Wilczyński Jacek, Janecka Sylwia, Wilczyński Igor. Anthropometric features and postural reactions in children with scoliosis and scoliotic posture. Journal of Education, Health and Sport. 2017;7(9):320-331. eISSN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.997474
http://ojs.ukw.edu.pl/index.php/johs/article/view/4891

The journal has had 7 points in Ministry of Science and Higher Education parametric evaluation. Part B item 1223 (26.01.2017).
1223 Journal of Education, Health and Sport eISSN 2391-8306 7

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 15.08.2017. Revised: 10.09.2017. Accepted: 10.09.2017.

Anthropometric features and postural reactions in children with scoliosis and scoliotic posture

Cechy antropometryczne a reakcje posturalne u dzieci ze skoliozą i postawą skoliotyczną

Jacek Wilczyński[1], Sylwia Janecka[2], Igor Wilczyński[3]

1. **Department of Neurology, Neurological and Kinesiotherapeutic Rehabilitation, Faculty of Medicine and Health Sciences, Jan Kochanowski University in Kielce**
2. **Ph.D. student, Faculty of Medicine and Health Sciences, Jan Kochanowski University in Kielce**
3. **Outpatient Rehabilitation Centre for Children, PZOZ in Starachowice**

SUMMARY

Introduction. The aim of the research was to analyze the correlation between the anthropometric features and postural reactions in children with scoliosis and scoliotic posture.
Material and method. The study included 28 girls aged 7-18 years old with scoliosis and scoliotic posture. Respondents were selected intentionally. Children attended to the Interschool Centre of Corrective Exercises in Starachowice. Height measurements were made by anthropometer, and the measurement of body weight was made with electronic scale. Those reactions were examined by static-dynamic Tecnobody’s ST 310 Plus Stability System platform. Variables were verified in terms of normal distribution by Shapiro-Wilk test. Depending on the compatibility of variable distributions with normal distribution, and the value of skewness and kurtosis, parametric or non-parametric tests have been used. To determine the correlation between the anthropometric variables and postural reactions the Spearman's rank correlation coefficient has been used. The level of significance was $p < 0,05$.
Conclusions. In Romberg’s test with opened eyes (OE), there were no significant correlations between the anthropometric variables and postural reactions. However, in the study with eyes closed (CE), there were significant, inversely proportional correlations between the body height and FBSD, and between the body height and AFBS. Inversely proportional correlations are understandable, because a higher children are generally slightly older, and together with age in children has been observed the reduction of postural reactions (better balance).

Analysis of relationships between BMI and postural reactions with eyes closed (CE) showed a significant directly proportional correlations only with Abs AY. Higher values of BMI corresponds to the higher values of Abs AY.
Key words: anthropometric features, body posture, scoliosis, scoliotic posture.

STRESZCZENIE

Wstęp. Celem badań była analiza korelacji między cechami antropometrycznymi a reakcjami posturalnymi u dzieci ze skoliozą i postawą skoliotyczną. **Materiał i metoda**. Badaniami objęto 28 dziewcząt w wieku 7-18 lat ze skoliozą i postawą skoliotyczną. Dobór badanych był celowy. Dzieci zapisane były do Międzyszkolnego Ośrodka Gimnastyki Korekcyjnej i Kompensacyjnej w Starachowicach. Pomiary wysokościowe wykonano antropometrem a pomiar masy ciała wagą elektroniczną. Reakcje te badano statyczno-dynamiczną platformą ST 310 Plus Stability System firmy Tecnobody. Zmienne zweryfikowano pod względem normalności rozkładu testem Shapiro-Wilka. W zależności od zgodności rozkładów zmiennych z rozkładem normalnym, oraz wartości skośności i kurtozy, stosowano testy parametryczne lub nieparametryczne. Do określenia korelacji między zmiennymi antropometrycznymi a reakcjami posturalnymi zastosowano współczynnik korelacji rang Spearmana. Jako poziom istotności przyjęto $p<0,05$. **Wnioski.** W teście Romberga z oczami otwartymi (OE) nie wystąpiły istotne korelacje między zmiennymi antropometrycznymi a reakcjami posturalnymi. Natomiast w badaniu z oczami zamkniętymi (CE) wystąpiły istotne odwrotnie proporcjonalne korelacje między wysokością ciała a FBSD oraz między wysokością ciała a AFBS. Korelacje odwrotnie proporcjonalne są zrozumiałe, gdyż wyższe dzieci są ogół nieco starsze a wraz z wiekiem u dzieci obserwuje się obniżanie reakcji posturalnych (lepszą równowagę). Analiza związków między BMI a reakcjami posturalnymi z oczami zamkniętymi (CE) wykazała istotne wprost proporcjonalne korelacje jedynie z Abs AY. Wyższym wartościom BMI odpowiadają wyższe wartości Abs AY.
Słowa kluczowe: cechy antropometryczne, postawa ciała, skolioza, postawa skoliotyczna.

