DOI: http://dx.doi.org/10.12775/MBS.2016.024

Medical and Biological Sciences, 2016, 30/3, 57-66

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INFLUENCE OF PHYSICAL EFFORT ON HABITUAL BODY POSTURES OF SPORTSMEN AND SPORTWOMEN DOING COMPETITIVE SPORTS

WPŁYW WYSIŁKU FIZYCZNEGO NA HABITUALNĄ POSTAWĘ CIAŁA ZAWODNIKÓW UPRAWIAJĄCYCH SPORT KWALIFIKOWANY

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Summary

Introduction. Influence of physical training on an individual development is a function of its intensity and consistency. The aim of this research was to present influence of sports training, peculiar to a given sports discipline, on competitors' habitual posture.

Material and method. Measurement of 35 spatial features of habitual body posture, with a use of the photogrammetric method, carried out among 151 competitors representing a variety of sports disciplines: judo, wrestling, volleyball, football, and fencing.

Results. A habitual posture peculiar to each sports discipline was described and importance of differences between features of habitual posture of people not doing qualified sports was established.

Conclusions. (1) Condition of people who do qualified sports may depend on knowledge, skills and responsiveness of a trainer. Diagnostics of body posture may be a crucial criterion in evaluating load applied in asymmetric sports. It enables correction of training methods. It is advisable to provide competitors with versatile training and improve balance between specific groups of muscles, especially in asymmetric disciplines; (2) regular medical examination should become the basis in selecting new entrants in sports clubs; (3) body posture disorders of adult competitors may result from absence of holistic training and inaccuracy in the initial stage of training, incorrect warm-up, and lack of exercises shaping the habit of correct body posture.

Streszczenie

Wstęp. Wpływ ćwiczeń fizycznych na rozwój osobniczy jest funkcją jego intensywności i długotrwałości. Celem podjętych badań jest wykazanie wpływu treningu sportowego właściwego danej dyscyplinie sportowej na habitualną postawę ciała sportowca.

Materiał i metody. Pomiar 35 przestrzennych cech habitualnej postawy ciała dokonano metodą fotogrametryczną wśród 151 zawodników: judo, zapasów, piłki siatkowej, piłki nożnej i szermierki.

Wyniki. Opisano postawę habitualną sportowca właściwą każdej dyscyplinie sportowej, określono istotność różnic z przyjętymi wielkościami cech postawy habitualnej osobników nie uprawiających sportu klasyfikowanego.

Wnioski. (1) Stan zdrowia uprawiających sport kwalifikowany może zależeć od wiedzy, umiejętności i wrażliwości prowadzącego szkolenie sportowe. Istotnym kryterium oceny stosowanych obciążeń w sportach asymetrycznych może być diagnostyka postawy ciała, umożliwiająca korektę metod treningowych i stosowanych środków w jej ramach. Wskazane jest wprowadzenie wszechstronnego szkolenia zawodników i doskonalenia funkcjonalnej równowagi poszczególnych grup mięśniowych, szczególnie w dyscyplinach asymetrycznych; (2) Należy wprowadzić właściwą selekcję w naborze młodych adeptów klubów sportowych w oparciu o systematyczne badania lekarskie; (3) Zaburzenia statyki postawy ciała w wieku dojrzałego zawodnika mogą być

konsekwencją nie stosowania zasad treningu holistycznego i błędów w początkowym etapie szkolenia, błędów w rozgrzewce i braku ćwiczeń kształtujących nawyk postawy prawidłowej w jej ramach.

Key words: habitual posture, sport, health
Słowa kluczowe: postawa habitualna, sport, zdrowie

INTRODUCTION

It has been assumed that increased physical activity is one of key notions in health promotion. Numerous facilities dealing with this issue are included in the Toronto model (HRF – *Heath Related Fitness*), prepared by Bouchard and Shephard [1], which claims that health stems from components of physical efficiency, which may be further positively modified by regular physical training [2, 3]. According to this concept, it has been accepted that adaptation involving effort incorporates pro-health elements. The way of creating pro-health adaptation, based on approach towards physical activity as eustress, includes also processes which are hardly beneficial to health. Such detrimental effects of training are mostly noticeable in competitive sports. Apart from effects such as exhaustion (overtraining), a variety of functional and structural changes have been observed. They usually result from specifics of sports discipline. According to Jethon [4], positive influence of physical activity is mainly supported by results of epidemiological research. Comparison between groups of people who exercise against those who do not, showed that in the latter group cases of coronary artery disease, heart failure, atherosclerosis, non-insulin dependent diabetes (type 2 diabetes), osteoporosis, colorectal cancer, and other diseases tend to appear more often. However, these observations may not always be supported by laboratory research, though negative aspects of physical activity are often pointed to. These changes are usually difficult to notice. Nonetheless, in co-operation with other disorders, they may lead to risk of health damage. Exertional female triad is a specific form of health disorder of young women. It consists of fertility disorder (amenorrhoea), eating habits disorder (anorexia, bulimia), and decrease in bone mineral density (osteopenia, osteoporosis). The main reasons for it are changes in life style, especially cutting down on calories intake in order to achieve desired body shape. This results in deficiency in secreting pituitary gland hormones and oestrogens. Reduction of body weight and decline of quality of meals leads to insufficiency of nutrients and, as a consequence, to decrease bone mineral density and immunosuppression [5, 6]. Photogrammetric examination of body posture of twenty-two boys, pupils from general and sports education classes revealed incorrectness in body postures of pupils from the general education class, which was also reflected in measurement results: torso forward inclination angle 5.46 degree, lumbar lordosis angle 168.92 degree, thoracic kyphosis angle 157.46 degree, compensation indicator 10.09, depth of thoracic kyphosis 9.01mm, torso lateral inclination 2.83 degree, pelvic lateral inclination 1.45mm and maximal spinal deflection off the straight line C7-S1 6.27mm [7]. Weber [8] believes that physical effort directed at correction of bad posture cannot influence structural changes and bone growth.

