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Habitual posture of fencers representing the Wielkopolska region

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Abstract

Background & Study Aim: It is well known that long-term sports training has the influence on body posture (long-term effects on the body-specific exercise). The issue is discussed on the example of competitive fencing. The aims of the paper was knowledge about habitual posture of fencers, type and degree of influence of fencing training on fencers' body posture and also frequency of excessive values in spatial indicators describing fencers' posture.

Material & Methods: The research was carried out in July 2013 among 23 fencers (mean age: 15 ±1.20 years; body height: 168.4 ±4.68 cm; body weight: 54.7 ± 8.26 kg). We measured 29 indicators in coronal, median and axial plane of pelvis and physiological spine curvatures. Selected indicators of the pelvis and spine were evaluated with use of a computer-based postural analysis. The most important in this method was that all measurements of spatial indicators were carried out simultaneously.

Results: In the plane median the competitive fencers reveal increase in length, height and angle of thoracic kyphosis, lumbar lordosis and trunk extension, maintaining at the same time optimal angle values of lumbar lordosis and thoracic kyphosis. In the plane coronal occur: increased shoulder asymmetry, distance from the line of spinous processes, and pelvis asymmetry also in axial plane.

Conclusions: Taking into consideration continuous increase in advancement and intensity of training, there appears a strong necessity for carrying professional diagnosis of health and body posture during periodic health examinations admitting to competitive sports. Developmental exercises and those improving aerobic capability are essential during the competitive fencing.

Key words: combat sport · kyphosis · pelvis · spine

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Habitual posture – determined by the tension of tonic and phasic muscles maintaining the body in an upright position, with limbs hanging loosely in an optimal, individual position, keeping a static and dynamic balance.

Spine – an adult's body is on average 70-75 cm long, which constitutes 40-45% of body height, and it consists of c. 33 vertebrae with alternating physiological sagittal curvatures. The spine provides support for the body sections located above the base of the sacrum.

Kyphosis – sagittal physiological front-to-back curve of thoracic spine.

Lordosis – sagittal physiological back-to-front curve of lumbar spine.

Projection moiré – a term derived from the name of a French fabric called "moiré", on which one can observe the appearance of light and dark fringe patterns. This is the result of an interference of two geometrical systems of linear structures (gratings-rasters). Interference effect is shown in the formation of a new system of lines (straight-line gratings) – moiré patterns. Moiré line gratings similarly to contour lines on the map describe the actual shape of an object.

Health is defined in the Constitution of the World Health Organization of 1948 as a state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity.

INTRODUCTION

Body posture is a crucial medical issue for three reasons: health diagnostics, prophylaxis of spinal overload and clinical pathology [1-3]. Examination of physiological factors and their influence on body posture showed that one of the most important relations is that between disorders and aerobic capability of an organism. Another significant and inversely proportional relation was revealed between test rates of muscle-heart correlation and body posture disorder, which points to weakening of integrating relations in organism [4]. The author of these analyses claims that along with development of an organism there occurs a physiological mechanism, counteracting posture disorder, and its significant agents are: components of life capability (i.e. objective health attitude), organism's energy potential and its functional integration, in particular proprioceptive control of spine and trunk movements. Development of posture disorders, not related to neurological or genetic predisposition, results from gradual 'capitulation' of factors counteracting disorders, in accordance with a mechanism of forming a long-lasting, functional-structural "trail" as an adaptation to asymmetric movement.

Combat sports are particularly intensely influencing body posture. Resulting from it differences in values describing spine and pelvis are determined by intensity and capacity of an effective stimulus. Sports disciplines in which asymmetric movement is performed continually and in unchanged training position, e.g. sprint canoeing or fencing, have a negative influence on shaping of some spine curvatures. Throwing in athletics are performed in relatively advantageous conditions for the spine, with intervals between throws, allowing for partial regeneration of locomotor system [5]. The evaluation of body posture and efficiency of its control system among sportsmen were discussed by many authors [6-16]. However, results of empirical research analysing the influence of competitive sports training on the shape of spine with reference to various sports disciplines are not unambiguous. Therefore, the following questions should be posed whether increased intensity and workload do not influence negatively sportsmen health, particularly those young, developing organisms. Or whether there is enough time for developmental and compensation exercises during training that will provide balance in physical development of a competitor and remove negative effects of asymmetric training.

