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Photogrammetric evaluation of body posture of 6-year-old boys training judo, in three repeated assessments

ROBERT WALASZEK[1]*, WIESŁAW CHWAŁA[2], KATARZYNA STERKOWICZ-PRZYBYCIEŃ[3], KATARZYNA BURDACKA[4], MARCIN BURDACKI[5], PAWEŁ KUROWSKI[6]

[1] Section of Biological Regeneration of the University of Physical Education, Kraków, Poland.
[2] Section of Biomechanics of the University of Physical Education, Kraków, Poland.
[3]Department of Gymnastics and Dance, Institute of Sport Sciences, University of Physical Education, Kraków, Poland.
[4] Department of Recreation Methodics of the University of Physical Education, Kraków, Poland.
[5] Institute of Physiotherapy of the Faculty of Health Sciences of the Jagiellonian University, Kraków, Poland.
[6] University of Physical Education, Kraków, Poland.

Purpose: The purpose of this work was to assess changes in body posture in a group of 6-year-old boys training judo, compared to a control group, in three repeated examinations. *Methods*: The study included 88 boys aged 6. Fifty-one of them started judo training in sports clubs at the beginning of the school year (JU). The control group included 37 boys attending reception classes in primary schools, selected at random (NT). Body posture was assessed 3 times at 3-month intervals, according to the general methodology of the Moire's technique, and 15 body posture indices were obtained as a result: 7 in the sagittal plane, 1 in the axial plane and 7 in the coronal plane. The system for photogrammetric body posture assessment of CQ Elektronik System was used in this study. *Results*: The ANOVA test showed that neither the group factor – the fact of judo training – nor the time factor had any significant effect on the number of "deviations from normal values" of body posture ($p > 0.05$). Statistically significant intergroup differences were noted for six body posture indices measured with the Moire's method. *Conclusions*: Steadily decreasing numbers of "deviations from normal values" of body posture indices in the JU group were observed over the three examinations. Regular 6-month judo training had a statistically significant effect on a decrease of body rotation in the axial plane – the effect of judo training may be considered corrective in this case.

Key words: *body posture, photogrammetry, physical activity, judo*

1. Introduction

A review of studies on the incidence of body posture disturbances demonstrated that they were quite often observed in children aged 6–7 [12], [13]. This age range is associated with boys' progressive development when they are particularly susceptible to a body posture defect development due to a rapid skeleton growth – the so called "school growth spurt" [11]. Starting school brings changes to a child's lifestyle. It often means prolonged sitting at the school desk and carrying a heavy backpack as well as using mobile phones and tablets of which use frequently causes an incorrect body position, overweight or obesity. An inadequate dose of physical activity during the day may lead to progression and preservation of the observed abnormalities at a later school age [5], [3], [14].

The early school times not only favour learning of new movements and development of coordination skills, but they also bring an improvement of the results of sport-type activities, such as running, jumping or throws. An organised physical activity may be very beneficial for children at this age, and appropriate training will influence their correct physical development and health, including their body posture [17].

* Corresponding author: Prof. Robert Walaszek, al. Jana Pawła II 78, 31-571 Kraków, Poland. Phone: (+48) 605 821 830, e-mail: robertwalaszek63@gmail.com

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According to the guidelines of the World Health Organisation, the appropriate duration of daily physical activity for children and adolescents aged 5–17 is 60 minutes, at the minimum [27]. Recommended for children are those sports which help form a correct body posture and those which contribute to a harmonious development of many motor skills. With no doubt, judo is one of them, and its practising may not only have a preventive effect but can also correct pre-existing posture defects [26].