The aim of research is to point to influence of sports training specific to a given sports discipline on a sportsperson's habitual body posture.

MATERIAL AND METHODS

Measurement of selected features of habitual body posture among 151 competitors, aged 11-35 years, was carried out in years 2004-2015. On average the competitors were characterized by 9.5 years of training, body weight 67.29kg, and height 175.46cm (Table I). Competitors of: male judo (Judo M), female wrestling (Zapas. K) and male wrestling (Zapas. M) were members of the national team. While: male volleyball (P.s. M), male football (P.N. M), female fencing (Szerm. K) and male fencing (Szerm. M), were participants of national competitions.

Tabela. I. *Charakterystyka materiału badawczego*
Table I. *Characteristics of research material*

Lp. No.	Dyscyplina sportowa Sports discipline	Liczba Amount	Staż tr. (lata) Training period (years)	W. c. Height	M. c. Weight	Średni wiek Average age
1	Judo M male judo	27	11	178.94	67.34	16-26
2	Zapasy M male wrestling	39	13	179.65	79.54	18-35
3	Zapasy K female wrestling	29	5	163.21	54.21	16-21
4	P. siatk. M. male volleyball	18	13	186.41	79.43	20-35
5	P. nożna M male football	15	14	182.37	78.96	15-32
6	Szerm. K female fencing	12	5	165.25	53.33	11-19
7	Szerm. M male fencing	11	6	172.44	58.33	11-19
	Suma Total	151				
	M Mean		9.57	175.46	67.29	15.2-26.7

The measurement involved 35 features, describing body posture in planes: sagittal, coronal, and transverse (Table II). The diagnostics was carried out with use of the moiré method. The measurement stand consisted of: a computer and a card, software, a screen, a printer, and an apparatus for projection and receiving with a camera for measurement of selected spine-pelvis features. It is possible to obtain a spatial image thanks to projecting lines of strictly defined parameters on the back. The lines, while being projected on the back, deform depending on the surface. Thanks to the use of object-lens, the picture may be received by a special optic system with a camera, and subsequently sent to the computer screen. Distortions of lines are saved in the computer and transformed by a numeric algorithm onto a contour map [9]. The picture of the back surface received in this way enables to interpret body posture in a number of ways. Apart from evaluation of torso asymmetry in the coronal plane, there is a possibility to assess spatial values of angular and linear parameters describing pelvis, physiological curvatures and frontal asymmetry of spinous processes, i.e. deflection from the C7-S1 line. A short time of examination helps to avoid fatigue of postural muscles, which happens more often in measurements carried out with use of somatoscopic methods. What is crucial in this method is that all real values of spatial position of different body parts are measured simultaneously [10].

Tabela II. *Opis wybranych cech opisujących postawę ciała*
Table II. *Description of features characterizing body posture*

