 centimetres. All the indicators have the negative sign indicating that they were all positioned in front of the gravitational line of the standing posture in the sagittal view. The largest distance from the gravitational line was registered for the position of the pelvis, followed by the position indicators of the head, shoulders, and knees. This type was obtained in 29.3% of subjects. The obtained average values of indicators suggest that there are only marginal deviations from the gravitational line. In this type of standing posture in the sagittal view the head is in the upright position, the shoulders are positioned correctly, the lower part of the abdomen is retracted, physiological curvatures of the spine are in the correct position, and the whole body is in the upright, erected position. This type of standing body posture corresponds with all its characteristics to type A of body posture obtained by other authors as well[2,9,10]. The mentioned authors call this type of posture the excellent or correct one.

Type 3 – marked impaired type of body posture: Arithmetic means (Table 1) of the third sagittal posture type (third cluster) range from –3.44 to –7.38 centimetres. All the indicators have the negative sign meaning that all four are positioned in front of the gravitational line of the sagittal body posture. The largest distance from the gravitational line was registered for the position of the pelvis, followed by the position indicators of the head, shoulders, and knees. This type was obtained in 28.9% of the subjects. The obtained average values of standing posture indicators showed considerable deviations from the gravitational line: the head is markedly protruded, the shoulders are slack, rounded, and the lower abdomen is protruded. Physiological curves of spine are pronounced; therefore, this type of body posture may be named marked impaired body posture. This type of body posture corresponds by all its characteristics to body posture type C, obtained by some other authors, too[2,9]. Auxter et al.[10] named this type of body posture as type D, describing it as a very poor alignment of body segments with very pronounced physiological curvatures. All the mentioned authors also named this type of standing posture as the poor or impaired, incorrect one.

Figure 3 displays the subjects who are closest to the centroid of the cluster they are pertaining to; therefore they represent that particular type of body posture. The obtained types of sagittal standing body posture are discriminated mostly by the position of shoulder in relation to the gravitational line, and only after that by the other indicators. A crucial feature of body posture is positioning of the head and pelvis, and exactly that, according to the obtained results, most significantly discriminated three types of the sagittal standing body posture.

Anterior plane posture types

Based on the results obtained by cluster and discriminant analyses it was viable to describe the obtained frontal plane posture types as follows:

Type 1 – correct type of body posture: Arithmetic means and standard deviations (Table 1) in the first cluster of this type of frontal standing posture show no significant deviations from the correct horizontal positions in the first three clusters (position of the head, position of shoulders, position of the pelvis 1.71 degrees. Positive values of these indicators reveal the lower position of the right side of the body in the area of knees and ankles. This can indicate the influence of the predominant body side, that is, the standing posture balance-keeping by the support shift to the take-off leg. Such a balancing is transferred through the joints of knees and hips, which may be the reason for a disbalance in the position of the left and the right indicators of ankles and knees. Although there are certain light deviations in the positions of knees and ankles, this anterior standing posture type may be described as correct.

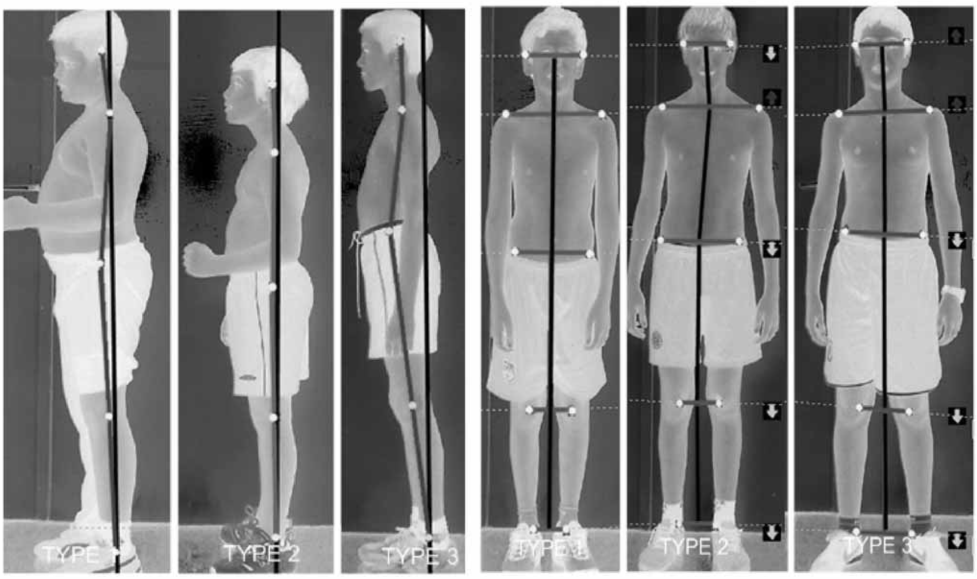

Fig. 3. Obtained frontal and sagital posture types.

Type 2 – mild scoliotic posture in lumbar region: In the second cluster average values (Table 1) are negative and significantly higher than those in the first one. They indicate the inclination to the left side of the head, pelvis, knees, and ankles. The obtained results indicate, similar as in the previously described type, the disbalance in the position of ankles, which is transferred to the positions of knees and the pelvis. The position of shoulders is correct, whereas the head is inclined. The difference between this and the first frontal standing posture is most obvious in the position indicators of the lower extremities. The subjects with the flat/lowered right foot pertain to the first posture type, whereas to the second type pertain those subjects with the flat/lowered left foot. Further, there is a significant difference in the position of the head as well, which is in this type tilted to the left, whereas in the first type it is in the normal position. Asymmetry in the position of the pelvis may suggest a mild scoliotic posture manifested in the lumbar spine region, which is confirmed by the correct position of shoulders. The positions of horizontal lines indicate mild deviations from the correct positions, with the pronounced lateral shift to the left of the upper part of the body (the trunk) in comparison to the lower part. Therefore, this type of anterior standing posture may be named mild scoliotic posture in lumbar region.