Previous research studies suggest a positive effect of practising martial sports and arts, including judo, on general fitness and on the development of coordination, motor skills and psychosocial abilities [9], [20]. Parents of the children attending judo classes note that positive education-induced changes occur in the development of their child's physical fitness. They also notice that the children acquire new skills, undertake physical exercise during their free time, often supporting their more vulnerable peers. They also see an educational value of the training that promotes courage, respect, discipline, responsibility and regularity in any undertaken activities [21]. According to the judo trainers, 45 minutes 2–3 times per week is the optimal duration of classes for children aged 4–6 [16]. The training includes comprehensive exercises, based on natural movements, such as (among others) running, climbing, crawling, creeping, rolling, overhangs, supports or jumps, in the form of games or tasks. Agility and acrobatic exercises, as well as flexibility exercises are used. Additionally, elements typical for judo are introduced, such as rolling in the lying position, kneeling exercises, drops, flips, deflection from balance, basic grips, introductions to throws, throws and holds as well as technical and tactic elements. The training is completed with basic elements of moderate resistance from the students. At this stage of the training, there are no fights or sparring matches that might have a negative effect on the delicate skeletal system where formation processes are still ongoing. It is exercises directed at comprehensive development of all motor skills that predominate in the training programme for pre-school and early-school children [4], [7], [16].

There are not many reports in the global literature concerning the effect of additional physical activity in the form of judo training on such an important health aspect as body posture of 6-year-old boys at their fast growing stage. Thus, it was assumed that regular judo training would cause positive changes to body posture of the examined boys.

The purpose of this work was to assess changes in body posture of 6-year-old boys training judo (JU) versus a control group (NT) in three repeated examinations by using the Moire's photogrammetric method.

The following research questions were formulated:

1. Are there any statistically significant differences in the amount of "deviations from normal values" of body posture indices between judokas and boys from the control group?
2. Does the amount of "deviations from normal values" of body posture indices change in the examined boys in the forthcoming examinations?
3. What is the effect of a regular 6 months' training on changes of the values of particular body posture indices?

2. Materials and methods

The research project gained the approval of the Bioethics Committee of the Regional Medical Chamber in Krakow (Opinion No. 75/KBL/OIL/2014 of October 1st, 2014). The parents of all the boys gave their consent for the participation of their child in the study and after its completion they were informed about its results.

The study included 88 boys with their residence place in Kraków; 51 of them started judo training in sports clubs at the beginning of the school year and they had 45-minutes' training sessions, three times a week. The control group included 37 boys attending reception classes at primary schools, selected at random. Body posture was assessed three times, at three-month- intervals between the examinations. The assessments were performed in September and October 2016, and December and January 2016/2017, and then in March and April 2017. Spontaneous physical activity of the examined boys was not controlled.

At each point of the assessment the height and body weight of the boys were measured. An anthropometer (Martin's type, USA) was used for the measurement of body height. The measurement was done with 1 cm accuracy. Body weight was measured with an electronic scale (Radwag, WPT 100/200 OW), with a 0.1 kg accuracy. BMI was calculated according to the following formula: body weight [kg]/body height^2 [m^2] [6].

To obtain reliable and comparable results, the JU group was reduced to 37 boys. Similarity of somatic features and BMI with respect to the boys from the control group (NT) were the selection criteria. To verify similarity between the JU and NT groups, distributions of age and somatic feature values were evaluated with the Shapiro–Wilk *W*-test. It was assumed that the distribution of the analysed variables would be different from the normal one at the calculated *p* value of ≤ 0.05 (Table 1). Then intergroup differences were evaluated with the *t* test for independent samples, for the following variables: age and body height (their distribution in both groups appeared to be close to normal) (Table 2) and with the non-parametric Mann–Whitney *U*-test for the following variables: body weight and BMI (due to a non-normal distribution of these parameters in the control group – Table 1). No statistically significant differences were found between the JU and NT groups both with respect to the age and with respect to somatic features. This fact allowed the authors for a further statistical analysis.

Table 1. Evaluation of age and somatic feature value distribution among the JU and NT boys with the Shapiro–Wilk *W*-test

Variables	JU [n = 37]		NT [n = 37]	
	W	*p*	*W*	*p*
Age [years]	0.96860	0.388	0.96609	0.328
Height [m]	0.98702	0.941	0.98169	0.801
Weight [kg]	0.97871	0.702	0.91492	0.009*
BMI [kg/m^2]	0.95524	0.153	0.91742	0.011*

*p ≤ 0.05 – non-normal distribution.

