Changes in the body composition and on fitness levels judo practitioners' in relation to pilot cadets' – effects of special programs

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A Study Design
B Data Collection
C Statistical Analysis
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Abstract

Background and Study Aim: The period of special preparation in judo practitioners as well as in cadet pilots is one of the most important elements of fitness formation closing the entire training process. Changes in fitness and physiological indexes in athletes as well as their comparison during different preparation periods provide a diagnostic value in the assessment of body performance. The aim of the study is knowledge about projected changes in the level of physical fitness and changes in the components of the body composition under the influence of a special training process in judo practitioners in relation to the control group.

Material and Methods: Twenty-eight cadets (males) were tested in two groups: A (tested, n = 14) was made up of cadets, aged 18.92 ±0.69 years, who trained in a sports judo section and who were preparing for the Polish Military Championships; B (control, n = 14) was made up of pilot cadets, aged 19.14 ±1.16 years, who followed a special fitness preparation programme for flights. Fitness tests and determination of the components of body composition were made prior to the training process (examination I) and after the training process (examination II). In the research, fat mass (FM), fat-free mass (FFM), muscle mass (MM), total body water (TBW), extracellular water content (ECW) and body cellular mass were determined (BCM) by means of the electrical bioimpedance method, using the AKERN 101 instrument.

Results: Groups A and B showed a statistically significant improvement in the total physical performance in examination II. In examination II, group A showed an upward trend in body composition components, whereas in group B a downward trend. A slight increase in FM was observed in both groups. In examination I, a significant difference ($p<0.05$) of higher values in FFM, TBW, BCM and MM was observed in group B rather than in A. In examination II, there were no significant differences between the groups in physical fitness tests and body composition components.

Conclusions: In groups A and B, the implemented special training process improved the total physical fitness, which was statistically significant in examination II compared to examination I. The special training process showed a statistically non-significant increase in the values of the body composition components FFM, TBW, BCM, ECW, MM and their decrease in the values of the pilot cadets.

Key words: acceleration +Gz (positive) • acceleration –Gz (negative) • fitness tests • physical fitness • Special Aviation Gymnastic Instruments • special preparation programme • training process

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Technique – *noun* a way of performing an action [36].

Training session – *noun* a period of time during which an athlete trains, either alone, with a trainer or with their team [36].

Training intensity – the effort of training. A number of methods are used to establish training intensities which give maximum benefits. These include the lactic acid method, minute ventilation method, and target heart-rate [37].

Shime waza – chokehold techniques. Judo is the only Olympic sport where choking is allowed. Legal areas of human actions by means of martial arts, where people using techniques of chokings: hapkido, Brazilian ju-jitsu, ju-jitsu, krav maga, kung-fu, sambo, unifight (as well as other martial arts, with local or regional impact and self-defence art) [37].

INTRODUCTION

The period of special preparation in judo practitioners (judokas) as well as in cadet pilots is one of the most important elements of fitness formation closing the entire training process. Changes in fitness and physiological indexes in athletes as well as their comparison during different preparation periods provide a diagnostic value in the assessment of body performance. The observations of such changes during testing make it possible to introduce training adjustments in athletes. More and more frequently, the determination of body composition components along with a diagnosis of physical fitness is being used for such studies [1-4]. Modern demands of competitive sports impose, on a coach, the necessity to have comprehensive knowledge for practical applications. It is also true for pilots with regard to the adaptation of fitness and physical capacity to the latest highly manoeuvrable aircraft. The period of special preparation for judo practitioners aims at applying significantly higher intensity measures to athletes, using repetition and interval methods and limiting continuous work. However, in the case of pilot cadets, the period of special preparation consists of shaping spatial orientation, eye-hand coordination, balance on a foundation of (targeted) body enhancement exercises with an emphasis on all motor skills.