Nr No	Symbol Symbol	Parametry Parameters		
		Miano Unit	Nazwa Name	Opis description
Płaszczyzna strzałkowa Sagittal plane				
1	Alfa alpha	Stopnie Degrees	Nachylenie odcinka lędźwiowo-krzyżowego Inclination of lumbosacral section	
2	Beta beta	Stopnie degrees	Nachylenie odcinka piersiowo-lędźwiowego Inclination of thoracic-lumbar section	
3	Gamma Gamma	Stopnie degrees	Nachylenie odcinka piersiowego górnego Inclination of upper thoracic section	
4	Delta delta	Stopnie degrees	Suma wartości kątów Sum of angle values	Delta = Alfa+Beta+Gamma Delta = Alpha+Beta+Gamma
5	DCK	mm	Długość całkowita kręgosłupa Length of the spine	Odległość między punktami C7 i S1 mierzona w pionie Distance between points C7 and S1 measured vertically
6	KPT	Stopnie degrees	Kąt wyprostu tułowia Angle of torso extension	Określony jest odchyleniem linii C7-S1 od pionu (w tył) Described by deflection of line C7-S1 from the vertical (backward)
7	KPT -	Stopnie degrees	Kąt zgięcia tułowia Angle of torso inclination	Określony jest odchyleniem linii C7-S1 od pionu (w przód) Described by deflection of line C7-S1 from the vertical (forward)
8	DKP	mm	Długość kifozy piersiowej Length of thoracic kyphosis	Odległość między punktami LL a C7 Distance between points LL and C7
9	KKP	Stopnie degrees	Kąt kifozy piersiowej Angle of thoracic kyphosis	KKP = 180 – (Beta+Gamma)
10	RKP	mm	Wysokość kifozy piersiowej Height of thoracic kyphosis	Odległość między punktami C7 a PL Distance between points C7 and PL
11	GKP	mm	Głębokość kifozy piersiowej Depth of thoracic kyphosis	Odległość mierzona poziomo między liniami pionowymi przechodzącymi przez punktu PL o KP Distance measured horizontally between vertical lines crossing points PL and KP
12	DLL	mm	Długość lordozy lędźwiowej Length of lumbar lordosis	Odległość między punktami S1 a KP Distance between points S1 and KP
13	KLL	Stopnie Degrees	Kąt lordozy lędźwiowej Angle of lumbag lordosis	KLL = 180 – (Alfa + Beta)
14	RLL	Mm	Wysokość lordozy lędźwiow. Height of lumbar lordosis	Odległość między punktami S1 a PL Distance between points S1 and PL
15	GLL -	mm	Głębokość lordozy lędźwiowej Depth of lumbar lordosis	Odległość mierzona poziomo między liniami pionowymi przechodzącymi prez punkty PL i LL Distance measured horizontally between vertical lines crossing points PL and LL
Płaszczyzna czołowa Coronal plane				
16	KNT -	Stopnie degrees	Kąt zgięcia tułowia w bok Angle of lateral torso inclination	Określony jest odchyleniem linii C7-S1 od pionu w lewo. Described by deflection of the Line C7-S1 from the vertical to the left
17	KNT	Stopnie Degrees		Określony jest odchyleniem linii C7-S1 od pionu w prawo Described by deflection of the Line C7-S1 from the vertical to the right
18	PBW	Mm	Prawy bark wyżej Right shoulder higher	Odległość mierzona pionowo między liniami poziomymi przechodzącymi przez punkty B2 i B4
19	LBW	Mm	Lewy brak wyżej Left shoulder higher	Distance measured vertically between horizontal lines crossing points B2 and B4
20	LŁW	Mm	Lewa łopatka wyżej Left shoulder blade higher	Odległość mierzona pionowo między liniami poziomymi przechodzącymi przez punkty Ł1 1 Łp
21	PŁW	Mm	Prawa łopatka wyżej Right shoulder blade higher	Distance measured vertically between horizontal lines crossing points Ł1 and Łp
22	PŁB	Mm	Kąt dolny lewej łopatki bardziej oddalony Lower angle of left shoulder blade more distant	Różnica oddalenia dolnych kątów łopatek od linii wyrostków kolczystych kręgosłupa mierzona poziomo na prostych przecho-dzących przez punkty Ł1 i Łp Difference in distances of lower angles of shoulder blades from the line of spinous processes, measured