Table 2. Evaluation of age and somatic feature differences between the examined boys in the first examination, with use of the *t*-test and the Mann–Whitney *U*-test

Variables	JU (n = 37)		NT (n = 37)		*p*
	$\bar{x}$	SD	$\bar{x}$	SD	
Age [years]	5.96	0.99	6.09	0.51	0.466
Height [m]	1.16	0.06	1.18	0.05	0.066
Weight [kg]	22.28	3.15	23.69	3.83	0.168
BMI [kg/m^2]	16.47	1.27	16.76	1.72	0.710

*p ≤ 0.05.

Body posture was assessed according to the general methodology of the Moire's technique and 15 body posture indices were obtained as a result: 7 in the sagittal plane, 1 in the axial plane and 7 in the coronal plane [15]. To enable photogrammetric examination, points and measurement lines with characteristic distribution pattern were marked. The system for photogrammetric body posture assessment of CQ Elektronik System was used in this study [23].

As the parameters obtained with the Moire's method are not normalised, based on the results obtained, the authors of this work have proposed creation of intervals for the indices measured, to define normal

Table 3. Means and standard deviations of somatic parameters and body posture indicators of boys practicing judo (JU) and non-training peers (NT) recorded in three subsequent studies

Parameters	Count	T1 (mean ± SD)	T2 (mean ± SD)	T3 (mean ± SD)
1	**2**	**3**	**4**	**5**
Height [m]	74	1.16 ± 0.06	1.18 ± 0.06	1.19 ± 0.06
JU	37	1.14 ± 0.07	1.16 ± 0.07	1.18 ± 0.07
NT	37	1.18 ± 0.05	1.20 ± 0.05	1.22 ± 0.05
Mass [kg]	74	22.73 ± 3.64	23.31 ± 3.64	24.12 ± 3.77
JU	37	21.81 ± 3.25	22.39 ± 3.25	23.15 ± 3.58
NT	37	23.64 ± 3.73	24.24 ± 3.82	25.10 ± 3.74
TT [deg]	74	5.19 ± 3.02	4.48 ± 3.24	5.73 ± 3.13
JU	37	4.57 ± 2.93	4.74 ± 2.88	5.12 ± 3.15
NT	37	5.82 ± 2.95	4.22 ± 3.58	6.33 ± 3.04
LLA [deg]	74	161.47 ± 9.10	157.50 ± 8.13	156.02 ± 6.98
JU	37	161.95 ± 10.64	156.90 ± 8.45	156.33 ± 5.98
NT	37	160.98 ± 7.05	158.10 ± 7.87	155.71 ± 7.92
TKA [deg]	74	162.90 ± 6.66	161.96 ± 7.06	160.51 ± 6.52
JU	37	165.26 ± 7.76	161.73 ± 6.85	161.36 ± 7.07
NT	37	160.54 ± 4.01	162.19 ± 7.35	159.66 ± 5.89
DTK [mm]	74	11.22 ± 8.23	19.65 ± 9.33	16.22 ± 9.54
JU	37	15.37 ± 8.96	19.35 ± 7.24	16.78 ± 8.97
NT	37	7.05 ± 4.34	19.95 ± 11.13	15.62 ± 10.18
DLL [mm]	74	14.50 ± 11.72	18.00 ± 11.51	15.45 ± 11.70
JU	37	18.92 ± 12.56	19.30 ± 11.33	16.32 ± 11.34
NT	37	10.08 ± 8.62	16.70 ± 11.70	14.57 ± 12.15
MR [mm]	74	21.89 ± 17.92	22.88 ± 11.11	17.53 ± 13.35