The cadets carried out a period of special preparation on Special Aviation Gymnastic Instruments (SAGI), discussed in other published scientific papers [5-8]. According to previous studies, the intensity of exercises on SAGI was lower than in the control group, though the strain on the body was comparable to triathlon in athletes [7]. Cadets performed isometric exercises, with simultaneous body rotations in different planes on SAGI. The exercises on SAGI heavily overburden the body due to accelerations: positive +Gz (head-leg direction) overloads and negative −Gz (leg-head direction) overloads. Due to the peculiarities of the training process (different training content) for pilot cadets and judo practitioners, a comparison of the same physiological and fitness indexes between them can provide valuable information necessary for the current correction in training session or in the training process [9].

In judo practitioners, a period of special preparation must ensure that they are in a top sporting form during the competition period. On the other hand, during this period in pilot cadets there is a need to maintain the necessary targeted physical fitness in combination with the formation of eye-hand coordination, spatial orientation and balance, ensuring proper preparation for flights in extreme conditions of their working environment [10, 11]. The intensity and type of physical effort affect the components of body composition [12, 13]. The use of fitness tests in airmen who practise judo with a determination of body composition components, during the special preparation period, when compared to pilot cadets, showed differences which were of diagnostic significance in the adaptation of the body under the intensity and load of the training process. Somatic characteristics, training intensity and the type of exercises influence changes in physiological indexes of the body, including body composition components [12, 13].

Taking this fact into account when comparing judo practitioners and pilot cadets in the training process, an interesting direction of changes in body composition components can be expected. Therefore, these research are analyse the magnitude of changes in body mass components such as fat mass (FM), fat-free mass (FFM), muscle mass (MM), total body water (TBW), extracellular water content (ECW) and cellular mass (BCM) before and after a special training process.

The aim of the study is knowledge about projected changes in the level of physical fitness and changes in the components of the body composition under the influence of a special training process in judo practitioners in relation to the control group.

MATERIAL AND METHODS

Participants

Twenty-eight cadets (males) were tested in two groups: A (judokas, n = 14) was made up of cadets who trained in a judo sports section and who were preparing for the Polish Military Championships; B (control; pilot cadets n = 14) who followed a fitness preparation programme for flights.

Group A, aged 18.92 ±0.69 years, was characterised by the following somatic features (body height 173.62 ±5.12 cm, body weight 67.56 ±6.36 kg, BMI 22.49 ±1.87 kg•m^2); after the training period the somatic characteristics were recorded (body weight 68.47 ±5.73 kg, BMI 22.77 ±1.66 kg•m^2) and a significant difference was observed for age and BMI.

Group B, aged 19.14 ±1.16 years, had the following somatic characteristics (body height 177.03 ±4.3 cm, body weight 73.21±5.05 kg, BMI 23.45 ±1.78 kg•m^2); after the training period body weight it equalled 72.45 ±5.74 kg, BMI 23.20 ±1.96 kg•m^2 with no significant difference from baseline measurements in somatic characteristics.

When comparing the groups, statistically significant differences were found prior to the training period for body height ($p<0.05$), body weight ($p<0.0001$) and BMI ($p<0.0001$). In contrast, no significant differences in body weight and BMI were found between the groups after the training period.

Fitness tests

In groups A and B, fitness tests were conducted twice: before (examination I) and after a special preparation period (examination II) – in tables "assess" The following fitness tests were used for the examination: Aviation Synthetic Efficiency Test (ASET) [14, 15], pull-ups on the bar, 16.5m run, 10x10m shuttle run, forward bends from lying down. In examinations I and II, the units of measurement in the used fitness tests were converted into points: 14 pull-ups 200 pts; >200 pts, 1 pull-up equalled 10 pts; the result of 2.90 s in a 16.5-meter race 200 pts, every 0.01 s 5 pts were awarded; 29.3 s in a 10×10-meter shuttle race 200 pts, every 0.1 s scored 3 pts; 71 repetitions of forward bends 200 pts, every forward bend scored 5 pts; 49.0 s in the ASET execution 200 pts, every 0.1 s scored 0.8 pts.

