Latuszewska J., Kowalska AM., Głowacki J. Assessment of body posture according to the Kasperczyk study scheme in screening tests in children. Issue Rehabil. Orthop. Neurophysiol. Sport Promot. 2018; 25: 31–44. DOI: 10.19271/IRONS-000078–2018–25.

ASSESSMENT OF BODY POSTURE ACCORDING TO THE KASPERCZYK STUDY SCHEME IN SCREENING TESTS IN CHILDREN

Joanna Latuszewska[1]
Anna Maria Kowalska[2]
Jakub Głowacki[3]
[1]Department of Educational Studies, College of Education and Therapy, Poznań, Poland
[2]Department of Musculoskeletal Rehabilitation, Poznan University of Physical Education, Poznań, Poland
[3]Department of General Orthopedics, Orthopedic Oncology and Traumatology, Poznan University of Medical Sciences, Poznań, Poland

OCENA POSTAWY CIAŁA WEDŁUG SCHEMATU BADANIA KASPERCZYKA W BADANIACH PRZESIEWOWYCH U DZIECI

Joanna Latuszewska[1]
Anna Maria Kowalska[2]
Jakub Głowacki[3]
[1]Wydział Studiów Edukacyjnych, Wyższa Szkoła Edukacji i Terapii w Poznaniu, Polska
[2]Katedra Rehabilitacji Narządu Ruchu, Akademia Wychowania Fizycznego w Poznaniu, Polska
[3]Klinika Ortopedii Ogólnej, Onkologicznej i Traumatologii, Uniwersytet Medyczny w Poznaniu, Polska

SUMMARY

Introduction

In the literature on the assessment of the body posture, numerous methods based on visual assessment are presented. Among them, the following can be distinguished: an examination according to a simplified orthopedic examination scheme, point-based methods (Kasperczyk's method, postural error chart based on criteria compiled by Wiktor Dega), body methods (Staffel, Brown, Wilson, Brownell and Wolański's classification) and a descriptive method (Klapp's method). Among these methods, the body posture examination scheme according to Kasperczyk deserves to be distinguished, as it is a very simple and quick examination for detecting abnormalities in the posture of children.

Aim

The aim of the study was to assess the occurrence of postural defects and their frequency in screening tests.

Material and methods

The study was conducted in 368 children aged 5–9 years. The study was conducted

STRESZCZENIE

Wstęp

W piśmiennictwie dotyczącym oceny postawy ciała prezentowane są liczne metody oparte na ocenie wzrokowej, wśród których wyróżnić można: badanie według uproszczonego schematu badania ortopedycznego, metody punktowe (metoda Kasperczyka, tabela błędów postawy w oparciu o kryteria Wiktora Degi), metody sylwetkowe (klasyfikacja Staffela, Browna, Wilsona, Brownella, Wolańskiego) i opisowe (metoda Klappa). Wśród tych metod, na wyróżnienie zasługuje schemat badania postawy ciała według Kasperczyka, który jest bardzo prostym i szybkim badaniem wykrywającym nieprawidłowości w postawie ciała dzieci.

Cel

Celem pracy było określenie występowania wad postawy i ich częstości w badaniach przesiewowych.

Materiał i metody

Badanie zostało przeprowadzone u 368 dzieci w wieku 5–9 lat w oparciu o autorski

based on an original questionnaire, which contained general data of a child, the results of anthropometric tests, the body posture examination scheme according to Kasperczyk, a table determining the measurement of the torso rotation angle (TRA), pelvis position, foot shape and functional tests.

Results

1. In 37.77% of the examined children, an average body posture was found. Only in 13.86% of the patients the body posture was bad or very bad (0.27%).
2. The most common deviation was the incorrect position of the abdomen and foot arch according to Kasperczyk.
3. The higher the BMI, the poorer the posture was presented by subjects, who confirmed deviations in functional tests: Dega's test and rectus femoris muscle test. In addition, with age, the irregularity in the pseudo-Lasègue's test was more frequent.

Conclusion

According to Kasperczyk method, the body posture measurement system allows for detection of so-called postural defects in a percentage similar to that of other authors, while the strongest factor negatively affecting the body posture is the increase of child's body weight.

Keywords: posture defects, point-based method, early school age, functional tests, torso rotation angle

Date received: 10th July 2018
Date accepted: 11th December 2018

kwestionariusz, który zawierał dane ogólne dziecka, wyniki badań antropometrycznych, schemat badania postawy ciała według Kasperczyka, tabelę określającą pomiar kąta rotacji tułowia (KRT), ustawienie miednicy, ukształtowanie stopy oraz testy funkcjonalne.