1	2	3	4	5
JU	37	33.08 ± 18.61	22.84 ± 11.49	17.59 ± 12.75
NT	37	10.70 ± 6.08	22.92 ± 10.88	17.46 ± 14.10
IT [deg]	74	1.47 ± 1.33	1.54 ± 1.17	1.43 ± 1.13
JU	37	1.58 ± 1.38	1.77 ± 1.21	1.53 ± 1.20
NT	37	1.36 ± 1.24	1.30 ± 1.10	1.32 ± 1.05
SS [mm]	74	4.78 ± 4.49	4.20 ± 4.29	3.69 ± 3.67
JU	37	5.00 ± 5.04	3.00 ± 2.70	4.00 ± 3.64
NT	37	4.57 ± 3.80	5.41 ± 5.20	3.38 ± 3.73
SB: *b-a* [mm]	74	6.32 ± 4.71	5.97 ± 4.78	6.39 ± 5.29
JU	37	6.57 ± 4.51	5.49 ± 4.93	8.35 ± 5.64
NT	37	6.08 ± 4.82	6.46 ± 4.64	4.43 ± 4.11
SB: *c-f* [mm]	74	12.35 ± 9.75	11.97 ± 10.18	10.05 ± 8.81
JU	37	14.95 ± 11.09	11.66 ± 7.28	11.35 ± 9.82
NT	37	9.76 ± 7.16	9.08 ± 8.38	8.76 ± 7.58
DDALBS [mm]	74	9.19 ± 6.76	8.23 ± 6.26	6.95 ± 5.16
JU	37	8.08 ± 6.46	7.51 ± 5.07	6.59 ± 4.62
NT	37	10.30 ± 6.78	8.95 ± 7.26	7.29 ± 5.69
SWT: *b-a* [mm]	74	11.47 ± 8.34	8.26 ± 5.67	9.54 ± 7.36
JU	37	11.95 ± 8.58	8.22 ± 5.72	10.91 ± 8.23
NT	37	11.00 ± 7.96	8.30 ± 5.70	8.16 ± 6.19
SWT: *n-w* [mm]	74	9.91 ± 9.20	11.97 ± 9.68	13.04 ± 8.85
JU	37	8.43 ± 8.49	10.49 ± 8.90	13.86 ± 8.98
NT	37	11.38 ± 9.51	13.46 ± 10.30	12.22 ± 8.77
DHASIS [mm]	74	2.39 ± 2.07	1.92 ± 2.01	1.62 ± 1.96
JU	37	2.28 ± 2.08	2.08 ± 2.01	1.57 ± 1.71
NT	37	2.49 ± 2.04	1.76 ± 2.01	1.68 ± 2.19
MDFSLS C7-S1 [mm]	74	6.64 ± 2.98	5.84 ± 2.72	5.75 ± 2.81
JU	37	6.68 ± 2.45	6.22 ± 2.74	5.30 ± 2.48
NT	37	6.59 ± 3.39	5.46 ± 2.69	6.22 ± 3.06

Legend: TT – Tilt of the trunk, LLA – Lumbar lordosis angle, TKA – Thoracic kyphosis angle, DTK – Depth of thoracic kyphosis, DLL – Depth of lumbar lordosis, MR – Maximum rotation, IT – Inclination of the trunk, SS – Set of shoulders, SB: b-a – Set of blades: below – above, SB: c-f – Set of blades: closer – further, DDALBS – Difference deflection angles of the lower blade of the spine, SWT: b-a – Setting the waist triangles: below – above, SWT: n-w – Setting the waist triangles: narrowly – wider, DHASIS – Difference of the height anterior superior iliac spine, MDFSLS C7-S1 – Maximum deviation from the straight line of the spine C7–S1.