INTRODUCTION

Human body seems to be symmetrical. But this is an illusion because the thorough examination denies it [1,2]. While the human body, when it comes to outer contour of the body and internal organs is forming symmetrically, however in the early period of development many symptoms of asymmetry appears and successively intensifies. That is why, at one level with symmetry, asymmetry of the body is considered as a normal symptom in the body structure. Nevertheless, in some cases it's a pathology that affects on the human posture, which is defined as a two-legged standing position with a head and torso situated as an extension of straightened lower extremities. It's a labile position, which requires a continual balancing [3,4]. The system, which is the human body, is guided by the law of minimum effort, and it seeks to such location of the center of gravity, so that it influence on the quadrangle basis formed by the feet. This creates the most favorable conditions to maintain the balance with the lowest muscle work. Any deviation or loading at one side of the body results a displacement of the center of gravity, and causes a conditional bending or movement of the other side in the opposite direction, which increases the asymmetry of posture [5,6]. Short-term, slight imbalances controlled by the orthostatic reflex and natural, reflexive muscle activity are taking place without a large expenditure of energy. Correcting the repetitive, asymmetrical deviations of the trunk, spinal curvatures, or changes of the position or shape of any part of the body, requires a continuous activity of muscles, joint capsules and ligaments. Such an asymmetrical distribution of forces is not tolerated by the body for a long time. This results as a compensative fixation of displacements within the body [7,8,9]. Then we deal with postural defects, scoliosis and pathological distortions. Because of the complex structure and functioning of the balance system, testing the ability of its behavior is a diagnostically difficult aspect. Various kinds of tests, both static and dynamic, as well as posturographic platforms are used for this. The aim of the study was to analyze the correlation between the anthropometric features and postural reactions in children with scoliosis and scoliotic posture.

MATERIAL AND METHODS

The study included 28 girls aged 7-18 years old with scoliosis and scoliotic posture. All examined persons were selected intentionally. Children attended to the Interschool Centre of Corrective Exercises in Starachowice. The research was conducted in June 2011. There were tested the following anthropometric features: body height, body weight and BMI. Height measurements were made by anthropometer with an accuracy of 0.5 cm, and the body weight measurement by electronic scale with an accuracy of 0.5 kg. On the basis of these measurements, the BMI's weight and growth indicator has been calculated. For the study of postural reactions, computerized posturography has been used. These reactions were examined by static-dynamic Tecnobody's ST 310 Plus Stability System platform. The research based on continuous observation of the centre of feet pressure (COP). By recording the horizontal deflections of the body (postural sway) as a function of time, the detailed information concerning the postural system has been obtained. The COP displacements reflected the movements of center of body mass (COM) in the frontal and sagittal plane. The frequency of signal was 20 Hz. The change of the maximum pressure on the soles of the feet during the deviations of the body was perceived by mechanical-electronic transducer consisting of three sensors installed inside the platform. Recorded signal was processed from the analog information into digital, and then elaborated by computer program. The appropriate software created the possibility to calculate the resultant ground reaction force, which is the sum of the moments of the forces acting on the platform in three points of measurement. Vector addition of force moments allowed to designate the resultant ground reaction force at the moment, which is graphically presented as a dot on statokinesiogram. There was performed a standard stability rating test in a free-standing position (Romberg's