Wyniki

1. U 37,77% badanych dzieci stwierdzono postawę przeciętną. Tylko u 13,86% badanych stan postawy ciała był zły lub bardzo zły (0,27%).
2. Najczęściej występującym odchyleniem było nieprawidłowe według Kasperczyka ustawienie brzucha oraz wysklepienie stopy.
3. Im wyższe BMI, tym gorszą postawę prezentowali badani, co potwierdziły odchylenia w testach funkcjonalnych: w teście Degi i w teście mięśnia prostego uda. Poza tym wraz z wiekiem częściej występowała nieprawidłowość w teście pseudo-Laseque'a.

Wniosek

Schemat badania postawy ciała według Kasperczyka pozwala na wykrycie tak zwanych wad postawy w odsetku zbliżonym do badań innych autorów, przy czym najsilniejszym czynnikiem wpływającym negatywnie na postawę ciała jest wzrost masy ciała dziecka.

Słowa kluczowe: wady postawy, metoda punktowa, wiek wczesnoszkolny, testy funkcjonalne, kąt rotacji tułowia

Data otrzymania: 10 lipca 2018
Data zaakceptowania: 11 grudnia 2018

Introduction

Body posture defects are a common health problem among children and adolescents.

Body posture screening tests allow early detection of threats in the formation of postural abnormalities. In the literature on the assessment of the body posture, numerous methods based on visual assessment are presented. Among them, the following can be distinguished: an examination according to a simplified orthopedic examination scheme, point-based methods (Kasperczyk's method, postural error chart based

on criteria compiled by Wiktor Dega), body methods (Staffel, Brown, Wilson, Brownell and Wolański's classification) and a descriptive method (Klapp's method) (Dega 1996; Senger 1996; Kasperczyk 1994; Mrozkowiak and Strzecha, 2012).

Among these methods, the body posture examination scheme according to Kasperczyk deserves to be distinguished, as it is a very simple and quick examination for detecting abnormalities in the posture of children (Kasperczyk, 1994). Examinations according to these schemes aim at detecting existing posture defects, which is useful in order to implement corrective procedures. Posture examinations should be carried out in particular during a child's growth burst. It is a period critical for the formation of a child's body posture occurring in the school period – 6–7 years of age – related to a dynamic growth of bones in disproportion to the muscle apparatus, the task of which is to stabilize the skeleton (Kutzner-Kozińska, 1981; Hagner *et al.*, 2010). We assume that in the period of rapid growth typical for childhood, a relationship exists between anthropometric parameters and the occurrence of postural defects.

Aim

The aim of the study was to assess the occurrence of postural defects and their frequency in screening tests.

Material and methods

Three hundred and sixty-eight children aged 5–9 were subject to examinations upon the initiative and consent of one of the authorities of the communes near Poznań. The study was conducted based on an original questionnaire, which contained general data of a child, the results of anthropometric tests, the body posture examination scheme according to Kasperczyk, a table determining the measurement of the torso rotation angle (TRA), pelvis position, foot shape and functional tests.

In the study, visual analyses of selected elements of the body structure and posture were used, applying scoring according to Kasperczyk (Kasperczyk, 1994).

The assessment concerned ten elements viewed in the sagittal and frontal plane (front and back). The children were placed in a well-lit place, about 2 meters from the examiner, in a comfortable position. Each participant was given an appropriate results very good, average, bad or very bad body posture.

The following functional tests were also performed:

1. Dega's test
2. Pseudo-Lasègue's test
3. Thomas test
4. Fingertip-to-floor test
5. Rectus femoris muscle test
6. Schober's test
7. Otto's test

Achilles tendon (gastrocnemius muscle test) Modified Beighton Scale (Kasperczyk, 1994; Buckup, 1998; Zembaty, 2002).

The torso rotation angle was also measured in the upper thoracic, lower thoracic and lumbar sections of the spine. The torso rotation angle measurement was performed using the Bunnell scoliometer (Bunnell, 1984; Kotwicki *et al.*, 2006).

Body height and weight were measured according to the principles of anthropometry, based on guidelines for performing screening tests in children and adolescents (Oblacińska and Ostręga, 2003).

The arch of the foot was examined using the plantoconturography test. A comparison of the patient's plantogram with reference to foot types, developed by Bochenek and Clarke, was made (Kasperczyk, 1994).

Statistical methods

In terms of the statistics of quantitative characteristics, the minimum and maximum value, the average, the median and standard deviation were determined. The Spearman's rank correlation coefficient was calculated

to determine the relationship between variables on the interval scale, not having a distribution consistent with normal distribution. To compare non-compliant variables measured on an ordinal or interval scale with normal distribution, a Mann-Whitney test (in the case of two groups) or Kruskal-Wallis analysis (for three or more groups) were carried out. The Dunn test of multiple comparisons was also used. In order to study the relationships between categorical variables, the chi-square test of independence, Fisher's exact test or Fisher-Freeman-Halt exact test were performed. $\alpha = 0.05$ was assumed as the limit level of statistical significance. The result was considered statistically significant when $p < \alpha$. Statistical calculations were made using Statistica by StatSoft and StatXact by Cytel.