In consequence, the issue of a sport influence on a spine shape requires further investigation. In this paper this issue was analysed on the example of competitive fencers.

The aims of the paper was knowledge about habitual posture of fencers, type and degree of influence of fencing training on fencers' body posture and also frequency of excessive values in spatial indicators describing fencers' posture.

MATERIAL AND METHODS

Participants

The research was carried out in July 2013 in the Sports and Recreation Centre in Drzonków (Poland), during a training meeting preparing for a competition season. It involved 23 fencers, aged 11-19 years (12 girls and 11 boys). The average body weight was 54.7 kg, height 168.4cm, and training expiries 5.5 years (Table 1).

Bioethical Committee at Poznan University of Medical Sciences in Poland granted permission to use their research findings within the project entitled "Characteristics of habitual posture in people of varied physical activity (sportspeople, children, teenagers, adults)" – Resolution No. 525/11. In the case of underage fencers written parental agreement was necessary for them to participate in the research.

Procedure

According the aims of the paper we did following empirical tasks: diagnosed habitual posture of fencers; determined type and degree of influence that fencing training has on fencers' body posture; analysed frequency of excessive values in spatial indicators describing fencers' posture against individuals not involved in combat sports.

In attempt to achieve the research aim, it was necessary to describe the competitors' postures minutely. It was assumed that habitual posture, which was evaluated, was a relatively permanent individual feature. The most important in this method was that all measurements of spatial indicators were carried out simultaneously. This attitude reflects individual's emotional, mental, social and welfare condition.

The method involved measuring selected indicators in coronal, median and axial plane of pelvis and physiological spine curvatures (Table 2).

In their evaluation a computer-based postural analysis device was used. It consists of a computer with

Table 1. The characteristic of examined young fencers (n = 23)

Cod number	Initials	Birth	Weight (kg)	Height (cm)	Training duration (years)
1	M.J.	1999	39	159	4
2	K.D.	1995	67	186	7
3	R. R.	1997	64	178	5
4	G.M.	1996	56	170	8
5	G.A.	1995	59	170	6
6	K.K.	1995	74	176	7
7	O.O.	1997	60	179	4
8	M.A.	1996	51	156	6
9	V.M.	1996	53	166	7
10	M.K.	1998	48	163	4
11	P.D.	1998	49	163	5
12	W.W.	2000	55	159	3
13	B.Z.	1998	49	158	5
14	G.W.	1998	43	158	6
15	W.Z.	1995	57	169	6
16	M.Z.	1993	54	167	10
17	P.R.	1994	61	176	8
18	S.A.	1996	54	164	6
19	L.K.	1996	66	184	5
20	P.M.	1999	53	167	4
21	K.F.	1998	53	167	5
22	S.J.	1998	40	159	5
23	K.A.	1999	54	180	4
Mean values (± SD)		15 ±1.20	54.7 ±8.26	168.4 ±4.68	5.5 ±1.41

specialist software and a camera to measure selected indicators of pelvis-spine system. Thanks to projecting lines on a patient's back, spatial visualisation is presented. Those lines, while projected on the patient's back, deform depending on the surface. The picture is then sent to the computer. Deformities of lines recorded by the computer are transformed by a numerical algorithm [17].

The results, in form of a spatial graphic picture, enable to describe analysed features numerically. The line values reflect the distance of selected anthropometric points on the patient's back, while the angle values describe the deviation in setting in relation to the horizontal or distance from the camera. Received picture allows for a multi-faceted interpretation of body posture.