Test). The test consisted of two successive samples lasting 30 seconds each: first with opened eyes (OE – open eyes), second with closed eyes (CE – close eyes). Measurements were taken in the morning. Tested person was carefully instructed about the test sequence. The silence has been assured during examination, because auditory stimuli acting on man in terms of attention can significantly impair the postural reflexes. The examined person has been ensured about the total harmlessness of the performed test. During the study, the investigator was behind the tested person all the time, not passing any messages. During the measurements with opened eyes (OE), the examined person has been asked to focus his sight on a point of reference, located on the computer screen. The center of vision speckle was located at a distance of 1 meter from examined person. Before starting the test with closed eyes (CE), researcher made sure that the tested person is able to maintain an upright posture without visual control. The examined person stood on a platform barefoot, because shoes could interfere his posture. The feet were set with careful precision: heels 2 cm from each other, feet apart at the angle of 30°, so that the center of gravity of a polygon base was in the sagittal axis of the platform at a distance of 3 cm from its center. To facilitate the correct positioning of the tested person, the platform was equipped with a pattern to keep the feet apart. The examined person took a habitual position with arms lowered along the torso and head straight. Test started at the time when investigated person took a posture, and on the screen the way of centre of feet pressure deviation was displayed. It has been analyzed the following postural reactions, so-called the centre of feet pressure deviations:

- Average load point X (Average COP X) in relation to the axis of the platform. It provides lateral coordinates X (mm).
- Average load point Y (Average COP Y) in relation to the axis of the platform. It provides anterior-posterior coordinates Y (mm).
- The mean deviation Y (Forward-Backward Standard Deviation Y). Is the mean oscillation along the Y axis (mm), medium anteroposterior deviation (mm) - the average distance between the extreme deviations of the centre of feet pressure in the sagittal plane
- The mean deviation X (Medium-Lateral Standard Deviation X), is the mean oscillation along the X axis (mm) and medium lateral deviation (mm), which is the average distance between the extreme deviations of the centre of feet pressure in the lateral plane.
- Anteroposterior speed (Average Forward-Backward Speed Y), is the mean oscillation speed along the Y axis (mm/s). It is the length quotient of deviations of the centre of feet pressure during the test, which indirectly informs about the dynamics of regulation process of postural stability in a standing position.

- Lateral speed (Average Medium-Lateral Speed X), is the mean oscillation speed along the X axis (mm/s). It is the length quotient of deviations of the centre of feet pressure during the test, which indirectly informs about the dynamics of regulation process of postural stability in a standing position.
- Circumference P (Perimeter). It is the total length of the path traveled by the COP in both planes during the oscillation (mm).
- EA area (Ellipse area). It is the total area which circled the COP in both planes during the oscillation (mm^2).
- Circumference ratio (Perimeter ratio). It is the ratio of circumference (perimeter) with eyes closed (CE) to the circumference with eyes opened (OE) in Romberg's Test.
- Surface ratio (Area ratio). It is the ratio of ellipse area with eyes closed (CE) to the ellipse area with eyes opened (OE) in Romberg's Test.

Variables were verified in terms of normal distribution by Shapiro-Wilk test. Depending on the compatibility of variable distributions with normal distribution, and the value of skewness and kurtosis, parametric or non-parametric tests have been used. Correlations between scoliotic variables and postural reactions were determined by Spearman's coefficient. To demonstrate the relationships between postural variables and somatic variables the analysis of variance has been made. The level of significance was $p < 0,05$.