Results

Table 1. Anthropometric data, KRT measurement.

Anthropometric data	Average	SD	Min.	Max.
Age	7.08	0.84	5	9
Body weight	26.86	6.18	16.2	64
Body height	1.28	0.76	1,05	1.52
BMI	16.34	2.59	12.29	39.06
Arm span	125.19	8.13	100	156
Upper torso rotation angle Th	0.56	1.23	0	8
Lower torso rotation angle Th	0.90	1.46	0	8
Torso rotation angle LS	1.14	1.65	0	12

Upper Th-TRA in the upper thoracic spine; Lower Th-TRA in the lower thoracic spine; LS-TRA in the lumbar section of the spine.

Table 1 presents anthropometric data. The average age of the patients was 7.08 (SD 0.84). The average body weight was 26.86 (SD 26.86) kg, while the body height was 1.28 (SD 0.76) m. The BMI index was calculated based on body weight and body height, which was 16.34 (SD 2.59). The arm span was also calculated, and it was 125.19 (SD 8.13).

The torso rotation angle in the upper thoracic spine was 0.56° (SD1.23), in the lower thoracic section, it was 0.90° (SD 1.46), while in the lumbar section of the spine, it was 1.14° (SD 1.65).

The average number of points in the body posture examination scheme according to Kasperczyk was 4 (SD 2.32).

In most patients (80.43%), no irregularities in the position of the head were observed. In 16.30%, the head was slightly extended forward, and in 3.26%, the head was severely extended forward.

The most common deviation was the incorrect position of the abdomen and foot arch according to Kasperczyk. Then, in terms of the number – an extension of scapulas and an asymmetrical position of shoulders.

In the case of 63.59% of the patients, the condition of shoulders was normal, while other patients had shoulders, which were lightly asymmetric or extended forward (34.78%). In most patients (94.29%), normal arching of the chest was observed. In terms of thoracic kyphosis, normal arching was observed in most children (75.54%). Increased kyphosis was observed in 9.51%, while decreased kyphosis – in 14.94%. Increased lumbar lordosis was observed in 37.5% of the children. Scoliosis was suspected in 8.96% of the children.

The normal position of knees was observed in 64.67% of the patients. Among the defects of the lower limbs, valgus knees (22.01%) and varus knees (9.78%) dominated, while severely valgus knees were observed in 2.44% and severely varus knees in 1.09%. Only 56.79% of the children have normal foot arches. In 22.01%, the feet are flattened, in 10.89% – flat, and in 10.33% – flat valgus (Table 2).

In most children (48.10%), a very good body posture was observed in the final body posture assessment according to Kasperczyk. In 37.77% of the examined children, an average body posture was found. Only in 13.86% of the patients the body posture was bad or very bad (0.27%). The above results were presented in Table 3.

Table 2. Comparison of the results of body posture assessment according to Kasperczyk.

Elements assessed			**n**	**%**
Head	correct position		296	80.43
	extended forward		60	16.30
	severely extended forward		12	3.26
Shoulders	correct condition		234	63.59
	asymmetrical or slightly extended forward		128	34.78
	severely asymmetrically extended forward		6	1.63
Scapulas	scapulas form a uniform back surface		211	57.34
	scapulas extended more than one finger's width		140	38.04
	scapulas extended more than two fingers' width		17	4.62
Chest	well arched		347	94.29
	cobbler's chest	flattened	15	4.08
		flat with signs of rickets	1	0.27
		cobbler's and funnel chest	1	0.27
	Pigeon chest	slight pigeon-like changes in the shape	3	0.81
		pigeon chest with signs of rickets	1	0.27
		pigeon chest with rachitic rosary and Harrison's groove	0	0
Abdomen	flat abdomen		141	38.31
	convex abdomen		142	38.59
	extended beyond the chest line		85	23.10
	pendulous abdomen		0	0
Kyphosis	gently shaped kyphosis		278	75.54
	increased thoracic kyphosis	enlarged	35	9.51
		severely enlarged	0	0
		sustained hyperkyphosis	0	0
	decreased thoracic kyphosis	flattened	43	11.68
		straight spine, flat back	12	3.26
Lordosis	gently shaped lumbar lordosis		230	62.50
	slightly deepened		99	26.90
	strongly deepened		35	9.51
	sustained hyperlordosis		4	1.09
Scoliosis	straight spine		335	91.03
	mild scoliosis		30	8.15
	severe scoliosis with rotation		2	0.54
	severe curvature with a rib hump		1	0.27
Knees	straight limbs, knees and heels are adjacent to each other		238	64.67
	Varus knees	the distance between knees is more than 1 cm	36	9.78
		severe varus with a space of more than 3 cm	4	1.09
	Valgus knees	the distance between medial ankles is more than 1 cm	81	22.01
		severe valgus with a space of more than 3 cm	9	2.44

Table 2. (cont.) Comparison of the results of body posture assessment according to Kasperczyk.