Apart from assessment of trunk asymmetry in the plane coronal, there is a possibility of determining spatial values of angle and line indicators describing pelvis, physiological curvatures and coronal asymmetry of spinous processes, i.e. the deviation of the topmost spinous process from C7-S1 line. A short time of recording helps to avoid fatigue of postural muscles, which is often while examinations performed

Table 2. Recorded indicators of the pelvis-spine system

No.	Symbol	Unit	Indicators	
			Name	Description
			Plane median	
1	Alpha	degrees	Lumbar-sacral curvature	
2	Beta	degrees	Thoracic-lumbar curvature	
3	Gamma	degrees	Upper thoracic curvature	
4	Delta	degrees	Total value of angles	Delta = Alpha+Beta+Gamma
5	DCK	mm	Total length of spine	Distance between C7 and S1 measured vertically
6	KPT	degrees	Angle of trunk extension	Described in deviation of C7-S1line from the vertical (backwards)
7	KPT -	degrees	Angle of trunk lean	Described in deviation C7-S1 line from the vertical (forward)
8	DKP	mm	Length of thoracic kyphosis	Distance between LL and C7
9	KKP	degrees	Angle of thoracic kyphosis	KKP = 180 – (Beta+Gamma)
10	RKP	mm	Height of thoracic kyphosis	Distance between C7 and PL
11	GKP	mm	Depth of thoracic kyphosis	Distance measured horizontally between vertical lines crossing PL and KP
12	DLL	mm	Length of lumbar lordosis	Distance between S1 and KP
13	KLL	degrees	Angle of lumbar lordosis	KLL = 180 – (Alpha + Beta)
14	RLL	mm	Height of lumbar lordosis	Distance between S1 and PL
15	GLL -	mm	Depth of lumbar lordosis	Distance measured horizontally between vertical lines crossing PL and LL
			Plane coronal	
16	KNT -	degrees	Angle of trunk tilt sideways	Determined by deviation of C7-S1 line from the vertical to the left.
17	KNT	degrees		Determined by deviation C7-S1 from the vertical to the right
18	LBW -	Mm	Right shoulder higher	Distance measured vertically between horizontal lines crossing B2 and B4
19	LBW	Mm	Left shoulder higher	
20	LŁW	Mm	Left scapula higher	Distance measured vertically between horizontal lines crossing Ł1and Łp
21	LŁW -	Mm	Right scapula higher	
22	OL	Mm	Interior angle of the left scapula is further	Difference in distance of the interior angles of the scapulae from the line of spinous processes, measured horizontally on lines crossing Łl and Łp
23	OL -	Mm	Interior angle of the right scapula is further	
24	KNM	degrees	Angle of pelvic tilt, the right ala higher	Angle between the horizontal line and a line crossing M1 and Mp
25	KNM -	degrees	Angle of pelvic tilt, the left ala higher	
26	UK (dex)	Mm	Maximal deviation of a spinous process to the right	The highest deviation of a spinous process from the horizontal led from S1. The distance measured along horizontal axis.
27	UK- (sin)	Mm	Maximal deviation of a spinous process to the left.	
			Plane axial	
28	KSM	degrees	Right pelvic tilt	Angle between the line crossing Ml, perpendicular to camera axis and the line crossing Ml and MP
29	KSM -	degrees	Left pelvic tilt	Angle between the line crossing Mp, perpendicular to camera axis and the line crossing Ml and MP