Physiological examination

An analysis of the dynamic changes in HR of the examined persons was recorded during training units to monitor training intensity using the POLAR- TEAM 2 system.

Body composition test

The measurements were taken with a body composition analysis instrument, AKERN type BIA 101SE. The method for measuring body composition was based on **(bioelectrical impedance analysis)** the use of low current and the difference in resistance of individual body tissues in order to determine FM [kg], FFM [kg], TBW [kg], BCM [kg], ECW [kg], ICW [kg] and MM [kg]. During the analysis of the components of body composition, the examined person was in a lying (horizontal) position with his limbs at a 30-degree angle from the body axis. The electrodes were glued to the skin on the hand and foot. Before sticking the electrodes, the skin was washed with a gauze pad soaked in a disinfectant [16].

Ethical issues

The consent for the research was granted by the Ethics Committee of the Military Institute of Aviation Medicine in Warsaw - decision no 03A/2009 of July 8, 2009.

Procedures

Special preparation programme for judo practitioners

The judo practitioners' special preparation process involved training in an anaerobic and aerobic transition zone with a particular emphasis on strength, speed and endurance. The author exploited special elements of technical exercises. The workouts were conducted using the repetition and the interval method. Special preparation included sparring's. The training unit was implemented for 90 minutes, three times a week. The intensity of the training units was monitored by heart rate (HR) using the PRO TEAM device. The mean heart rate during the training units equalled 141 ±2.8 bpm

Special physical preparation programme for pilots

The pilot's special physical preparation process was carried out on Special Air Gymnastic Instruments (SAGI). The exercises on the Rhon wheel, gyroscope and looping had the total effect of being performed in all planes and axes of the body. In this way, the exercises affected the cardiovascular, nervous and muscular systems as well as the vestibular and vegetative ones. The exercises were designed to increase spatial orientation, eye-hand coordination, balance and resistance to airsickness. In addition, the exercises on SAGI were intended to ensure a high psychomotor level in the cadet pilots, also by maintaining a level of targeted physical fitness during this period. The exercises were performed individually and in teams. The next unit was implemented for 90 minutes, three times a week. The intensity of the training units was monitored by heart rate (HR), using the PRO TEAM device. The mean heart rate during the training units equalled 108 ±4.5 bpm.

Judo practitioners and pilot cadets were provided with identical food and accommodation conditions during the six-month training process. All the examined persons followed a standard diet in accordance with the principles of group catering. The daily food ration equalled 4,500 kcal, including 150 g fat (30%), 112.5 g proteins (10%) and 675 g carbohydrates (60%).

Statistical analysis

The results were subjected to a statistical analysis. The mean (M) and standard deviation (SD or ±) were calculated. A normal distribution of the examined variables was checked by means of the Kolmogorov-Smirnov test. Homogeneity of variance was tested using Levene's test. The difference between examinations I and II in groups A and B was calculated by a two-factor analysis of variance (ANOVA) with repeated measurements. A comparative analysis was applied between groups A and B in examinations I and II, using an analysis of variance with the Tukey Honest Significant Difference (HSD) test for post hoc pair comparisons. A partial effect size η^2p (partial eta squared) was calculated for each variable [17]. A statistical analysis of the examination was performed using Statistica 13.3 statistical software. The difference between the means was considered statistically significant when the p-value was under than 0.05.

RESULTS

There is a statistically significant difference in group A in the pull-ups on the bar in examination II compared to examination I. Groups A (judokas) and B (pilot cadets) also showed a statistically significant increase in total physical fitness in examination II compared to examination I (Table 1).

No significant changes were shown in the other indicators. In group B, examination I showed statistically significantly higher values of FFM, TBW, BCM, MM compared to group A. In examination II in group B, a decrease in FFM, TBW, BCM, MM resulted in no statistical significance in these components compared to group A. There were no significant differences in physical fitness tests between group A and B (Table 2).