Elements assessed		n	%
Feet	well-arched feet	209	56.79
	flattened feet	81	22.01
	flat feet	40	10.87
	flat valgus feet	38	10.33

Table 3.Body posture assessment according to Kasperczyk.

Body posture according to Kasperczyk	Very good	Average	Bad	Very bad				
	n	%	n	%	N	%	n	%
	177	48.10	139	37.77	51	13.86	1	0.27

Table 4. Comparison of the results of muscle flexibility assessment using selected functional tests and pelvis position.

	Normal	Deviation
	n (%)	n (%)
Beighton score	171 (46.47)	197 (53.53)
Dega's test	305 (82.88)	63 (17.12)
Pseudo-Laseque's test	264 (71.74)	104 (28.26)
P-P test	232 (63.04)	136 (36.96)
Thomas test	332 (90.22)	36 (9.78)
Rectus femoris muscle test	355 (96.47)	13 (3.53)
Schober's test	361 (98.10)	7 (1.90)
Otto's test	365 (99.18)	3 (0.81)
Achilles tendon	362 (98.37)	6 (1.63)
Pelvis position	276 (75)	92 (25)

Deviations were most often observed in the Beighton score, as in more than half of the patients (53.53%), loose joints were observed. The results of Dega's test were normal in 82.88% of the patients. In the case of most patients, normal results were achieved in pseudo-Laseque's test (71.74%) and in the P-P test (63.04%). In the significant majority of the patients' results of the Thomas test (90.22%), Rectus femoris muscle test (96.47%), Schober's test (98.10%), Otto's test (99.18%) and Achilles tendon (98.37%) were normal. In 75% of the patients, a proper pelvis position was observed (Table 4).

Table 5 presents the patients' foot shapes. A normal foot shape was observed in more than half of the patients – 60.05%. From the conducted examinations, it can be concluded that 22.83% of the children have flat feet, 4.62% – valgus feet, 11.41% have flat valgus feet and 1.09% have hollow feet. Varus feet were not observed.

Table 6 shows a statistically significant difference between BMI and the body posture examination scheme according to Kasperczyk; the higher the BMI, the worse the posture of the patients. Differences in the BMI result were as follows: patients with very good posture (BMI = 15.91) differ from patients with average posture (BMI = 16.55) and bad posture (BMI = 17.26). Moreover, the more correct the pelvis position, the better the body posture of the patients ($p < 0.0001$).

It was stated that children with a positive result in Dega's test ($p < 0.0001$) and a positive result in the Rectus femoris muscle test ($p < 0.0001$) differ significantly in terms of BMI from children with negative results of the above-mentioned tests. Moreover, children with positive results in

Table 5. Foot shape evaluation using plantoconturography.

Foot	Normal		Flat		Valgus		Flat Valgus		Varus		Hollow	
	n	%	n%	%	n%	%	n%	%	n	%	n	%
	221	60.05	84	22.83	17	4.62	42	11.41	–	–	4	1.09

Table 6. Relationships between age, BMI, pelvis position and body posture assessment according to Kasperczyk and pelvis position.

	Body posture examination scheme according to Kasperczyk	Pelvis position	
	p	RS	p
Age	p = 0.330	–0.05	p = 0.824
BMI	p < 0.0001*	0.21*	p = 0.702
Pelvis position	p < 0.0001*	–	–

pseudo-Laseque's test ($p < 0.0001$) and the rectus femoris muscle test ($p = 0.027$) differ statistically significantly from children with negative results in the above-listed tests in terms of age (Table 7).

posture (TRA = 0.45) and average posture (TRA = 0.45).

A relationship was also observed between the TRA in the lower thoracis section of the spine and the body posture assess-

Table 7. Relationships between functional tests and foot shape, and the body posture examination scheme according to Kasperczyk, pelvis position, age and BMI.

Functional tests	Body posture assessment according to Kasperczyk	Pelvis position	Age	BMI
	P	p	p	p
Beighton score	p = 0.123	p = 0.763	p = 0.143	p = 0.685
Dega's test	p = 0.067	p = 0.936	p = 0.187	p < 0.0001*
Pseudo-Laseque's test	p = 0.158	p = 0.789	p < 0.0001*	p = 0.058
P-P test	p = 0.708	p = 0.618	p = 0.137	p = 0.782
Thomas test	p = 0.954	p = 0.224	p = 0.768	p = 0.232
Rectus femoris muscle test	p = 0.126	p = 0.325	p = 0.027*	p < 0.0001*
Schober's test	p = 0.360	p = 0.685	p = 0.575	p = 0.417
Achilles tendon	p = 0.980	p = 0.642	p = 0.486	p = 0.657
Foot	p < 0.0001*	-	p = 0.031*	-

Upper Th-TRA in the upper thoracic spine; Lower Th-TRA in the lower thoracic spine; LS-TRA in the lumbar section of the spine.