RESULTS

The age of respondents was between 7-18 years old. It has been examined one child aged 7 years old. His height was 120,00 cm, weight 19,00 kg and BMI 13,19. There were two 9 year old children. Their average height was 133,00 cm, weight 27,50 kg and BMI 15,55. It has also been examined one child at the age of 10 years old. His height was 138 cm, weight 36,00 kg and BMI 18,90. There were four 11 years old children. Their average height was 145,00 cm, weight 36,75 kg and BMI 17,45. There were three 12 years old children. Their average height was 148,33 cm, weight 39,33 kg, and BMI 17,84. There were five 13 year old children. Their average height was 154,80 cm, weight 43,80 kg and BMI 18,23. It has also been examined five 14 years old children. Their average height was 160,60 cm, weight 48,60 kg and BMI 18,93. There were two 15 years old children. Their average height was 167,50 cm, weight was 56,50 kg and BMI 20,13. It was examined one child aged 16 years old. His height was 164,00 cm, weight 51,00 kg and BMI 18,96. There were three children aged 17 years old. Their average height was 166,33 cm, weight 50,67 kg and BMI 18,34. It has been examined one child aged 18 years old. His body height was 171,00 cm, weight was 55,00 kg and BMI 18,81 (Tab. 1). Postural reaction of AX (OE) was from 0,07 with opened eyes (OE) to 0,54 with closed eyes (CE). Abs of AX was from 0,86 with opened eyes (OE) to 4,32 with closed eyes (CE). Postural reaction of AY was from 2,07 with opened eyes (OE) to 5,96 with closed eyes (CE). Abs of AY was from 4,14 with opened eyes (OE) to 9,39 with closed eyes (CE). Postural reaction of FBSD was from 6,57 with opened eyes (OE) to 7,32 with closed eyes (CE). Postural reaction of MLSD was from 3,89 with opened eyes (OE) to 5,54 with closed eyes (CE). Postural reaction of AFBS was from 11,96 with opened eyes (OE) to 17,29 with closed eyes (CE). Postural reaction of AMLS was from 9,96 with opened eyes (OE) to 13,89 with closed eyes (CE). Perimeter was from 539,46 with opened eyes (OE) to 759,04 with closed eyes (CE). Ellipse area was from 447,46 with opened eyes (OE) to 850,32 with closed eyes (CE). PR was 146,68 and AR was 213,89 (Tab. 2).

Analysis of relations between height, weight and BMI and postural reactions with opened eyes (OE) did not show any significant effects (Tab. 3). It has also been performed the analysis of relations between height, weight and BMI and postural reactions with closed eyes (CE). The analysis showed a significant relations between height and FBSD (R=-0,3995), (p=0,027) and between height of the body and AFBS (R=-0,4172), (p=0,027) (Tab. 4). Both postural reactions are concerned with sagittal plane. The analysis of the correlations between BMI and postural reactions with closed eyes (CE) showed a significant associations only in Abs of AY (CE) (0,4516), (p=0,016). It is a directly proportional relationship. Higher values of BMI corresponds to a higher values of Abs of AY (Tab. 4).

DISCUSSION

Scoliosis arise and develop only during the growth period. They are a group of multi-faceted distortions involving the spine and directly related elements of skeleton, muscles and ligaments. These diseases are caused by the primordial imbalance of vertically-poised spine. The balance of spine is probably disturbed by the tension asymmetry of a deep muscles of the back. Distortions stated in scoliosis are the result of biological reactions system, aiming to restore the disturbed mechanical balance of the spine. The analysis of compensation phenomenon of scoliosis confirms this conception. Tension asymmetry of back muscles is probably forming under the influence of stimuli changes from the CNS [10]. Changes in CNS may be located in different parts, e.g. damages of the anterior horns of spinal cord or alpha or gamma systems, but may also be derived from higher levels, as it is in spastic changes. Further studies on the etiology of scoliosis should focus on CNS, and therefore it is necessary to include the neuropathologists [11]. A range of typical features of idiopathic scoliosis, such as e.g. right-sided curvature or formation of a different types in a specified age limits, indicates that the reasons of their formation may come from the cardiovascular trunk or other organs. However, to the time of the final clarification of the etiology of scoliosis, we should adopt a kind of pathomechanical concept, which will direct a further studies, and facilitate the elaboration of the way of treatment. Usually, the treatment of scoliosis is the desire to stop or reverse the biological corrective process and that's why it fails so often. Only in-depth knowledge of the pathogenesis and development of scoliosis can indicate the appropriate ways of treatment [12,13] In advanced scoliosis, musculoligamentous and bone changes are secondary, resulting from uneven axial loading of the spine. EMG studies did not explain, if the changes of muscle tension on the convex and concave side of the curvature are primary or secondary. Interpretation of the EMG results is different and often totally opposed. Asymmetrical tension of back muscles is not caused by morphological changes in muscle tissue, but is formed under the influence of changes in stimuli from the CNS [14,15]. A child with developmental disorders in postural tension, unable to sufficiently stabilize the proximal segments of the body (head, torso, pelvic girdle) compensates these deficiencies by running the self-stabilizing replacement. We can distinguish two ways. First one is called the passive stabilization, achieved through the manipulation of supporting plane and projection of the center of gravity, or by using the passive periarticular components for the purposes of stabilization [16,17]. The second way is an excessive proximal or distal stabilization, so-called fixation, that is activated on the basis of reflexive, tonic activity. Both the first and second way forces the nonphysiological, strained arrangements of the specified body segments. Postural consequences of passive, replacement stability is mainly the off-axis arrangement of individual body segments: head, torso and pelvic girdle. Lack of sufficient proximal postural tone creates an insufficient conditions of stabilization of the torso and pelvic girdle in a standing position, excluding their axial setting relative to each other in the sagittal and frontal plane. Therefore, there occurs an excessive, forward deflection of the trunk, excessive backward deviation of the trunk, or lateral displacement of the trunk, relative to the pelvic girdle. That causes such arrangement of body segments, in which the projection of the center of gravity slides out beyond the boundaries of the quadrilateral support. Initiation of the compensatory mechanisms in the form of using the passive, periarticular components depends on shifting the center of gravity from the axis of specified joint, so that the muscle stabilization of the joint can be replaced by passive resistance, mainly by ligaments. However, this entails a whole series of irregularities. Carrying out a numerous studies which depends on the assessment of posture and gait patterns, and examinations of posture patterns in primarily flaccid children, as well as many years of observations and therapeutic struggles with children with developmental disorders allows to conclude that the course of compensatory development of antigravity mechanism is predictable [18]. Body posture is an integral part of individual development, and should be seen as such, and its irregularities are the result of initiating compensatory mechanisms of development. Scoliosis are the diseases associated with disorders of the central stabilization of the body caused by postural hypotonia [19,20]. Disorders of postural reactions that occurs in scoliosis, affects on the pathoetiology of scoliosis, and the reversal movements of individual body segments increases the amplitudes of postural reactions.