In group A in examination I, there was a statistically significant negative correlation between FM and 10x10m and ASET. There was also a statistically significant correlation between forward bending and lying down as well as FFM, TBW, ECW, BCM, MM and body mass (BM) In examination II, a statistically significant correlation was observed between forward bending and lying down; also in FFM, TBW, BCM, MM and BM. A statistically significant correlation between ASET and FM was found (Table 3).

In group A in examination II, the most significant positive correlations were found between the forward ends test and the five body composition indicators. A negative statistically significant correlation was found between body height (HB) and ASET ($r = -0.59$, $p<0.05$) and positive correlation with running at 16.5m ($r = 0.55$, $p<0.05$) (Table 4).

In group B in examination I, a statistically significant correlation was observed between FM and 10x10m, 16.5m and total fitness (Table 5).

In group B in examination II the most significant negative correlations were found between the 16.5 m run test and the four body composition indicators (Table 6).

DISCUSSION

The implementation of the special training period in groups A and B (pilot cadets) showed no significant differences in somatic characteristics in examination II. The training units used in groups A and B, which differed in type and intensity of the exercises, resulted in different directions of shifts in body composition components. A non-significant increase in body composition components was observed in group A, whereas an opposite trend was observed in group B. This trend of shifts in body composition components showed no significant differences between groups A and B. Intensity, a type of exercise, duration of the training unit and diet may cause a different direction of shift in body composition components in physically active individuals. At this point, it is necessary to stress an increase in body weight in group A and a decrease in group B.

Table 1. Results of body composition components (M and SD) in examinations I and II, and in physical fitness tests in groups A (judokas, n = 14) and B (pilot cadets, n = 14).

Group	Variable [indicator]				
	Examination I	Examination II	$\eta^2_{p(\%)}$	F	p
		FFM [kg]			
A	56.50 ± 5.45	57.17 4.78	0.46	0.12	0.72
B	60.02 ±2.93	59.24 ±2.94	1.88	0.50	0.48
		TBW [kg]			
A	41.35 ±3.97	41.85 ±3.49	0.49	0.12	0.72
B	43.95 ± 2.13	43.36 ±2.15	1.96	0.52	0.47
		ECW [kg]			
A	18.19 ±1.84	18.45 ±1.73	0.59	0.14	0.70
B	19.30 ±1.30	19.18 ±1.47	0.19	0.05	0.81
		BCM [kg]			
A	31.39 ±3.16	31.75 ±3.04	0.35	0.09	0.76
B	33.40 ±1.81	32.77 ±1.86	2.98	0.79	0.37
		FM [kg]			
A	11.10 ±3.06	11.29 ±2.87	0.08	0.02	0.86
B	13.19 ±3.71	13.20 ±4.17	0	0.00009	0.99
		MM [kg]			
A	38.39 ±3.82	38.85 ±3.61	0.41	0.10	0.74
B	40.86 ±2.14	40.14 ±2.14	2.95	0.79	0.38
		pull-ups on the bar [pts]			
	174.57 ±48.98	205,92 ±29.11	14.01	4.23	**<0.05**
	202.21 ±41.00	230.21 ±54.37	8.34	2.36	0.13
		run 10x 10m [pts]			
A	191.85 ±24.27	196.57 ±24.98	0.97	0.25	0.61
B	200.85 ±29.87	197.42 ±28.69	0.36	0.09	0.75
		run 16.5 m [pts]			
A	181.78 ±56.69	210.71 ±52.76	6.98	1.95	0.17
B	182.14 ±49.75	205.00 ±30.44	7.63	2.14	0.15
		forward bends [pts]			
A	203.92 ±85.08	246.07 ±67.71	7.48	2.10	0.15
B	212.85 ±63.29	258.21 ±80.70	9.52	2.73	0.11
		ASET [pts]			
A	203.88 ±44.46	223.14 ±38.82	5.42	1.49	0.23
B	211.02 ±51.15	231.34 ±42.21	4.80	1.31	0.26
		total physical fitness [pts]			
A	956.02 ±154.60	1082.42 ±108.91	19.38	6.25	**<0.02**
B	1009,10± 131.55	1122.20 ±129.77	16.78	5.24	**<0.05**

M average; **SD (±)** standard deviation; **ASET** Aviation Synthetic Efficiency Test; η^2_p partial eta squared; **F** result of the analysis of variance; **p** significance level, probability; **pts** points

Table 2. Comparison of results of body composition components and physical fitness tests (M and SD) between groups A (judokas, n = 14) and B (pilot cadets, n = 14) in examinations I and II.