and disturbed body posture. For the following parameters: Tilt of the trunk (TT), Maximum rotation (MR), Inclination of the trunk (IT), Set of shoulders (SS), Set of blades: below – above (SB: b-a), Set of blades: closer – further (SB: c-f), Difference deflection angles of the lower blade of the spine (DDALBS), Setting the waist triangles: below – above (SWT: b-a), Setting the waist triangles: narrowly – wider (SWT: n-w), Difference of the height of the anterior superior iliac spine (DHASIS) and Maximum deviation from the straight line of the spine C7–S1 (MDFSLS C7-S1) the interval ± SD is considered the normal value, corresponding to the acceptable variability of results in a healthy population. This interval included dispersion of results from the "0" value corresponding to the ideal posture within the listed variables. The calculations were done on absolute values. When a parameter value exceeding the predefined range was obtained for the examined individual it was conventionally called "deviation from the normal value" indicating disturbed body posture. For the other parameters: Lumbar lordosis angle (LLA), Thoracic kyphosis angle (TKA), Depth of thoracic kyphosis (DTK) and Depth of lumbar lordosis (DLL), the values defining a normal posture were determined by calculating the arithmetical mean and the interval ± SD. As a result, the range of acceptable variability of values was obtained. Similarly to the previous case, the results outside the range presented above were deemed "deviations from normal values" reflecting a disturbed posture. Table 3 shows the main statistics in the form of the arithmetical mean and the ± SD of the somatic parameters and the values of posture indices taken in three consecutive assessments, whereas Table 4 presents the intervals of the normal values of posture indices.

Table 4. Normal value ranges of the measured body posture indices

Indicators of body posture	Normal ranges
Tilt of the trunk (TT) [deg]	0–3.02
Lumbar lordosis angle (LLA) [deg]	152.37–170.57
Thoracic kyphosis angle (TKA) [deg]	156.24–169.56
Depth of thoracic kyphosis (DTK) [mm]	2.99–19.45
Depth of lumbar lordosis (DLL) [mm]	2.78–26.22
Maximum rotation (MR) [mm]	0–17.92
Inclination of the trunk (IT) [deg]	0–1.33
Set of shoulders (SS) [mm]	0–4.49
Set of blades: below – above (SB: b-a) [mm]	0–4.71
Set of blades: closer – further (SB: c-f) [mm]	0–9.75
Difference between deflection angles of the lower blade of the spine (DDALBS) [mm]	0–6.76
Setting the waist triangles: below – above (SWT: b-a) [mm]	0–8.34
Setting the waist triangles: narrowly – wider (SWT: n-w) [mm]	0–9.20
Difference of the height of anterior superior iliac spines (DHASIS) [mm]	0–2.07
Maximum deviation from the straight line of the spine C7–S1 (MDFSLS C7-S1) [mm]	0–2.98

2.1. Statistical methods

A statistical analysis was performed with the use of the SPSS 13.0 software. Basic descriptive statistics were calculated: the average and SD. Statistical hypotheses concerning differentiation of the variables depending on the group factor (JU; NT) and time factor (1st examination, 2nd examination, 3rd examination) were verified with the ANOVA test for multiple measurements. The assumptions on the variance equality and distribution normality of the examined variables were met to a large extent. Significance level at $p \leq 0.05$ was assumed. The numbers of “deviations from normal values” of body posture indices in consecutive measurement points were calculated by summing up the number of the examined boys in whom a “deviation from normal values” was found for a specific index.

3. Results

The boys from the JU group had a worse body posture than those from the NT group (a larger number of “deviations from normal values”) in all examinations (1–3), however the number of deviations differentiating both groups in the first examination was 37, whereas in the last one (the third one) it was only 7 (Table 5).

Table 5. The numbers of deviations from normal values for body posture indices in three consecutive examinations

Indicators of body posture	Assessment I		Assessment II		Assessment III	
	JU	NT	JU	NT	JU	NT
TT	14	20	15	11	16	21
LLA	14	7	11	7	8	14
TKA	16	8	14	10	17	13
DTK	12	5	19	17	16	12
DLL	12	9	12	15	8	10
MR	26	3	16	20	11	10
IT	18	14	24	14	16	15
SS	15	15	10	14	11	10
SB: b-a	16	16	13	19	21	11
SB: c-f	19	12	20	12	16	9
DDALBS	11	20	7	14	9	13
SWT: b-a	18	14	11	8	17	12
SWT: n-w	10	18	17	21	23	21
DHASIS	13	17	13	12	9	10
MDFSLS C7-S1	18	17	16	12	9	19
Total	232	195	218	206	207	200