CONCLUSIONS

1. In a study with opened eyes (OE), there were no significant correlations between the anthropometric variables and postural reactions.
2. In a study with closed eyes (CE), there were significant, inversely proportional correlations between the body height and FBSD, and between the body height and AFBS.
3. Analysis of relationships between BMI and postural reactions with eyes closed (CE) showed a significant, directly proportional correlations only with Abs AY. Higher BMI values corresponded with higher values of Abs AY.

REFERENCES

1. Zawieska D. Analiza parametrów antropometrycznych sylwetki człowieka. Archiwum Fotogrametrii, Kartografii i Teledetekcji 2004, 14:1-9.
2. Zawieska D, Zeyland-Malawka E, Prętkiewicz-Abacjew E. Objawy asymetrii w postawie ciała dzieci i młodzieży – potencjalne zagrożenie pełnosprawności układu ruchu i zdrowia. Nowiny Lekarskie 2006, 75, 4: 394–398.
3. Przewęda R. Rozwój somatyczny i motoryczny. WSiP, Warszawa 1981: 88-112.
4. Głowacki M, Kotwicki T, Pucher A. Skrzywienie kręgosłupa. W: Wiktora Degi Ortopedia i Rehabilitacja. Red. W Marciniak, A Szulc, PZWL, Warszawa 2008; 37: 68-111.
5. Kagawa M, Connie Wishart C, Hills AP. Influence of Posture and Frequency Modes in Total Body Water Estimation Using Bioelectrical Impedance Spectroscopy in Boys and Adult Males. Nutrients. 2014; 6 (5): 1886–1898. doi: 10.3390/nu6051886.
6. Michiel MA, Janssen, Roeland F et al. Experimental animal models in scoliosis research: a review of the literature. The Spine Journal 2012; 4: 347-358.
7. Negrini S, Negrini F, Fusco C et. al. Idiopathic scoliosis patients with curves more than 45 Cobb degrees refusing surgery can be effectively treated through bracing with curve improvements. The Spine Journal 201; 11, 5: 369-380.