23	ŁŁB	Mm	Kąt dolny prawej łopatki bardziej oddalony Lower angle of right shoulder blade more distant	horizontally on straight lines crossing points Ł1 and Łp
24	LTT w	Mm	Lewy trójkąt taliowych jest wyższy Left waist triangle is higher	Różnica odległości mierzona pionowo między punktamiT1 i T2 a T3 i T4. PLTT = LTT – PTT Difference in distance measured horizontally between points T1 - T2 and T3 – T4
25	PTT w	Mm	Prawy trójkąt taliowych jest wyższy Right waist triangle is higher	
26	LTT s	Mm	Lewy trójkąt taliowy jest Szerszy Left waist triangle is wider	Różnica odległości mierzona poziomo między prostymi przechodzącymi przez punkty T1 i T2 a T3 i T4 Difference in distance measured horizontally between straight lines crossing points T1 - T2 and T3 – T4
27	PTTS s	Mm	Prawy trójkąt taliowy jest Szerszy Right waist triangle is wider	
28	KNM	Stopnie Degrees	Kąt nachylenia miednicy, prawy talerz biodrowy wyżej Pelvic inclination, right iliac crest is higher	Kąt między linią poziomą a prostą przechodzącą przez punkty M1 a Mp Angle between horizontal line and a straight line crossing points M1 and Mp
29	KNM -	Stopnie Degrees	Kąt nachylenia miednicy, lewy talerz biodrowy wyżej Pelvic inclination, left iliac crest is higher	
30	UK	Mm	Maksymalne odchylenie wyrostka kolczystego kręgu w prawo Maximal deflection of spinous process to the right	Największe odchylenie wyrostka kolczystego od pionu wyprowadzonego z S1. Odległość mierzona jest w osi poziomej. Maximal deflection of spinous process from the vertical from S1. Distance measured in the vertical axis.
31	UK -	Mm	Maksymalne odchylenie wyrostka kolczystego kręgu w lewo. Maximal deflection of spinous process to the left	
32	Nr kręgu Number of vertebra		Nr kręgu maksymalnie odchylonego w lewo lub prawo Number of the vertebra maximally deflected to the left or to the right	Numer kręgu najbardziej odchylonego w lewo lub prawo w asymetrycznym przebiegu linii wyrostków kolczystych, licząc jako 1, pierwszy kręg szyjny (C1) Jeśli średnia arytmetyczna przyjmuje wartość np. od 12,0 do 12,5 to jest to Th5, jeśli od 12,6 do 12,9 to jest to Th6. Number of vertebra deflected to the left or to the right in the asymmetric line of spinous processes, counting as the first one, the first cervical vertebra (C1). If the arithmetic mean assumes value, e.g. from 12,0 to 12,5 it is then Th5, if from 12,6 to 12,9 it is then Th6.
Płaszczyzna poprzeczna Transverse plane				
33	KSM	Stopnie Degrees	Miednica skręcona w prawo Pelvic inclination to the right	Kąt między linią przechodząca przez punkt Ml i będącą jednocześnie prostopadłą do osi kamery a prostą przechodzącą przez Ml i MP Angle between the line crossing point M1, being at the same time perpendicular to the camera axis and the line crossing M1 and MP
34	KSM -	Stopnie Degrees	Miednica skręcona w lewo Pelvic inclination to the left	Kąt między linią przechodząca przez punkt Mp i będącą jednocześnie prostopadłą do osi kamery a prostą przechodzącą przez Ml i MP Angle between the line crossing point Mp, being at the same time perpendicular to the camera axis and the line crossing M1 and MP

Źródło: badania własne
Souce: authors' research

RESULTS

The diagnostics of the habitual posture features provided 5285 results of measurements. Importance of differences in results between men and women at the age 18 years, doing recreational sports, was analysed [11]. These results were acknowledged as a norm (Table III). Empirical data, in form of qualitative features, underwent statistical analysis. Basic indexes such as arithmetic mean and standard deviation were established. A set of features displayed normal distribution, thus further calculations were based on relevant parametric tests. In order to determine mutual statistical dependency between features, Pearson's correlation coefficients were calculated. The analysis of importance of differences between two means was performed with student's t-test, and homogeneity of variances was checked with F test; variance ratio test (Table 4, Fig. 1). For the statistical calculations Statistica StatSoft, Inc. (2005). STATISTICA (data analysis software system), version 6.3 www. statsoft. nr lic. AXAP311B316618AR was used.

A habitual posture of a judo competitor in the coronal plane is characterised by a considerably lifted right shoulder and closer location of the left shoulder blade against the line of spinous processes, high asymmetry of the waist triangles, with the left one usually higher, and the right one – wider. There also occurs asymmetric route of the line of spinous processes, with protrusion on the level of the ninth thoracic vertebra. In the transversal plane appears left-sided pelvic torsion of a small angle. In the sagittal plane the posture is properly oriented vertically, lumbar lordosis, lumbosacral and upper thoracic parts are only slightly deepened. The most significant differences against respective postural features of a person doing physical activity on the recreational level

Tabela III. *Średnie wielkości wybranych cech postawy ciała zawodników judo (Judo M), zapaśniczek (Zapasy K) i zapaśników (Zapasy M), piłkarzy nożnych (P.N. M) i siatkówki (P.S. M), szermierek (Szerm. K) i szermierzy (Szerm. M) (n=151)*

Table III. *Mean values of selected features of bosy posture of judo competitors (Judo M), female wrestlers (Zapasy K), Male wrestlers (Zapasy M), football players (P.N.M), volleyball players (P.S.M), female fencers (Szerm. K) and male fencers (Szerm. M) (n=151)*