Table 3. Numerical characteristics of indicators

No.	Feature symbol	Girls				Boys			
		Min	Max	M	SD	Min	Max	M	SD
1	Alfa	3.0	16.0	10.33	3.47	3.0	14	5.81	4.46
2	Bata	8.0	15.0	10.66	2.34	7.0	16.0	11.0	2.4
3	Gamma	4.0	14.0	8.58	2.96	4.0	17.0	10.36	3.32
4	Delta	19.0	45.0	29.58	6.89	20.0	42.0	27.45	5.83
5	DCK	530	648	593.33	37.98	519.0	654.0	600	41.78
6	KPT	15.0	20.0	17.5	1.62	9.0	22.0	16.45	3.69
7	KPT-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	DKP	439.0	579.0	504.0	42.41	449.0	569.0	518.63	38.02
9	KKP	151.0	167.0	160.75	4.55	152.0	164.0	158.54	3.53
10	RKP	277.0	388.0	330.0	38.22	311.0	390.0	343.36	24.67
11	GKP	19.0	49.0	27.16	8.09	25.0	49.0	36.27	7.19
12	DLL	373.0	497.0	437.33	35.62	345.0	478.0	431.18	37.33
13	KLL	149.0	168.0	159.0	4.82	154.0	169.0	162.63	4.24
14	RLL	220.0	308.0	263.25	25.6	208.0	287.0	256.81	21.99
15	GLL-	21.0	57.0	39.91	11.67	22.0	70.0	38.09	15.72
16	KNT-	0.0	1.0	0.25	0.45	0.0	1.0	0.27	0.46
17	KNT	0.0	1.0	0.33	0.49	0.0	0.0	0.0	0.0
18	LBW-	0.0	13.7	2.7	5.13	0.0	5.1	0.77	1.76
19	LBW	0.0	23.9	7.67	7.08	0.0	30.8	9.94	9.36
20	LŁW	0.0	23.9	8.25	7.94	0.0	34.2	9.79	9.88
21	LŁW-	0.0	8.5	0.99	2.55	0.0	12.0	1.86	3.78
22	OL	0.0	11.1	1.85	3.7	0.0	1.2	0.1	0.36
23	OL-	0.0	13.6	5.13	4.93	0.0	18.5	6.94	7.12
24	KNM	0.0	11.0	1.75	3.27	0.0	7.0	2.18	2.44
25	KNM-	0.0	12.0	3.33	3.93	0.0	7.0	1.18	2.27
26	UK- (sin)	0.0	8.0	3.0	2.44	0.0	7.0	3.54	3.17
27	UK (dex)	0.0	6.0	1.16	2.2	0.0	7.0	1.63	3.17
28	KSM	0.0	12.0	2.16	3.83	0.0	14.0	3.0	4.21
29	KSM-	0.0	8.0	1.25	2.41	0.0	4.0	0.9	1.44

with use of somatoscopy. The most important in this method was that all measurements of spatial indicators were carried out simultaneously.

Statistical analysis

The results were compiled with use of the basic statistical methods, describing: the minimal value, the maximal value, the mean and median, standard deviation, coefficient of variation, skewness and kurtosis. In order to display the influence of competitive fencing of body posture, the results were compared with those of a similar group of girls and boys not involved in combat sports.

Table 4. Comparison of postural indicators in the plane median of boys and girls not performing competitive sports (1) and the group of male and female fencers (2) in respective age groups

Compared groups	Symbol, indicator, range of norms and size of age category														
	Alpha	Beta	Gamma	Delta	DCK	KPT	KPT-	DKP	KKP	RKP	GKP	DLL	KLL	RLL	GLL-
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12 yers															
1G	2.53-16.83	3.54-17.83	6.35-13.83	12.53-48.49	296.0-365.3	3.0-3.0		239.17-317.56	152.06-167.63	159.52-221.63	8.8-26.8	204.63-273.18	151.65-171.54	116.73-162.54	8.2-26.4
2G	10	14	9	33	564	17	0	478	157	335	34	373	156	229	38
13 years															
1B	0.0-23.12	6.01-12.72	8.01-14.37	14.02-52.69	305.5-371.8	3.0-3.0		237.28-330.07	154.96-164.06	173.86-231.84	10.1-25.8	213.07-270.32	156.16-170.35	115.43-157.04	7.5-21.6
2B	11	10	7	28	554	17	0	489	163	316	34	410	158	238	29
2B	8	12	11	31	612	18	0	537	156	366	39	431	160	261	47
2B	14	12	17	42	574	22	0	465	152	314	49	408	154	260	35
14 years															
1G	5.12-15.92	6.12-11.95	9.43-17.62	20.67-45.49	334.6-361.9	3.0-3.0		273.82-332.61	153.41-162.63	191.51-242.71	10.3-23.8	221.62-279.91	156.07-167.18	121.19-167.82	7.1-20.6
2G	3	9	7	19	600	16	0	552	164	359	25	432	168	241	37
2G	10	12	4	26	572	15	0	475	164	296	27	456	158	277	51
2G	12	12	12	36	530	17	0	453	156	285	28	412	156	244	43
2G	7	8	8	23	571	19	0	514	164	350	26	383	165	220	24
1B	4.92-14.61	5.28-11.92	9.51-15.72	19.92-42.25	324.6-380.2	3.0-3.0		256.65-336.13	153.72-164.12	191.17-237.82	8.6-24.2	210.62-278.61	155.62-171.07	114.85-166.12	6.1-21.0
2B	5	11	9	25	600	16	0	513	159	337	29	439	164	263	41
2B	7	12	12	30	519	18	0	449	156	311	36	345	161	208	26