The ANOVA test showed that neither the group factor – the fact of judo training – nor the time factor had any significant effect on the number of "deviations from normal values" of body posture ($p > 0.05$). Statistically significant intergroup differences were noted for six body posture indices measured with the Moire's method – these indices were as follows: TKA, DTK, DLL, MR, IT and SB: c-f. An interaction with the time factor was found only for two indices: DTK and MR (Table 7, Figs. 1 and 2). The between-subject effect test provided 90 observations of deviations from normal body posture values (Table 6).

Table 6. Between-subject effects

Between-subject effects		
		N
Group	1	45
	2	45
Examination	1	30
	2	30
	3	30

N – total number of "deviations from normal body posture values" in the examined boys.

Table 7. Tests of between-subject effects of the examined dependent variables

Variables	Source			
	Group		Assessment	
	F	*p*	*F*	*p*
Number of "deviations from normal values"	0.192	0.826	0.426	0.655
TKA [deg]	4.678	0.032*	2.825	0.062
DTK [mm]	6.292	0.013*	5.374	0.005*
DLL [mm]	8.251	0.004*	2.130	0.121
MR [mm]	18.505	0.000*	18.372	0.000*
IT [deg]	4.284	0.040*	0.565	0.569
SB: c-f [mm]	11.457	0.001*	0.440	0.645

*$p \leq 0.05$.