Lp. No.	Cecha postawy ciała Body posture feature	Norma Norm		Dyscypliny sportowe Sports disciplines						
		M male	K female	Judo M male judo	Zapasy M male wrestling	Zapasy K female wrestling	P.S. M male volleyball	P.N. M male football	Szerm. K female fencing	Szerm. M male fencing
1	KNT	0.7	0.8	0.96	0.22	4.89	0	0.28	0	0
2	KNT-	1.2	1.3	1.56	0.47	6.67	1.02	0.49	0.25	0.27
3	KPT	2.6	3.5	1.56	1.59	2.83	3.07	2.53	17.5	16.45
4	KPT-	2.5	2.0	0.96	0.58	0	0.43	0.02	0	0
5	KNM	2.3	2.3	0.43	1.22	4.89	1.16	0.38	1.75	2.18
6	KNM-	2.4	2.1	0.37	0.12	6.67	0.17	1.32	3.33	1.18
7	KSM-	4.5	5.1	2.36	4.05	3.61	5.33	4.18	1.25	0.9
8	KSM	4.3	8.4	0.49	0.12	0	0.9	1.61	2.16	3
9	UK	2.7	4.0	0.77	1.03	2	0.98	1.14	1.16	1.63
10	UK-	6.1	5.4	4.11	3.35	4.18	2.97	3.16	3	3.54
11	NK	Th_9	Th_{10}	Th_9	Th_{10}	Th_9	Th_3	Th_3	Th_8	Th_7
12	LŁB	2.5	2.3	3.87	4.11	4.97	8.82	7.6	5.13	6.94
13	PŁB	8.5	10.3	1.52	0.5	4.31	0	0	1.85	0.1
14	LŁW	4.9	5.3	2.34	0.72	12.54	1.69	2.31	8.25	9.79
15	PŁW	5.9	6.2	1.72	2.92	5.12	2.15	3.25	0.99	1.86
16	LBW	6.3	4.7	1.12	5.27	4.31	5.16	2.72	7.67	9.94
17	PBW	7.1	6.1	4.45	2.45	4.94	1.02	1.36	2.7	0.77
18	LTTw	13.1	11.2	19.11	6.03	6.45	16.45	14.42	2.61	3.27
19	PTTw	16.0	9.3	1.63	5.11	5.45	4.9	7.84	8.04	8.36
20	LTTs	9.0	9.8	3.18	1.88	2.43	1.63	3.78	4.56	4.98
21	PTTs	6.4	6.2	5.91	6.51	6.89	3.15	3.5	2.34	1.98
22	Alfa	6.5	9.3	7.02	11.5	8.53	5.97	6.22	10.33	6.36
23	Beta	10.2	10.1	10.66	9.91	11.23	9.83	10.24	10.33	11
24	Gamma	11.9	9.6	13.07	11	9.47	10.38	11.51	8.58	10.36
25	Delta	28.4	28.9	30.74	32.76	28.63	26.2	27.99	29.58	27.45
26	KLL	163.3	160.4	162.29	168.66	160.7	166.56	171.88	159	162.63
27	DLL	278.6	271.9	246.16	234.98	388.13	263	237.86	437.33	431.18
28	RLL	156.1	154.7	135.54	126.66	226.23	142.83	119.32	263.25	256.81
29	GLL-	19.5	18.1	17.85	15.54	37.23	17.6	17.27	39.91	38.09
30	KKP	158.1	160.3	156.28	158.92	159.5	159.77	158.23	160.75	158.54
31	DKP	342.8	310.7	318.38	304.51	464.83	315.78	317.24	304.66	318.63
32	RKP	241.5	214.1	226.9	222.59	306.97	215.54	361.39	330	243.36
33	GKP	22.4	21.0	21.11	18.7	29.22	21.03	20.38	27.16	36.27
34	DCK	395.7	367.5	363.54	346.46	433.13	358.38	347.42	593.33	600

Source: authors' research
Źródło: badania własne

appear in parameters of the coronal plane, excluding torso forward inclination. In the sagittal plane these are mainly features of thoracic kyphosis, length and height of lumbar lordosis, as well as length of the spine. The judo training does not seem to have any influence on left-sided pelvic torsion in the transversal plane, asymmetry in width of waist triangles and partial angles of spinal physiological curvatures (alpha and beta), (Table IV, Fig. 1).

In comparison with similar postures of men on a similar ontogenetic stage and doing sports moderately, the habitual postures of volleyball players in the coronal plane is characterised by: slight left-sided lateral torso inclination, lifted left shoulder, wider and higher left waist triangle and lifted right iliac crest, with the left shoulder blade placed much closer to the spine. Maximal deflection of the spinous process from the straight line, when it occurs, is directed to the right, and on the level of the third thoracic vertebra. If it occurs to the left, then the values are higher. Pelvic torsion in the transversal plane the pelvis occurs more often to the left than to the right. In the sagittal plane, it shows a significant torso extension, average degree of decrease in depth and angle of thoracic kyphosis, significant decrease in depth and angle of lumbar lordosis, and very small lateral inclination of lumbosacral part of the spine. The most important differences in postures between players and people doing sports recreationally appear in the parameters of the coronal plane. In the sagittal plane these are mainly features of thoracic kyphosis, lumbar lordosis and total length of the spine. Exception here is the angle of thoracic kyphosis, which only slightly differs from the same parameter measured for a person who does not do any competitive sport. A complete lack of influence can be observed in pelvic left-sided torsion in the

Tabela IV. *Istotność różnic cech habitualnej postawy ciała między osobnikami uprawiającymi i nie uprawiającymi sport kwalifikowany*