Statistically significant relationships were observed between the torso rotation angle in the upper thoracic spine and the body posture assessment according to Kasperczyk ($p < 0.0001$, $rS = 0.18$) and the pelvis position ($p = 0.017$). Patients with bad posture have a larger torso rotation angle in the upper thoracic section (TRA = 1.23) than patients with very good

ment according to Kasperczyk ($p = 0.027$, $rS = 0.11$). In the lower thoracic section of the spine, a larger torso rotation angle was observed in patients with bad posture (TRA = 1.70) than in patients with very good posture (TRA = 0.80) and average posture (TRA = 0.75).

The occurrence of relationships between the TRA in the lumbar section of the spine and the body posture assessment according to Kasperczyk was examined. Patients with very good posture (TRA = 0.79) had

a smaller TRA in the lumbar section than patients with average posture (TRA = 1.32) and bad posture (TRA = 1.90) (Table 8).

Table 8. Relationships between the torso rotation angle and the body posture assessment according to Kasperczyk, pelvis position, age and foot.

Rotation angle	Body posture assessment according to Kasperczyk	Pelvis position	Age	Foot		
	p	rS	p	P	rS	p
Upper Th	p < 0.0001*	0.18*	p = 0.017*	p = 0.441	rS = 0.04	p = 0.847
Lower Th	p = 0.027*	0.11*	p = 0.190	p = 0.323	rS = 0.05	p = 0.791
LS	p < 0.0001*	0.20*	p = 0.224	p = 0.508	rS = 0.03	p = 0.810

Upper Th-TRA in the upper thoracic spine; Lower Th-TRA in the lower thoracic spine; LS-TRA in the lumbar section of the spine.

A statistically significant relationship between the torso rotation angle in the LS section of the spine and the Beighton score (p = 0.042) was observed. This means that the larger the torso rotation angle in the lumbar section, the greater the hypermobility in patients (Table 9).

Table 9. Relationships between the torso rotation angle and functional tests.

	Beighton score	Dega's test	Pseudo-Laseque's test	P-P test	Thomas test	Rectus femoris muscle test	Schober's test	Otto's test	Achilles tendon
Upper Th	p = 0.080	p = 0.912	p = 0.681	p = 0.600	p = 0.228	p = 0.240	p = 0.503	–	p = 0.577
Lower Th	p = 0.333	p = 0.246	p = 0.631	p = 0.105	p = 0.409	p = 0.071	p = 0.668	–	p = 0.868
LS	p = 0.042*	p = 0.880	p = 0.812	p = 0.256	p = 0.456	p = 0.246	p = 0.466	–	p = 0.934

Discussion

According to some authors, posture defects constitute a significant health problem among school-aged children and adolescents (Janiszewska *et al.* 2009; Kocka *et al.* 2013).

Abnormalities in the body posture are related to numerous factors. Sedentary lifestyle negatively affects the development of the locomotor system, and numerous studies also point to low physical activity of children outside of school (Ćwirlej *et al.*, 2005). Sources of such problems may include both a long-term sedentary position as well as an incorrectly adjusted workstation of a child (Kasperczyk *et al.*, 2007; Obodyńska, 2017). The sedentary position is often related to extending the head forward, deepening kyphosis in the thoracic section of the spine, decreased lumbar lordosis, which results in the compression of abdominal organs and poorer functioning of internal organs. Failing to care to maintain proper posture, neglecting exercises strengthening postural muscles, overweight or obesity, limited physical activity are other factors exposing children to disorders in the normal development of children's posture.

In literature, a significant amount of data is available on the prevalence of postural defects in children (Kania – Gudzio and Wiernicka, 2002; Lamari *et al.*, 2005; Grivas *et al.*, 2006; Penha *et al.*, 2008; Chromik *et al.*, 2009; Hagner *et al.*, 2010; Maciałczyk-Paprocka *et al.*, 2012; Janusz *et al.*, 2015). Epidemiological data is diverse, and it states that the prevalence ranges from a dozen to several dozen percent of the population (Kania – Gudzio and Wiernicka, 2002; Chromik *et al.*, 2009; Hagner *et al.*, 2010; Maciałczyk-Paprocka *et al.*, 2012). Such differences may arise from the use of different diagnostic

criteria, research methods or a different experience of researchers. For medical or corrective purposes, objective methods are selected, while for the needs of epidemiological or school research, subjective methods of the body posture assessment and simplified clinical and functional tests are often used (Mrozkowiak *et al.*, 2015).