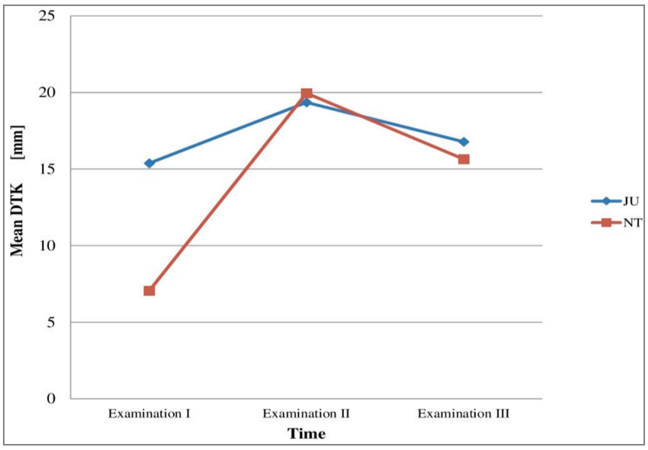

Fig. 1. Mean DTK values in three consecutive examinations

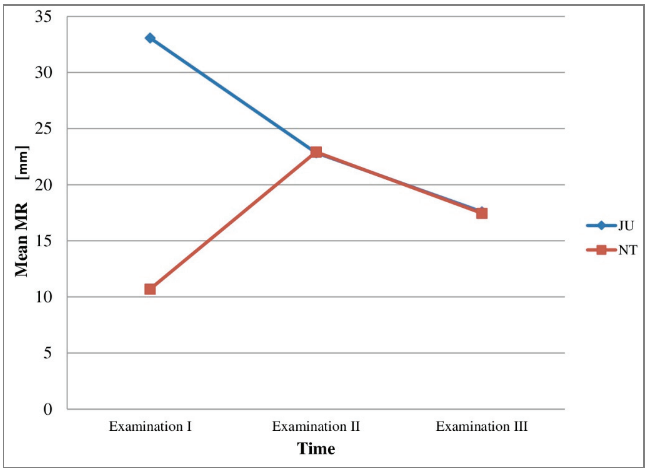

Fig. 2. Mean MR values in three consecutive examinations

4. Discussion

The results of the study confirm the expected effects of body posture improvement in 6-year-old boys starting regular judo training, in spite of the fact that in each of the three examinations the boys from the JU group presented a worse body posture than the boys from the NT group. It may be assumed that body posture disturbances observed in the children prompted their parents to find an additional organised physical activity for them, which they thought might correct their posture defects. Fukuda et al. [10] underline multidimensional values of judo training related to health improvement, development of physical fitness and learning of abilities that are useful in self-defence. The choice of judo as the form of an additional physical activity is good for children. This is confirmed by the research of Sekulic et al., who compared the effects of 9-months' judo training and recreational sports games on the development of physical fitness in 7-year-old boys. Tests of physical fitness performed at two points in time showed a statistically significant larger improvement of flexibility (sit-and-reach-test for flexibility), agility (shuttle-run-test), muscle endurance (sit-ups) in boys who trained judo, compared to their peers attending recreational sports game activities. Additionally, judokas presented a significantly lower increase of the fatty tissue, measured as the sum of two skin folds (triceps, subscapular) [18].

Favourable results of practising taekwondo on body posture of children and adolescents were found by Wąsik et al. [25]. Body posture defects were found in 41% of the athletes and in as many as 79% of non-training subjects from the control group. Shoulder asymmetry occurring in 20 out of 24 non-training peers was found only in 4 out of 26 training subjects with a longer training experience. The authors observed significant differences in favour of the subjects practising taekwondo, as compared to the non-training ones, in symmetrisation of the shoulder girdle, shoulder blades and iliac alae.

However, scientific evidence confirming a positive effect of judo training on the body posture of 6-year-old boys is absent in the literature. Walaszek et al. [24] measured body posture parameters in groups of 8-year-old judokas and non-training boys at two points in time, 6 months apart. In the first measurement, the non-training children presented better results in 11 out of 15 assessed indices. At the beginning of the study, there were statistically significant differences between the JU and NT group in the values of 5 body posture indices, as follows: TKA and DTK – judokas had less pronounced thoracic kyphosis, MR – judokas had as much as 3 times more rotated trunks in the axial plane than non-training boys, SB: c-f – judokas presented markedly more asymmetric shoulder blade position (the difference in winged shoulder blades incidence was as high as 43%). Only for the DLL index did the boys from the JU group have more pronounced lumbar lordosis – the difference measured linearly was 64%. In the second examination, the difference between the JU and NT groups with respect to the DLL index values was still present, but it was smaller (by 25%) than the difference found during the first examination. Differences were also shown for the SB: b-a – values – the boys from the NT group had both shoulder blades positioned almost at the same level; the boys form the JU group still showed some asymmetry.

According to the research done by Bieć and Demczuk-Włodarczyk [2], the individuals who practice martial sports have a better body posture, compared to the general population of the same age. This research included athletes representing various styles of martial sports and their average training experience was 5 years.

The authors of this work proposed a method of easy determination of normal value ranges for particular indices measured with the Moire's photogrammetric method and of body posture assessment based on the amount of "deviations" noted. This way of using the indices obtained with the Moire's method seemed to facilitate interpretation of the obtained results.

In spite of the absence of a statistically significant difference in the amount of noted deviations for the indices defined for a correct body posture in three consecutive measurements, it is noticeable that it was the JU group that (however subtly) had steadily improving results in each subsequent measurement point, expressed as decreasing numbers of deviations. There were 232 deviations in the first examination, 218 – in the second one and only 207 – in the third one. No such trend was observed in the NT group – the number of deviations increased in the second examination to 206 to decrease down to 200 in the third one (however not reaching the level of 195 deviations found during the first examination). It seems that a gradual improvement of body posture in boys from the JU group was caused by the regular judo training.