RESULTS

The basic values describing spine and pelvis features are presented in Table 3. Postures of female (K) and male (M) competitive fencers is described by the following average values: lumbar-sacral tilt (Alpha) K:10.33 and M:5.81 degree, thoracic-lumbar tilt (Beta) K:10.66 and M:11.0 degree, upper thoracic tilt (Gamma) K:8.58 and M:10.36 degree, total sum of angle values (Delta) K: 29.58 and M:27.45 degree, degree of trunk extension (KPT) K: 17.5 and M:16.45 degree, angle of trunk tilt (KPT-) non applicable, length of thoracic kyphosis (DKP) K:504.0 and M:518.63 mm, angle of thoracic kyphosis (KKP) K:160.75 and M:158.54 degree, height of thoracic kyphosis (RKP) K:330.0 and M:343.36 mm, depth of thoracic kyphosis (GKP) K:27.16 and M:36.27 mm, length of lumbar lordosis (DLL) K:437.33 and M:331.18 mm, angle of lumbar lordosis (KLL) K:159.0 and M:162.63 degree, height of lumbar lordosis (RLL) K:263.25 and M:256.81 mm, depth of lumbar lordosis (GLL-) K: 39.91 and M:38.09 mm, angle of trunk tilt to the left (KNT-) K:0.25 and M:0.27 degree, to the right (KNT) K:0.33 and M:0.0 degree, shoulder asymmetry – wen the right one is higher (LBW-) K:2.7 and M:0.77 mm, when the left one is higher (LBW-) K:7.67 and M:9.94 mm, scapula asymmetry – when the left lower interior angle is higher (LŁW) K: 8.25 and M:9.79 mm, when the right one is higher (LŁW-) K:0,99 and M:1,86 mm, asymmetry in distance of lower interior angles from the spinous processes line – when the right one is further (OL-) K:5,13 and M:6.94 mm, when the left one is further (OL) K:1.85 and M:0,1 mm, pelvic asymmetry in the plane coronal – left pelvic tilt (KNM) K:1.75 and M:2.18 degree, right pelvic tilt (KNM-) K:3.33 and M:1.18 degree, deviation of the spinous process from the vertical – to the right (UK) K:1.16 and M:1.63 mm, to the left (UK-) K: 3.0 and M:3,54

Table 5. Comparison of postural indicators in the plane median of boys and girls not performing competitive sports (1) and the group of male and female fencers (2) in respective age groups

Compared groups	Symbol, indicator, range of norms and size of age category														
	Alpha	Beta	Gamma	Delta	DCK	KPT	KPT-	DKP	KKP	RKP	GKP	DLL	KLL	RLL	GLL -
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15 years															
1B	4.32-13.27	6.21-13.17	8.63-15.31	16.82-41.75	314.5-388.4	3.0-3.0		256.82-345.03	153.18-164.35	180.45-246.23	6.5-26.9	209.74-295.54	157.36-173.65	112.93-171-91	4.7-23.6
2B	3	13	11	27	620	14		552	156	355	32	461	164	265	62
2B	6	10	13	28	610	20		509	157	352	45	415	165	258	29
16 years															
1G	4.9-12.5	5.3-13.1	7.2-12.6	20.3-34.1	313.5-375.5	3.0-3.0		252.0-327.4	155.59-166.22	176.5-232.9	9.2-24.6	217.1-270.1	156.4-167.8	119.9-159.9	6.6-23.8
2B	15	9	9	33	549	20	0	439	162	277	21	432	156	272	30
2B	13	8	9	30	596	19	0	480	163	289	19	497	159	308	33
2B	9	11	8	29	605	16	0	514	161	332	20	456	159	273	57
2B	10	11	6	27	639	17	0	542	163	362	24	456	160	277	46
1B	4.1-10.3	5.1-11.7	8.1-14.3	17.3-36.3	322-402.4	3.0-3.0		270.9-348.9	155.0-165.0	189.2-255.2	9.8-23.6	220.5-279.9	159.0-169.4	119.9-161.5	8.8-21
2B	6	9	10	25	567	16	0	531	161	330	30	437	165	238	34

mm, pelvic asymmetry in the plane axial – to the right (KSM) K:2.16 and M:3.0 degree, to the left (KSM-) K:1.25 and M:0.9 degree.