Type 3 – mild scoliotic posture with bilateral impairment: In the third cluster average values (Table 1) of the indicators of positions of the head and shoulders are positive and indicate the elevated left side, whereas the rest three indicators are negative (position of the pelvis, position of knees, and position of ankles), meaning that at these points the left side of the body is lowered. Inclination to the right side of the head is on average 2.05 degrees and of shoulders 0.58 degrees. The inclination to the right of the pelvis is 1.43 degrees on average, of knees 1.87, and of ankles 1.46 degrees. The obtained results indicate the existence of disbalance in the positions of lower extremities and the pelvis, like in the previous clusters. The position of shoulders is incorrect and indicates the elevated left side. The difference between the third and second types of standing posture and the first type is mostly manifested in the indicators of the position of lower extremities. The significant difference between types may be seen in the position of the head, which is in this type tilted to the right, in the first type it is in the normal position, whereas in the second type it is tilted to the left. Asymmetry of the position indicators of the pelvis in the second type indicated the mild form of scoliotic posture manifested in the lumbar part of the spine. In the third anterior standing posture type, besides the asymmetry of the pelvis position to the one side, there is the asymmetry of the shoulders to the other side. All these indicate scoliotic posture of the subjects who pertain to the third cluster. In this type scoliotic posture is more pronounced than in the second type, and it is manifested even in the thoracic part of the spine. The position of the horizontal lines suggest mild deviations from the correct positions, but with asymmetries in the position both in shoulders and the pelvis, oriented to different lateral sides (compensation). This type of anterior body posture is called mild scoliotic posture type with bilateral curvatures.

Figure 3 displays the subjects who are closest to the centroid of the cluster they are pertaining to; therefore, they represent that particular type of body posture. The obtained anterior types of posture are less expressed than those obtained with the help from the sagittal indicators of body posture. Studying the literature we did not find any classification of anterior standing body posture types, presumably meaning there were poorer chances and opportunities for posture type classification establishing in the anterior view. Types of scoliotic posture can be recognized by means of the selected frontal posture indicators, but as we had already determined that the subjects had no structural deformities, the obtained deviations were minimal – 2 degrees on average.

Certain limitations should be considered when interpreting the results of this study. First of all, the studied sample included only boys, which does not allow concluding on the reliability of the method and posture types among girls. Therefore, it is recommended to make the same study for the sample of girls to determinate body posture types among girls of the same age.

It is interesting to notice that most boys have small deviations in standing body posture (22.34%), whereas pronounced deviations expressed in both planes were obtained in 10.26% of subjects. Only 4.03% boys in the sample had good body posture, whereas in the rest of the observed subjects (63.37%) greater or smaller deviations were obtained either in the anterior or sagittal plane. It can be concluded that 95.97%, almost 96% of boys, who are just 10–13 years of age, have expressed musculoskeletal deformities. Therefore, proper and well-timed diagnosis of irregularities in body stance, that is, in body posture of children who are in the period of accelerated growth and development, can preserve proper growth by the introduction of adequate kinesitherapeutic procedures and programmes. Simple usage of the presented method (Image Posture Analyzer) facilitates such standing posture evaluation and can be in the future main method for determination body posture types or only location of body posture parameters in sagittal and anteroposterior plane. This simple and quick method for assessing body posture can improve a work of school medical doctors and kinesitherapist to make fast control of body posture and to give exercise program based on the results obtained with usage of the presented method (Image Posture Analyzer).

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TIPOVI TJELESNOG DRŽANJA I NJIHOVA OBILJEŽJA U DJEČAKA DOBI OD 10 DO 13 GODINA

SAŽETAK

Osnovni je cilj ovoga rada bio primjenom metode za procjenu tjelesnog držanja baziranoj na software-u »Posture Image Analyzer« odrediti tipove tjelesnog držanja u dječaka razvojne dobi (N=273 boys, aged 10–13 years). Dobiveni tipovi omogućili bi bolje razumijevanje posturalnog problema te pravilnijeg i pravovremenog odabira kinezioloških operatora u terapijskim postupcima. Na fotografijama ispitanika izmjeren je položaj 9 pokazatelje (5 u frontalnoj ravni i 4 u sagitalnoj ravni). Nakon obrade rezultata taksonomskom analizom, metodom K-means klustering i dikriminacijske analize, dobiveno je po tri tipa tjelesnog držanja u frontalnoj ravni i 3 tipa u sagitalnoj ravni. U sagitalnim pokazateljima tjelesnog držanja razlikujemo tri tipa tjelesnog držanja: (a) pravilno sagitalno tjelesno držanje (29,3%), (b) blago nepravilno sagitalno tjelesno držanje (41,8%), (c) izrazito nepravilno sagitalno tjelesno držanje (28,9%). U frontalnim pokazateljima tjelesnog držanja razlikujemo tri tipa tjelesnog držanja: (a) pravilno frontalno tjelesno držanje (19,4%), (b) blago skoliotično tjelesno držanje slabinskom dijelu (47,6%), (c) blago skoliotičano tjelesno držanje s dvostranim iskrivljenjem (33%).