This suggestion may be confirmed by the results of a study using the photogrammetric method and presented by Drzał-Grabiec and Truszczyńska [8] – regular kyokushin karate training of a two-year- or longer duration formed correctly (enhanced) spine curvatures in the sagittal plane in children aged 7–10 years. The mean value of the (DTK) parameter in the karate group was 13.2 mm, and in the control group this was only 5.5 mm. There were very similar changes of the (DLL) parameter: the mean value in the karate training group was 13.8 mm, and in the control group – 9.7 mm. Practically the same favourable changes occurred in the same parameters as a result of judo training in the boys examined within this work. The research of Drzał-Grabiec and Truszczyńska showed also statistically significant inter-group differences of the following parameters: IT, TT, SS [8]. In our work, statistically significant inter-group differences were shown for the following parameters: TKA, MR, IT and SB: c-f.

When evaluating body posture indices it is worth noting that the JU boys showed smaller fluctuations of their values – this may reflect more stabilised posture, compared to the control group where the changes were clearly irregular. For example, the boys from the NT group had only 3 deviations from the established normal range of the MR parameter during the first examination, during the second examination this result increased up to 20 and during the third one – decreased back to 10. A similar trend may be observed for the DTK parameter, where the numbers of deviations in the NT group were as follows: 5 during the first measurement, 17 during the second one and 12 during the last one.

As far as the MR parameter is considered, the boys from the JU group statistically significantly improved their results as compared to the NT group. Thus it may be concluded that regular judo training had a corrective effect on this parameter. The mean value of the MR parameter for the JU group decreased from the level of 33.1 mm (by about 12°) in the first examination to a level of 17.6 mm (by about 6°) in the third one. The achieved angular value in the last examination seems almost normative as in the studies by Stoliński and Kotwicki on a population of children aged 7–10 where values ranging from 1 to 3° were noted in as many as 735 out of 1000 subjects [22]. The positive changes of the MR parameter may be supported by a clear decrease of the number of deviations from its normal value in the JU group: from 26 (70% of possible "deviations") to as little as 11 (30% of possible "deviations"). Also the mean value achieved for this parameter enabled the JU boys, during the third examination, to fall within the normal range defined by the authors.

Very important changes, however non statistically significant, occurred in the JU boys for the SB: c-f parameter. From examination to examination, the set of shoulder blades of the training boys was more and more symmetrical with respect to the spinal line (from 8.08 mm to 6.59 mm). Using the Moire's method, Bibrowicz [1] identified the asymmetries that may be most useful for early detection of scoliosis: asymmetries of the distances between the inferior angles of the shoulder blades and spine. These have decreased in the judokas examined within this work. These favourable changes may definitely decrease the risk of scoliosis occurrence. Also in the experiment by Drzał-Grabiec and Truszczyńska [8], symmetrisation of shoulder girdle position of the examined karate training children was found that was expressed by an improvement of shoulder line in this group, compared to the control group. Both authors concluded that karate training is a perfect supplement to the individual process of body posture defect correction, and that athletes who trained karate regularly for a period longer than 2 years had a better body posture than those from the control group. What seems to be important in their conclusions was that the karate training in the age range analysed by the authors (7–10 years) was very similar to "our" judo training in terms of its programme promoting a general development and lack of sparring matches and fights.

During the study, the group of the JU boys was subjected to a comprehensive training. Its purpose was to develop their motor potential, and to provide them with a wide range of motor skills enabling others to recognise the children's specific talents [19]. The effect of the exercises offered during judo classes may constitute a perfect base for further specialisation and form a foundation for other sports disciplines. The results of this work point out a positive effect of exercises on improvement of body posture indices in 6-year-old boys and at the same time they confirm that additional motor activity has a compensatory and a corrective role.

5. Conclusions

During three consecutive body posture examinations, no statistically significant differences were observed in the amount of deviations from normal values between the JU and NT groups. Steadily decreasing numbers of "deviations from normal values" of body posture indices in the JU group were observed in the period of the three study examinations; no such trend was found in the NT group – the least number of "deviations" was measured in this group during the first examination. A regular 6-months' judo training had a statistically significant effect on the mean value change of some body posture indices. The most important change was to the MR parameter where the training boys significantly improved their results, so the effect of the judo training may be definitely described in this case as corrective.

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