Received values of the fencers' body postures were divided into three categories in accordance with norms calculated for children and youth who do not do combat sports [20]. Features describing the spine in the plane median and axial: I – too low value of a feature, II – optimal, III – too high. Features describing trunk in the plane coronal: AS I – small asymmetry, up to 1.5° or 5 mm, AS II – medium, from 1.5° to 3° or from 5to10 mm, AS II – big, above 3°or 10 mm (Tables 4-9).

As can be seen in the percentage of normal and excessive features describing the spine in the plane median, features such as: length, height and depth of thoracic kyphosis and lumbar lordosis, as well as trunk extension angle, are increased in comparison with the group not involved in any competitive sports. However, optimal angle of thoracic kyphosis and lumbar lordosis tend to appear with similar frequency. In the plane coronal, all the examined features display lower frequency of occurrence.

Detailed analysis of excessive values of "median" spinal features in group of boys shows that optimal curve of lumbar-sacral and thoracic-lumbar parts, and increased: length, height and depth of thoracic kyphosis and lumbar lordosis, occur most often at the age of 13. At the age of 17 the angle of lumbar-sacral tilt is flattened, while height of thoracic kyphosis and lumbar lordosis – increased. In the plane coronal excessive trunk extension and shoulder asymmetry (the right one is higher) occur most often. In the group of female fencers, aged 12, 17, 18 and 19 years, all "median" and "coronal" features occur with a frequency similar to that of the group of non-sportsmen. At the age of 14, the angle of lumbar lordosis is optimal, while length, height and depth of thoracic kyphosis and lumbar lordosis, as well as trunk extension, are increased. At the age of 16 thoracic-lumbar and upper thoracic curves, depth and angle of thoracic kyphosis, and angle of lumbar lordosis are in their optimal values, while trunk extension is increased. Length and height of thoracic kyphosis, as well as length, height and depth of lumbar lordosis are most often increased. At the age of 14, in the plane coronal there most often occurs a small asymmetry in line of the spinous processes to the left, while at the age of 16 – shoulder asymmetry (the right one is higher).

Table 6. Comparison of postural indicators in the plane median of boys and girls not performing competitive sports (1) and the group of male and female fencers (2) in respective age groups

Compared groups	Symbol, parameter, range of norms and size of age category														
	Alpha	Beta	Gamma	Delta	DCK	KPT	KPT -	DKP	KKP	RKP	GKP	DLL	KLL	RLL	GLL -
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
17 years															
1G	4.7-10.1	6.0-12.4	7.1-11.7	21.0-34.4	309.1-350.7	3.0-3.0		254.7-307.1	156.4-166.71	170.9-212.7	11.6-24.0	229.1-262.7	159.4-168.6	124.6-153.0	8.6-20.6
2G	10	8	5	23	646	20	0	538	167	378	23	427	162	268	21
1B	4.9-12.5	7.1-12.3	8.9-14.3	20.9-39.1	339.3-380.5	3.0-3.0		284.4-340.4	154.3-163.5	202.5-242.1	14.3-24.9	230.3-273.3	159.2-168.6	122.7-163.5	10.6-22.4
2 B	4	9	11	24	654	9	0	569	160	390	41	444	167	265	24
2 B	2	16	4	22	643	12	0	554	160	361	39	475	162	282	70
2 B	4	7	9	20	632	19	0	537	164	345	25	478	169	287	22

Table 7. Comparison of postural indicators in the plane median of boys and girls not performing competitive sports (1) and the group of male and female fencers (2) in respective age groups