8. Wilczyński J. Kierunek wtórnych bocznych skrzywień kręgosłupa u dziewcząt i chłopców w wieku 12-15 lat z województwa świętokrzyskiego. Studia Medyczne 2010; 19: 29-33.
9. Weiss H. Inclusion criteria for physical therapy intervention studies on scoliosis - a review of the literature. Stud Health Technol Inform. 2012; 176: 350-353.
10. Matyja M. Neurorozwojowa analiza wad postawy ciała u dzieci i młodzieży. AWF, Katowice 2012.
11. Matyja M, Domagalska M. Podstawy usprawniania neurorozwojowego według Berty i Karela Bobathów. Katowice: AWF, 2009.
12. Matyja M, Gogola A. Prognozowanie rozwoju postawy dzieci na podstawie analizy jakości napięcia posturalnego w okresie niemowlęcym. Neurol. Dziec. 2007; 16 (32): 49-56.
13. Matyja M, Zmudzka-Wilczek E, Karasz B. Neurorozwojowa analiza ćwiczeń korekcyjnych. Fizjoter. Pol. 2006; 6 (3): 251-259.
14. Domagalska M. Neurofizjologiczne aspekty diagnostyki i terapii wad postawy. W: Wady postawy ciała u dzieci i młodzieży Red. Nowotny J. PAN-WSA, Bielsko-Biała, 2009: 1-5.
15. Putzier M, Groß C, Zahn RK, Pumberger M, Strube P. Characteristics of neuromuscular scoliosis. Orthopade. 2016; 45 (6): 500-8.
16. Porte M, Patte K, Dupeyron A, Cottalorda J. Exercise therapy in the treatment of idiopathic adolescent scoliosis: Is it useful ?. Arch Pediatr. 2016 Jun;23(6):624-8.
17. Monticone M, Ambrosini E, Cazzaniga D, Rocca B, Motta L, Cerri C, Brayda-Bruno M, Lovi A. Adults with idiopathic scoliosis improve disability after motor and cognitive rehabilitation: results of a randomised controlled trial. Eur Spine J. 2016; 25 (10): 3120-3129.
18. Pialasse JP, Mercier P, Descarreaux M, Simoneau M. Sensorimotor Control Impairment in Young Adults With Idiopathic Scoliosis Compared With Healthy Controls. J Manipulative Physiol Ther. 2016; 39 (7): 473-9.
19. Yen TC, Toosizadeh N, Howe C, Dohm M, Mohler J, Najafi B. Postural Balance Parameters as Objective Surgical Assessments in Low Back Disorders: A Systematic Review. J Appl Biomech. 2016; 32 (3): 316-23.
20. Weiss HR. Current knowledge on physiotherapy for scoliosis. Orthopade. 2016; 45 (6): 549-50.

Table 1. Anthropometric parameters of examined[1]

Age of examined	n	Body height		Body weight		BMI	
		x	s	x	s	x	s
7	1	120,00	0,00	19,00	0,00	13,19	0,00
9	2	133,00	0,00	27,50	0,71	15,55	0,40
10	1	138,00	0,00	36,00	0,00	18,90	0,00
11	4	145,00	3,65	36,75	4,99	17,45	1,89
12	3	148,33	4,51	39,33	7,02	17,84	2,86
13	5	154,80	5,26	43,80	4,76	18,23	1,18
14	5	160,60	6,35	48,60	3,65	18,93	2,32
15	2	167,50	9,19	56,50	4,95	20,13	0,44
16	1	164,00	0,00	51,00	0,00	18,96	0,00
17	3	166,33	2,89	50,67	3,21	18,34	1,65
18	1	171,00	0,00	55,00	0,00	18,81	0,00
Total	28	153,39	13,04	43,14	9,76	18,05	2,04

Table 2. Postural reactions with opened eyes (OE – *close eyes*)
and closed eyes (CE – *close eyes*)