Period of assess	Variable [indicator]				
	Group A	Group B	η^2_p	F	P
		FFM [kg]			
I	56.50 ±5.45	60.02 ±2.93	14.87	4.54	<0.05
II	57.17 ±4.78	59.24 ±2.93	6.72	1.89	0.18
		TBW[kg]			
I	41.35 ±3.97	43.95 ±2.13	15.14	4.63	<0.05
II	41.85 ±3.49	43.36 ±2.15	6.76	1.88	0.18
		ECW [kg]			
I	18.19 ±1.84	19.30 ±1.30	11.58	3.41	0.07
II	18.45 ±1.73	19.18 ±1.47	5.34	1.46	0.23
		BCM [kg]			
I	31.39 ±3.16	33.40 ±1.81	13.98	4.22	<0.05
II	31.75 ±3.04	32.77 ±1.86	4.28	1.16	0.29
		FM [kg]			
I	11.10 ±3.06	13.19 ±3.72	9.15	2.62	0.11
II	11.29 ±2.87	13.20 ±4.17	7.13	1.99	0.16
		MM [kg]			
I	38.39 ±3.82	40.86 ±2.14	14.61	4.45	<0.05
II	38.85 ±3.61	40.14 ±2.14	4.80	1.31	0.26
		pull-ups on the bar [pts]			
I	174.57 ±48.98	202.21 ±41.00	9.15	2.62	0.11
II	205.92 ±29.11	230.21 ±54.37	7.70	2.17	0.15
		run 10x10 m [pts]			
I	191,85 ±24.27	200.85 ±29.87	2.86	0.76	0.38
II	196.57 ±24.98	197.42 ±28.69	0.03	0.07	0.93
		run 16.5 m [pts]			
I	181.78 ±56.69	182,14 ±49.75	0.001	0.003	0.98
II	210.71 ±52.76	205.00 ±30.44	0.47	0.12	0.72
		forward bends [pts]			
I	203.92 ±85.08	212.85 ±63.29	0.38	0.09	0.75
II	246.07 ±67.71	258.21 ±80.70	0.71	0.18	0.66
		ASET [pts]			
I	203.88 ±44.46	211,02 ±51.15	0.59	0.15	0.69
II	223.14 ±38.82	231.34 ±42.21	1.08	0.28	0.59
		Total physical fitness [pts]			
I	956.02 ±154.60	1009,10 ±131.55	3.55	0.95	0.33
II	1082.42 ±108.91	1122.20 ±129.77	2.88	0.77	0.38

M average; **SD (±)** standard deviation; η^2_p partial eta squared; **F** result of the analysis of variance; **p** significance level, probability; **pts** points

Table 3. Correlation between body composition components and physical fitness tests in group A (judokas, n = 14) in examination I.

Physical fitness test [points]	Body composition component [indicator]							
	FFM [kg]	TBW [kg]	ECW [kg]	BCM [kg]	FM [kg]	MM [kg]	BH [cm]	BM [kg]
pull-ups on the bar	−0.006	−0.009	0.13	−0.13	0.04	−0.11	**0.54***	0.01
run 10x10 m	0.19	0.19	−0.02	0.36	**−0.57***	0.34	0.15	−0.10
run 16.5 m	−0.08	−0.09	−0.19	0.16	−0.43	0.001	0.09	−0.28
forward bends	**0.77§**	**0.77§**	**0.78§**	**0.70***	0.28	**0.71#**	0.42	**0.80§**
ASET	0.28	0.28	0.16	0.36	**−0.61****	0.35	0.02	−0.05
total physical fitness	0.50	0.50	0.44	0.51	0.25	0.50	0.47	0.30