Compared groups	Symbol, parameter, range of norms and size of age category														
	Alpha	Beta	Gamma	Delta	DCK	KPT	KPT-	DKP	KKP	RKP	GKP	DLL	KLL	RLL	GLL-
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18 years															
G	5.2-13.4	7.7-12.5	7.6-11.6	22.6-34.2	329.5-405.5	3.0-3.0		275.5-345.9	156.11-164.1	190.0-238.2	14.6-27.4	239.6-304.2	155.5-165.3	129.7-179.7	11.6-24.6
2G	16	15	14	45	648	17	0	579	151	388	49	451	149	260	56
19 years															
G	3.8 – 10.9	5.9 – 12.1	9.7 – 15.7	23.6-39.0	351.4-414.2	3.0-3.0		271.3-351.8	156.3-159.4	191.8-256.9	11.5-24.1	240.5-268.8	160.3-167.1	130.1-160.1	7.8 - 22.1
2G	9	11	12	32	600	17	0	492	157	309	30	473	160	290	43

DISCUSSION

The research revealed that in the group of fencers, in the plane median, increased length, height and depth of thoracic kyphosis and lumbar lordosis, as well as trunk extension occur most often. At the same time optimal angles of lumbar lordosis and thoracic lordosis are maintained. In the plane coronal, increased asymmetry of shoulders, line of spinous processes, scapulae, as well as pelvic asymmetry in the plane axial can be observed.

Analysing these results, and comparing them to research of other scientists, It can be claimed that habitual posture of the examined group of fencers does not correspond with posture of swimmers, handball players, male fencers, female wrestlers or hockey players. It does, however, have certain common features with female wrestlers. Both groups display in the plane median: increased length of the spine, from C1 to S1, trunk extension; and in the plane coronal: significant pelvic, shoulder and scapulae asymmetry [15].

Iwanowski [18] diagnosed larger kyphosis angles in female and male swimmers than in non-competitive swimmers at the same age. Research carried out among the national team of handball and hockey players revealed significant pine curvatures, in particular thoracic kyphosis, and low placement of the top of thoracic kyphosis and lumbar lordosis. Male fencers were also characterised by large curvatures, especially lumbar-sacral one; hockey players displayed

Table 8. Comparison of postural indicators in the plane coronal and axial of boys and girls not performing competitive sports (1) and the group of male and female fencers (2) in respective age groups

Compared groups	Symbol, indicator, range of norms													
	KNT-	KNT	LBW-	LBW	LŁW-	LŁW	OL-	OL	KNM-	KNM	UK-	UK	KSM-	KSM
	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1G and B	from -5 to 5			from -3 to 3			from -6 to 6		from -3 to 3		from -5 to 5		from -3 to 3	
	12 years													
2G	0	0	12	0	8.5	0	0	4.9	0	1	2	0	1	0
	13 years													
2B	0	0	5.1	0	0	5.1	0	4.9	0	7	0	3	0	3
2B	0	0	0	10.3		0	0	3.7	1	0	7	0	0	2
2B	0	0	0	6.8	0	8.5	0	1.2	0	5	0	7	0	14
	14 years													
2G	0	1	0	23.9	0	23.9	0	11.1	12	0	8	0	0	4
2G	0	0	0	5.1	0	6.1	0	1.2	3	0	3	0	0	0
2G	1	0	13.7	0	0	1.7	0	6.2	3	0	6	0	0	12
2G	0	0	0	15.4	0	22.2	0	11.1	5	0	4	0	8	0
2B	0	0	0	6.8	0	10.3	0	1.2	4	0	3	0	2	0
2B	0	0	3.4	0	0	13.7	0	11.1	0	2	6	0	1	0

large values of physiological curvatures and high placement of the top of thoracic kyphosis and lumbar lordosis[19]. There has been, however, observed certain similarity between the habitual posture of the examined fencers and that of footballers and volleyball players. Research by Zeland-Malawka [20] showed that football and volleyball players have their trunks slightly deviated backwards. What is more, volleyball players also have long lumbar lordosis. Mrozkowiak [21] also noticed increased length of thoracic kyphosis and lumbar lordosis.