Postural reactions with opened eyes (OE – *open eyes*)									
Postural reactions (OE)	n	x	med	min	maks	rozs	s	skoś	kurt
AX	28	0,07	0	-4	2	6	1,25	-1,012	3,002
Abs AX	28	0,86	1	0	4	4	0,89	1,651	4,575
AY	28	2,07	2	-18	32	50	7,37	1,840	11,831
Abs AY	28	4,14	2	0	32	32	6,40	3,646	14,309
FBSD	28	6,57	6	3	12	9	2,54	0,288	-0,745
MLSD	28	3,89	4	2	10	8	1,87	1,953	4,756
AFBS	28	11,96	10	5	31	26	5,57	1,798	4,100
AMLS	28	9,96	9	4	22	18	3,90	1,230	2,291
P	28	539,46	493	248	1079	831	195,80	1,272	1,825
EA	28	447,46	438,5	102	1660	1558	314,37	2,260	7,616
Postural reactions with closed eyes (CE – *close eyes*)									
Postural reactions (CE)	n	x	med	min	maks	rozs	s	skoś	kurt
AX	28	0,54	0,5	-15	12	27	6,02	-0,555	0,841
Abs AX	28	4,32	3	0	15	15	4,14	0,980	0,201
AY	28	5,96	7	-17	26	43	9,81	-0,303	-0,068
Abs AY	28	9,39	8,5	0	26	26	6,46	0,552	-0,022
FBSD	28	7,32	6	3	16	13	3,56	1,244	0,960
MLSD	28	5,54	5	2	16	14	2,62	2,432	8,964
AFBS	28	17,29	16,5	8	36	28	6,83	0,944	0,983
AMLS	28	13,89	13	8	22	14	4,11	0,609	-0,616
P	28	759,04	723	449	1330	881	232,50	0,714	-0,106
EA	28	850,32	647	144	3776	3632	781,18	2,525	7,165
PR	28	146,68	140,5	71	226	155	36,45	0,271	-0,338
AR	28	213,89	187,5	31	719	688	149,03	1,691	3,896

[1] n – number of examined; x – average; med. – median, min – minimum value; maks – maximum value; r – interval; skoś – skewness; k – kurtosis.

Table 3. Anthropometric variables and postural reactions with opened eyes (OE)

Postural reactions (OE)	Height	Weight	BMI
AX (OE)	R=-0,0771	R=-0,077	R=-0,0912
	p=0,697	p=0,697	p=0,644
Abs AX (OE)	R=-0,1226	R=-0,087	R=-0,0254
	p=0,534	p=0,660	p=0,898
AY (OE)	R=0,1123	R=0,0627	R=-0,0004
	p=0,569	p=0,751	p=0,998
Abs AY (OE)	R=-0,0247	R=0,1159	R=0,3043
	p=0,901	p=0,557	p=0,115
FBSD (OE)	R=-0,1946	R=-0,2404	R=-0,247
	p=0,321	p=0,218	p=0,205
MLSD (OE)	R=-0,3305	R=-0,2686	R=-0,0664
	p=0,086	p=0,167	p=0,737
AFBS (OE)	R=-0,3075	R=-0,2759	R=-0,2387
	p=0,111	p=0,155	p=0,221
AMLS (OE)	R=-0,1468	R=-0,1146	R=-0,0414
	p=0,456	p=0,561	p=0,834
P (OE)	R=-0,3265	R=-0,2945	R=-0,2374
	p=0,090	p=0,128	p=0,224
EA (OE)	R=-0,302	R=-0,2543	R=-0,094
	p=0,118	p=0,192	p=0,634

Table 4. Anthropometric variables and postural reactions with closed eyes (CE)

Postural reactions (CE)	Height	Weight	BMI
AX (CE)	R=0,2296	R=0,2427	R=0,1446
	p=0,240	p=0,213	p=0,463
Abs AX (CE)	R=0,0168	R=-0,0278	R=-0,0371
	p=0,932	p=0,888	p=0,851
AY (CE)	R=0,21	R=0,1895	R=0,0465
	p=0,284	p=0,334	p=0,814
Abs AY (CE)	R=0,1564	R=0,3221	R=**0,4516**
	p=0,427	p=0,095	**p=0,016**
FBSD (CE)	R=**-0,3995**	R=-0,3072	R=-0,1013
	p=0,035	p=0,112	p=0,608
MLSD (CE)	R=-0,294	R=-0,106	R=0,2287
	p=0,129	p=0,591	p=0,242
AFBS (CE)	R=**-0,4172**	R=-0,3514	R=-0,1639
	p=0,027	p=0,067	p=0,405
AMLS (CE)	R=-0,1974	R=-0,1832	R=-0,1134
	p=0,314	p=0,351	p=0,566
P (CE)	R=-0,4125	R=-0,3588	R=-0,1892
	p=0,029	p=0,061	p=0,335
EA (CE)	R=-0,3092	R=-0,1858	R=0,052
	p=0,109	p=0,344	p=0,793
PR	R=-0,1115	R=-0,0206	R=0,1897
	p=0,572	p=0,917	p=0,334
AR	R=-0,1547	R=0,015	R=0,2649
	p=0,432	p=0,939	p=0,173