The method of the body posture assessment according to Kasperczyk used in the study was selected due to a very simple manner of conducting examinations, which are possible to carry out in a relatively short time, convenient location, without the use of expensive and complex equipment. This method allows for an analytical description of the elements of the posture, postural defects, their location, scope and nature. As opposed to silhouette-based methods, it allows for individual diversification of the body posture (Kasperczyk, 1994). According to Mrozkowiek *et al.*, the use of the silhouette-based method to control defects in body posture and their correction is insufficient (Mrozkowiak *et al.*, 2015).

The author's own studies demonstrated that in 48.10% of the patients, very good body posture was observed in the final body posture assessment according to Kasperczyk. Average posture was observed in 37.77% of the children, and bad posture in 13.86%. Only 0.27% of the children had very bad body posture. Using Kasperczyk's method, researchers Kania-Gudzio and Wiernicka assessed that children with a slight defect constitute 59.3% of the population, and with a significant defect – 22.5% of the population (Kania – Gudzio and Wiernicka, 2002). Studies conducted by Maciałczyk-Paprocka *et al.* demonstrated errors in body posture assessed using the method according to the error chart by Dega in 840 children, which constituted 71.4% (Maciałczyk-Paprocka *et al.*, 2012). During the observations of body posture in children between 6 and 10 years of age over a period of three years, Hagner observed that, before the commencement of school education in the case of 6-year-old children, very good or good posture assessed using Kasperczyk's method was observed in 41.47%, while after three years of schooling, such posture was observed only in 26.83% of the children. A sudden growth in the frequency and intensity of postural defects concerned most of the controlled elements (Hagner *et al.*, 2010).

In the author's own studies, a statistically significant difference between BMI and the body posture examination scheme according to Kasperczyk was observed. The higher the BMI, the worse the posture of the patients. Patients with very good posture (BMI = 15.91) differed from patients with average posture (BMI = 16.55) and bad posture (BMI = 17.26). Moreover, the more normal pelvis position, the better the body posture of the patients.

A visual assessment of selected postural elements shows the position of specific body points and allows for the localization of defects, allowing for a determination of the relevant corrective procedure to be chosen. The results of the point-based evaluation according to Kasperczyk for the purposes of this study demonstrated that the most common deviations from the normal body posture include the abdomen position and foot arch. Then, there are winged scapulas and asymmetrical shoulder position. In terms of the shape of thoracic kyphosis in the author's own studies, normal results were observed in 75.54% of the children. Among lower limb defects, valgus knees dominated; however, in 64.67% of the children, a normal knee position was observed.

In the studies conducted by Kania-Guzio and Wiernicka, the most common defect was shoulder asymmetry and scapula asymmetry (Kania – Gudzio and Wiernicka, 2002). Most deviations in normal body posture in the studies conducted by Maciałczyk-Paprocka *et al.*, were diagnosed within the shoulders, head, and lower limbs (Maciałczyk-Paprocka *et al.*, 2012).

The analysis of the prevalence of foot defects in the study, taking clinical tests into

account, as well as the plantoconturography method, led to results similar to the findings of other authors. In the studies concerning the assessment of foot arch using the plantoconturography method, Plaskiewicz *et al.* demonstrated that most children from cities (65%) and villages (75%) have normally shaped feet, and the most common defect is flatfoot (Plaskiewicz *et al.* 2015).

From the studies conducted by Klimczak *et al.*, it can be concluded that 48% of the children have normal feet, 25% have flatfoot, and 28% inflicted feet in relation to the plantoconturogram compared with reference foot types (Klimczak *et al.*, 2014).

Functional tests used in the body posture assessment determine the frequency of the occurrence of contracture in the joints, failure of the examined muscle groups, range of motion in the joints and can become a valuable guideline in corrective treatment.

In the author's own studies, deviations most often occurred in the Beighton score, as in more than half of the children (53.53%), loose joints were observed. Czaprowski *et al.* noticed the impact of loose joints (which results from failure of the ligamentous system) on the spinal rotation in scoliosis. They show that, in more than half of the patients with idiopathic scoliosis, the occurrence of hypermobility of joints (51.4%) was observed in comparison to the control group, in which excessive mobility of joints occurs only in 19% of cases (Czaprowski, 2011).

The study conducted by Lamari N. M. *et al.* identified joint hypermobility in healthy children aged 4–7. Scores > 4 were found for 64.6% of the children which is a similar result to the author's research. Hypermobility most often concerned wrists (80%) and fifth fingers (36.6%). Lower scores were associated with greater age (Lamari *et al.*, 2005).

There are still only a few studies determining the occurrence of hypermobility of joints among children and adolescents. With early diagnosis of loose joints and the introduction of a frequent control of body posture, persons with the risk of scoliosis can introduce preventive actions or properly programmed rehabilitation at an early stage (Kopff and Raczkowski, 2011).