A significant element of fencing training are excessive values of thoracic and lumbar parameters, their height, length and depth, which may result in disorders of intervertebral discs, lateral recess or spinal stenosis [22-24]. First pains in lumbar-sacral area, repeating and maintain after workout effort, should be the reason for a thorough diagnostics, changes in training and prophylaxis limiting spinal overload during training. Exercises that contribute to spinal overload should be performed after a proper warm up, alternating with those that lessen overload in lumbar area (anti-gravity exercises). Beginners whose postural muscles are not strong enough, as well as women exercising during menstruation, should be particularly careful while performing exercises causing lumbar area overload.

Taking into consideration continuous increase in advancement and intensity of training, there appears a strong necessity for carrying professional diagnosis of health and body posture during periodic health examinations admitting to competitive sports. Such examination should secure optimal health condition of training youth and estimate the influence of physical load in a developing organism. Developmental exercises and those improving aerobic capability, general efficiency and health condition are essential in forming body postures of competitors in every kind of sport. Unilateral specialization of a developing organism may lead to postural disorders or worsen already existing ones. It should be highlighted that disadvantageous influence of specific training on young women's spines may in the future result in medical problems in their pregnancy, when the spinal is additionally loaded, and skeletal configuration of spine and pelvis changes under the influence of hormones. It is thus advisable to introduce also exercises that prevent spinal overload.

Table 9. Comparison of postural indicators in the plane coronal and axial of boys and girls not performing competitive sports (1) and the group of male and female fencers (2) in respective age groups

Compared groups	Symbol, indicator, range of norms													
	KNT-	KNT	LBW-	LBW	LŁW-	LŁW	OL-	OL	KNM-	KNM	UK-	UK	KSM-	KSM
	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1G and B	from 5 to 5			from 3 to 3			from 6 to 6		from 3 to 3		from 5 to 5		from 3 to 3	
	15 years													
2B	1	0	0	12	0	8.5	0	1.2	0	4	0	5	3	0
2B	0	0	0	30.8	0	34.2	0	18.5	0	7	0	0	0	7
	16 years													
2B	0	0	0	17.12	0	17.1	0	17.3	0	1	7	0	4	0
2G		1	0	6.8	0	12	11.1			4		6		3
2G	1	0	0	5.1	0	5.1	0	1.2	0	11	8	0	1	0
2G	0	0	0	8.5	0	10.3		3.7	2	0	0	4	0	7
2G	0	0	0	6.8	0	0	7.4	0	1	0	2	0	1	0
	17 years													
2G	0	1	0	13.7	0	8.5	0	13.6	7	0	2	0	4	0
2B	1	0	0	18.8	0	10.3	0	3.7	0	1	4	0	0	1
2B	1	0	0	1.7	3.4	0	0	0	1	0	0	6	0	3
2B	0	0	0	5.1	12	0	0	14.8	0	4	6	0	0	3
	18 years													
2G	0	1	0	6.8	0	1.7	0	8.6	4	0	5	0	0	0
	19 years													
2G	0	1	6.8	0	6.8	0	3.7	0	8	0	0	3	0	0

CONCLUSIONS

Typical habitual posture of a fencer is characterised by: increased height, length, and depth of thoracic kyphosis and lumbar lordosis, as well as trunk extension in the plane median; in the plane coronal: small asymmetry of pelvis, shoulders, scapulae and line of spinous processes; in the plane axial: right pelvic tilt.

Specific fencing training influences physiological curvatures of spine, increasing their depth, length and height. It also significantly influences vertical position of the trunk, and asymmetries in the planes coronal and axial.

Frequency of occurrence of excessive values in the examined indicators of spatial postural description of male and female fencers is much higher within line indicators of lumbar lordosis, thoracic kyphosis and trunk verticality, when compared with the group of non-sportsmen. However, a similar frequency occurs within angle of both curvatures in the plane median, also in the plane coronal: asymmetry of spinous processes and placement of the interior angles of scapulae against it; and in the plane axial: pelvic symmetry.

It is advised to aim at versatile training of fencing competitors, shaping functional balance of particular muscle groups, and performing specialist diagnostics of health condition and body posture during periodic health examinations admitting to competitive sports.

COMPETING INTERESTS

Authors declare no conflicts of interest.

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