Table IV. *Importance of differences in features of habitual postures between people doing sports recreational and competitive*

Cecha Feature	Dyscypliny sportowe Sports disciplines													
	Judo M male judo		Zapasy M male wrestling		Zapasy K female wrestling		P.S. M male volleyball		P.N. M male football		Szerm. K female fencing		Szerm M male fencing	
	P-value	p	p-value	p	p-value	p	p-value	p	p-value	p	p-value	p	p-value	p
KNT	0,0340	*	2,2806	***	0,0010	**	2,7670	***	0,0101	*	0,0002	***	0,0101	*
KNT-	0,0264	*	5,4508	***	0,0344	*	0,3628		0,0010	**	0,0002	***	2,7706	***
KPT	9,2912	***	5,1706	***	3,7511	***	0,1498		0,8493		1,6230	***	1,2531	***
KPT-	7,2021	***	7,8216	***	4,4719	***	3,5303	***	1,0210	***	2,4608	***	1,6508	***
KNM	2,6921	***	1,5210	***	3,4555	***	4,2756	***	1,5412	***	0,7113		0,0340	*
KNM-	7,2114	***	1,4627	***	3,7185	***	8,6746	***	0,0013	**	0,0019	**	4,0507	***
KSM-	0,1835		0,0657		8,0467	***	0	***	0,4117		3,8615	***	9,1418	***
KSM	4,2132	***	7,8280	***	1,5507	***	2,3068	***	2,3248	***	1,3209	***	3,7416	***
UK	4,7912	***	4,5431	***	5,0514	***	4,4126	***	1,6711	***	7,5405	***	1,2711	***
UK-	2,1721	***	1,8620	***	6,9312	***	5,9909	***	7,0910	***	4,2706	***	7,1607	***
NK	0,1231		0,3141		0,3216		0,1272		0,1789		0,3167		0,1765	
LŁB	2,6621	***	1,5733	***	2,8123	***	0,5485		7,3611	***	0,0226	*	7,2812	***
PŁB	0,0006	***	4,6517	***	3,1223	***	9,2711	***	0,1235		8,4808	***	0,2187	
LŁW	2,2312	***	3,5654	***	2,1894	***	4,7898	***	2,1709	***	4,8922	***	8,0508	***
PŁW	1,2521	***	4,0725	***	0,0049	**	7,8072	***	1,0308	***	7,9614	***	9,1418	***
LBW	3,7521	***	0,0007	***	0,1802		0,0110	*	3,0913	***	2,2310	***	8,9811	***
PBW	1,9213	***	1,6949	***	0,0011	**	1,4191	***	6,3430	***	7,1271	***	1,7091	***
LTTw	1,1823	***	1,6245	***	1,8641	***	4,9343	***	0,1010		0,1211		0,1235	
PTTw	1,4481	***	1,7981	***	2,1777	***	2,2556	***	3,8119	***	3,8617	***	2,4816	***
LTTs	2,4623		5,0980	***	4,3773	***	6,8473	***	4,1818	***	2,2813	***	1,6215	***
PTTs	0,1443		0,6965		0,7565		2,0618	***	1,0210	***	2,3810	***	5,5101	***
Alfa Alpha	0,1389		1,9264	***	0,0384	*	0,2187		0,5552		0,2112		0,0801	
Beta	0,1902		0,3221		7,2305	***	0,3898		0,9362		0,1470		0,2150	
Gamma	0,0009	***	0,0021	**	0,6170		0,0004	***	0,4122		0,0051	**	0,0127	*
Delta	5,5312	***	1,3127	***	0,5287		0,0001	***	0,5115		0,1936		0,3125	
KLL	0,0173	*	1,0949	***	0,4777		1,8475	***	6,4153	***	0,3030		0,0315	*
DLL	6,1982	***	0	***	0	***	2,2720	***	2,9176	***	0	***	0	***
RLL	1,1113	***	0	***	0	***	1,4053	***	2,1981	***	0	***	0	***
GLL-	0,0030	**	1,4117	***	0	***	0,0052	**	0,0027	**	3,7991	***	5,5184	***
KKP	2,9112	***	0,0307	*	0,0232	*	0,0020	**	0,8258		0,5221		0,4065	
DKP	4,8101	***	0	***	0	***	7,7650	***	1,9763	***	0	***	0	***
RKP	2,4745	***	4,1051	***	0	***	3,6762	***	0	***	0	***	0	***
GKP	0,0220	*	3,3315	***	3,969	***	0,0477	*	0,0075	**	2,9755	***	4,6517	***
DCK	7,9155	***	0	***	0	***	1,4297	***	0	***	0	***	0	***

Source: authors' research
Źródło: badania własne

transverse plane, asymmetric width of waist triangles in the coronal plane, and beta angle in the sagittal one (Table IV, Fig. 1).