In the author's own studies, the torso rotation angle in most patients did not have large angle values, which indicates a small frequency of the occurrence of scoliosis in the population. This result is similar to the results obtained by other researchers (Korovessis and Stamatakis, 1996; Grivas *et al.*, 2006; Adamczewska *et al.*, 2017).

The body posture assessment according to Kasperczyk is a simple, easy and effective tool for non-invasive diagnosis of body posture parameters and screening tests in the school environment. It does not require a significant financial expenditure or the use of specialized equipment, and it precisely determines the occurrence of irregularities in particular elements of the body through proper scoring.

The analysis of body posture in a static position should be compared with functional tests verifying the mobility of the spine, the range of motion in proximal joints of lower and upper limbs, or the assessment of the occurrence of loose joints and measurements of the torso rotation angle using the Bunnel scoliometer. It may also be worth using simple tools for screening tests, such as the Functional Movement Screen, allowing for the identification of multifaceted disturbances of movement asymmetry between body segments (Kochański *et al.*, 2015).

Conclusions

According to Kasperczyk method, the body posture measurement system allows for detection of so-called postural defects in a percentage similar to that of other authors, while the strongest factor negatively affecting the body posture is the increase of child's body weight.

Acknowledgements

We would like to thank Professor Maciej Głowacki for his excellent help and editorial support.

REFERENCES

Adamczewska K., Wiernicka M., Michałowski Ł., Furmaniuk L., Goliwąs M., Flis-Masłowska M., Lewandowski J. N (2017) *„Stopień rotacji tułowia dzisięcioletnich dzieci szkół poznańskich".* Fizjoterap. Pol., 17 (3), pp. 96–102.

Barczyk K., Skolimowski T., Hawryluk A. (2004) *„Kształtowanie się asymetrii tułowia dzieci w młodszym wieku szkolnym".* Fizjoterap. Pol., 3, pp. 203–208.

Beighton P., Solomon L., Soskolne C. L. (1973) *'Articular mobility in an African population.'* Ann Rheum Dis., 32 (5), pp. 413–418.

Buckup K. *Testy kliniczne.* Warszawa: PZWL; 1998, pp. 5.

Bunnell WP. (1984) *'An objective criterion for scoliosis screening.'* J Bone Joint Surg Am. 66 (9), pp. 1381–1387.

Chromik K., Rohan-Fugiel A., Śliwa D., Fugiel J. (2009) *„Częstość występowania typów postawy ciała chłopców i dziewcząt w młodszym wieku szkolnym".* Acta Bio Optica et Informat. Med., 15 (4), pp. 346–347.

Czaprowski D., Kotwicki T., Pawłowska P., Stoliński Ł. (2011) *'Joint hypermobility In children with idiopathic scoliosis: SOSORT award 2011 winner.'* Scoliosis, 6 (22), pp. 1–10.

Ćwirlej A., Walicka – Cupryś K., Gregorowicz – Cieślik H. (2005) *„Aktywność ruchowa dzieci 10-letnich w czasie wolnym".* Przeg. Med. Uniw. Rzesz., 3, pp. 262–266.

Dega W. Senger A. Ortopedia i rehabilitacja. *Tom I Warszawa: PZWL*; 1996, pp. 472–474.

Grivas T., Vasiliadis E., Koufopoulos G., Segos D., Triantafyllopoulos G., Mouzakis V. (2006) *'Study of trunk asymmetry in normal children and adolescents.'* Scoliosis, 1 (19), pp. 1–8.

Hagner W., Bąk D., Hagner-Derengowska M. (2010) *„Zmiany w postawie ciała u dzieci w pierwszych trzech latach nauki szkolnej".* Forum Medycyny Rodzinnej, 4 (4), pp. 287–290.

Janiszewska R., Tuzinek S., Nowak S., Ratynska A., Biniaszewski T. (2009) *„Nieprawidłowości postawy ciała u dzieci 6–12 letnich – uczniów szkół podstawowych z Radomia – badania pilotażowe".* Probl Hig Epidemiol, 90 (3), pp. 342–346.

Kania – Gudzio T., Wiernicka M. (2002) *„Ocena postawy ciała dzieci w wieku 7–15 lat na podstawie wybranej losowo szkoły podstawowej miasta Poznania".* Nowiny Lekarskie, 71, pp. 151–159.

Kasperczyk J., Olczyk K., Jośko J., Tyrpień M. (2007) *„Ergonomiczna ocena stanowiska pracy dzieci w przedszkolu i szkole".* Probl Hig Epidemiol, 88 (3), pp. 365–369.

Kasperczyk T. *„Wady postawy ciała, diagnostyka i leczenie".* Kraków: Kasper; 1994., pp. 92–114, 182–188.

Klimczak K., Kochański B., Kałużny K., Plaskiewicz A., Smuczyński W., Ratuszek-Sadowska D., Woźniak K., Zukow W. (2014) *„Analiza występowania wad stóp u dzieci w wieku 6–10 lat".* J Health Sci, 4 (2), pp. 29–38.

Kochański B., Plaskiewicz A., Kałużny K., Dylewska M., Płoszaj O., Hagner-Derengowska M., Zukow W. (2015) *'Functional Movement Screen* (*FMS*) *– kompleksowy system oceny funkcjonalnej pacjenta.'* J Educ Health Sport, 5(4), pp. 90–101.

Kocka K., Kachaniuk H., Bartoszek A., Fałdyga U., Charzyńska-Gula M. (2013) *„Najczęstsze problemy zdrowotne dzieci w wieku szkolnym – na przykładzie szkoły podstawowej i gimnazjum w Lublinie".* Medycyna Ogólna i Nauki o Zdrowiu, 19 (4), pp. 508–513.

Kopff B., Raczkowski J.W. (2011) *„Zespół hipermobilności stawów – rzadko rozpoznawana patologia w obrębie narządu ruchu".* Kwart. Ortop., 2, pp. 80–92.

Korovessis P., Stamatakis M. (1996) *'Prediction of scoliotic Cobb angle with the use of the scoliometer.'* Spine, 21, pp. 1661–1666.

Kotwicki T., Frydryk K., Lorkowska M., Krawczyński A., Szulc A. (2006) *„Powtarzalność i zgodność pomiaru rotacji tułowia skoliometrem Bunnella u dzieci ze skoliozą idiopatyczną".* Fizjot. Pol., 2 (4), Vol.6, pp. 111–116.

Kutzner-Kozińska M.(1988) *„Korekcja wad postawy".* Warszawa: AWF; pp. 119–1

Lamari N.M., Chueire A.G., Cordeiro J.A. (2005) *'Analysis of joint mobility patterns among preschool children.'* Sao Paulo Med. J., 123 (3), pp. 119–123.
Maciałczyk-Paprocka K., Krzyżaniak A., Kotwicki T., Sowińska A., Stawińska-Witoszyńska, Krzywińska-Wiewiorowska M., Przybylski J. (2012) *„Występowanie błędów w postawie ciała u uczniów poznańskich szkół podstawowych".* Probl Hig Epidemiol, 93 (2), pp. 309–314.
Mrozkowiak M., Bereznyakova A. I., Cheremisina V. F., Zukow W. (2015) *„O narzędziach i wynikach badań".* J Educ, Health Sport, 5 (11), pp. 245–260.
Mrozkowiak M., Strzecha M. (2012) *„Mora projekcyjna współczesnym narzędziem diagnostycznym postawy ciała.'* Antropomotoryka, 60, pp. 33–47.
Oblacińska A., Ostręga W. *„Standardy i metodyka pracy pielęgniarki i higienistki szkolnej. Poradnik dla pielęgniarek i higienistek szkolnych pracujących w szkołach różnych typów".* Warszawa: Instytut Matki i Dziecka Zakład Medycyny Szkolnej; 2003, pp. 129.
Obodyńska E. (2017) *„Szkoła wobec konieczności wdrażania rozwiązań ergonomicznych w przestrzeni edukacyjnej – idea czy obowiązek?"* Pedagogika Przedszkolna i Wczesnoszkolna, Vol. 5, 1 (9), pp. 45–56.
Penha P.J., Casarotto R.A., Sacco I.C.N., Marques A.P., João S.M.A. (2008) *'Qualitative postural analysis among boys and girls of seven to ten years of age.'* Braz J Phys Ther, 12 (5), pp. 386–391.
Plaskiewicz A., Kałużny K., Kochański B., Wołowiec Ł., Hagner W., Zukow W. (2015) *„Ocena występowania wad stóp u dzieci w wieku 9–10 lat w środowisku miejskim i wiejskim".* J Educ, Health Sport, 5 (4), pp. 325–334.
Zembaty A. *„Kinezyterapia".* Kraków: Kasper S.C. 2002, pp. 173, 226, 544–545.

Authors reported no source of funding.
Authors declared no conflict of interest.

Autorzy nie zgłosili źródła finansowania.
Autorzy nie deklarowali konfliktu interesów.

Author responsible for correspondence:
Joanna Latuszewska
College of Education and Therapy
Department of Educational Studies
Grabowa 22
61-473 Poznań
Poland
j.latuszewska@wp.pl

Autor odpowiedzialny za korespondencję:
Joanna Latuszewska
Wyższa Szkoła Edukacji i Terapii
Wydział Studiów Edukacyjnych
ul. Grabowa 22
61-473 Poznań
Polska
j.latuszewska@wp.pl