A habitual posture of wrestling males in the coronal plane can be identified by: considerably lifted left shoulder and, slightly - right shoulder blade, closer location of the left shoulder blade to the line of spinous processes, substantial asymmetry in width of waist triangles, with the right one usually wider. Also a left-sided protrusion in the line of spinous processes, with a peak on the level of the tenth thoracic vertebra can be observed. In the transversal plane pelvic torsion is usually to the left, of an average angular size. In the sagittal plane, when compared with postures of judo competitors and volleyball players, wrestlers display increased angle of lumbar lordosis and smaller lateral inclination of lumbosacral part, smaller angle and length of thoracic kyphosis, length of the spine in the C7-S1 part, as well as length and depth of lumbar lordosis.

In the habitual posture of female wrestlers, in comparison with girls who do not do qualified sports, in the coronal plane appears a considerable symmetry of pelvis, shoulders and shoulder blades, which probably results in the left-sided scoliosis on the level of the ninth vertebra. In the transversal plane an increased pelvic torsion, usually left-sided, occurs. In the sagittal plane, the spine is much longer in the section C7-S1, decreased depth of thoracic kyphosis and lumbar lordosis. The most significant difference from the respective postural features of a person doing sport for recreational purpose develop in parameters of the coronal plane, excluding torso inclination. In the sagittal plane these are mainly features of thoracic kyphosis and lumbar lordosis, as well as the length of the spine. In comparison with male wrestlers, women showed weaker influence of training on partial angles

Cecha Feature	Judo M male judo	Zapasy M male wrestling	Zapasy K female wrestling	P.S. M male volleyball	P.N. M male football	Szerm. K female fencing	Szerm. M male fencing
KNT	*	***	**	***	*	***	*
KNT-	*	***	*		**	***	***
KPT	***	***	***			***	***
KPT-	***	***	***	***	***	***	***
KNM	***	***	***	***	***		*
KNM-	***	***	***	***	**	**	***
KSM-			***	***		***	***
KSM	***	***	***	***	***	***	***
UK	***	***	***	***	***	***	***
UK-	***	***	***	***	***	***	***
NK							
LŁB	***	***	***		***	*	***
PŁB	***	***	***	***		***	
LŁW	***	***	***	***	***	***	***
PŁW	***	***	**	***	***	***	***
LBW	***	***		*	***	***	***
PBW	***	***	**	***	***	***	***
LTTw	***	***	***	***			
PTTw	***	***	***	***	***	***	***
LTTs	***	***	***	***	***	***	***
PTTs				***	***	***	***
Alfa Alpha		***	*				
Beta			***				
Gamma	***	**		***		**	*
Delta	***	***		***			
KLL	*	***		***	***		*
DLL	***	***	***	***	***	***	***
RLL	***	***	***	***	***	***	***
GLL-	**	***	***	**	**	***	***
KKP	***	*	*	**			
DKP	***	***	***	***	***	***	***
RKP	***	***	***	***	***	***	***
GKP	*	***	***	*	**	***	***
DCK	***	***	***	***	***	***	***

Source: authors' research
Źródło: badania własne

Symbols
Difference of high importance (red, ***)
Difference of medium importance (green, **)
Difference of little importance (blue, *)
Difference of no importance (white)

Objaśnienia
Różnica wysoce istotna (kolor czerwony, ***)
Różnica średnio istotna (kolor zielony, **)
Różnica mało istotna (kolor niebieski, *)
Różnica nieistotna (kolor biały)

Fig. 1. *Graphic representation of importance of differences of habitual posture features between people doing sports recreational and competitive*

Ryc. 1. *Graficzna ilustracja istotności różnic cech habitualnej postawy ciała między osobnikami uprawiającymi i nie uprawiającymi sport kwalifikowany*

of physiological curvatures (alpha, gamma, delta) and the angle of lumbar lordosis (Table IV, Fig. 1).

The habitual posture of a football player in the coronal plane is characterised by: moderately lifted shoulder, iliac crest, and the right shoulder blade, closer position of the left shoulder blade to the line of spinous processes, sizeable asymmetry in height of waist triangles, with the left one usually higher than the right one. Also a left-sided protrusion in the line of spinous processes can be observed, most often to the left, on the level of third thoracic vertebra. In the transverse plane appears pelvic torsion to the left, of a small angle. In comparison with a volleyball player's posture in the sagittal plane, a football player displays much smaller angle of lumbar lordosis and torso extension. The most significant differences between a football player and a person doing sports on recreational level are displayed in parameters of the

coronal plane, excluding torso extension. In the sagittal plane these are mainly features of thoracic kyphosis and lumbar lordosis, as well as the length of the spine. Partial angles of physiological curvatures (alpha, beta, gamma and delta) remain unchanged by the training, as well as the angle of thoracic kyphosis, and left-sided pelvic torsion in the transversal plane. This influence is similar among the volleyball players. Their training does not seem to influence torso extension and lateral inclination to the left, location of the left shoulder blade against the line of spinous process, and angles of physiological curvatures alpha and beta (Table IV, Fig. 1).

Occurrence of values exceeding norms in description of female and male fencers against people doing sports recreationally is more often within linear parameters of lumbar lordosis and thoracic kyphosis, as well as vertical parameters of torso. On the other hand, there is similarity as far as the angle of both sagittal curvatures of the spine, in the coronal plane: asymmetry of the line of spinous processes and location of lower angles of shoulder blades against it, in the transversal plane: pelvic symmetry. Level and degree of the maximal deflection of the spinous process from the line C7-S1 is similar for both sexes. The most significant differences between females fencers and a person doing sports for recreational purpose are shown in the coronal plane, apart from the value of left-sided pelvic torsion and asymmetry in width of waist triangles. In the sagittal plane these are mainly features of thoracic kyphosis and lumbar lordosis, as well as the length of the spine. No influence of training, or a very limited one, on partial angles of physiological curvatures (alpha, beta and delta), angle of thoracic kyphosis and lumbar lordosis, was observed. Similar results of influence of physical effort within training are displayed by male fencers, which was to be expected. No influence on position of the right shoulder blade against the line of spinous processes, asymmetry of waist triangles, partial angles of physiological curvatures (alpha, beta, delta), and angle of thoracic kyphosis were observed (Table IV, Fig. 1).

What draws one's attention is a very long section of spine C7-S1 features of thoracic kyphosis and lumbar lordosis, quite disproportionate in comparison with other sportsmen and sportswomen. This probably results from the sports discipline trained. Such changes are not displayed by volleyball players, as it could be expected.

DISCUSSION

The issue of influence of competitive sports on sportsmen's posture was analysed by: Mrozkowiak [11-15], Mrozkowiak, Sokołowski, Kaiser [16-17], Bajorek et al. [18], Barczyk-Pawelec et al. [19], Furgiel et al. [20], Grabara [21-23]. Research of Drzał-Grabiec et al. [24] on a group of 50 children aged 7-10 years who had been training karate for two years showed in photogrammetric measurement of selected postural features increased thoracic kyphosis and lumbar lordosis. Research of Grabiec [25] on a group of 125 handball players aged 12-15 years revealed decreased values of partial angles (alpha, beta, gamma), and angle of lumbar lordosis against the control group. Measurement also pointed to correct position of pelvis in the coronal plane, as well as pelvis and shoulder blades in the sagittal plane. Research of Pietraszewska et al. [26] on a group of football players revealed that 29.3 per cent of them had vestigial left-sided scoliosis, as measured by Cobb's angle. Grabara's research [27] on the role of yoga in human's physical activity suggest propagating this system of exercises in all age groups, regardless of fitness level, for people doing recreational sports, as well as an addition to competitive sports. Thanks to its positive influence on spine ailments and attentiveness to correct body posture, some elements of yoga may also be an excellent complement of kinetic therapy, physical education, and physiotherapy exercises. Other research [28] on the group of 54 pupils of sports education class, athletics specialization, displayed asymmetry in the coronal plane (vestigial scoliosis, torso inclination, asymmetry of waist triangles). At the same time the author observes that shape of the spine in the sagittal plane was more often correct among athletes than the control group. Another spatial analysis of body posture with use of projection moiré in a group of 13-yearold handball players showed smaller inclination of thoracic section and bigger torso forward inclination, while in a group of 15-year-olds smaller inclination of lower part of the back, sum of partial angles (delta) and angle of lumbar lordosis, against the group of children not doing competitive sports, was observed. The author concludes: handball training may influence the quality of body posture [29]. Garbara's research [22] concerning influence of training of rhythmic gymnastics point out that when practiced at young age it may influence symmetry of body posture, shape of physiological curvatures of the spine, in particular

lumbar lordosis. It should be assumed that supplementary exercises, improving one's effort ability, health condition, action of specific systems, organs and the organism as a whole, are essential in forming body posture of diagnosed sportsmen [30]. Continuous increase of level and intensity of training imposes not only the need of detailed medical examination during recruitment, and regular medical control in order to secure optimal health condition of a competitor, but also evaluation of influence of discipline-oriented physical load on his/her organism.

CONCLUSIONS

In the light of examination results and analysis of the subject literature, the following conclusions may be presented:

1. Condition of people who do qualified sports may depend on knowledge, skills and responsiveness of a trainer. Diagnostics of body posture may be a crucial criterion in evaluating load applied in asymmetric sports, as it enables correction of training methods. It is advisable to provide competitors with versatile training and improve balance between specific groups of muscles, especially in asymmetric disciplines.

2. Regular medical examination should become the basis in selecting new entrants in sports clubs.

3. Body posture disorders of adult competitors may result from absence of holistic training and inaccuracy in the initial stage of training, incorrect warm-up, and lack of exercises shaping the habit of correct body posture.

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Received: 20.07.2016
Accepted for publication: 12.08.2016