*p<0.05; **p<0.02; ***p<0.01; #p<0.005; §p<0.002; **ASET** Aviation Synthetic Efficiency Test; **FFM** free fat mass; **TBW** total body water; **ECW** extracellular water; **FM** fat mass; **BCM** *body cell mass;* **MM** muscle mass; **BH** body height; **BM** body mass

Table 4. Correlation between body composition components and physical fitness tests in group A (judokas, n = 14) in examination II.

Physical fitness test [points]	Body composition component [indicator]							
	FFM [kg]	TBW [kg]	ECW [kg]	BCM [kg]	FM [kg]	MM [kg]	BH [cm]	BM [kg]
pull-ups on the bar	0.07	0.07	−0.02	0.13	−0.04	0.13	0.33	0.04
run 10x10 m	−0.33	−0.34	−0.37	−0.22	−0.52	−0.24	−0.42	**−0.54***
run 16.5 m	0.32	0.31	0.10	0.42	−0.13	0.42	**0.55***	0.20
forward bends	**0.67*****	**0.67*****	0.46	**0.70*****	0.36	**0.71#**	0.35	**0.74#**
ASET	−0.27	−0.27	−0.14	−0.32	**−0.61***	−0.31	**−0.59***	−0.53
total physical fitness	0.43	0.41	0.19	0.51	−0.19	0.51	0.26	0.25

*p<0.05; ***p<0.01; #p<0.005; **ASET** Aviation Synthetic Efficiency Test; **FFM** free fat mass; **TBW** total body water; **ECW** extracellular water; **FM** fat mass; **BCM** *body cell mass;* **MM** muscle mass; **BH** body height; **BM** body mass

This fact may have resulted in a decrease in the values of the body composition components in group B with the exception of FM in which there was a slight increase. In group B, however, the recorded decrease in the values of the body composition components in examination II remained at a higher level than in group A.

The specificity of the exercises with sufficiently low intensity on SAGI in different axes and planes may have caused stress on the body in the nervous, muscular, respiratory, blood circulation and vegetative systems in the cadets, not increasing but decreasing body composition components. In group B, the timing of the training unit and the intensity of the exercise may have increased the percentage of free fatty acids for energy demands, which is the highest under these conditions [18]. In group B in examination II, the observed increase in FM in line with exercise intensity with a concurrent decrease in BCM, MM ,FFM, TBW, may be related to the adaptation to this type of exercise, as well as to somatic characteristics.

The somatic characteristics in group B are more similar to those of the examined groups, with the best results on ASET [14, 10]. It was shown in our own research [10] that the results achieved on the ASET in pilot cadets were indicative of good motor predispositions for the pilot's job, taking into account body weight. These facts have to do with the optimum load of shaping motor skills and a high level of motor coordination.

Table 5. Correlation (r) between body composition components and physical fitness tests in group B (pilot cadets, n = 14) in examination I.

Physical fitness test [points]	Body composition component [indicator]							
	FFM [kg]	TBW [kg]	ECW [kg]	BCM [kg]	FM [kg]	MM [kg]	BH [cm]	BM [kg]
pull-ups on the bar	−0.16	−0.16	−0.25	0.00	−0.35	−0.02	−0.17	−0.35
run 10x10 m	−0.32	−0.32	−0.41	−0.10	**−0.75#**	−0.13	0.02	**−0.73#**
run 16.5 m	−0.18	−0.18	−0.40	0.11	**−0.86¶**	0.07	0.005	**−0.74#**
forward bends	−0.07	−0.06	−0.04	−0.07	0.17	−0.07	−0.27	0.08
ASET	−0.02	−0.01	−0.03	0.009	−0.21	0.009	0.003	−0.17
total physical fitness	−0.23	−0.23	−0.36	−0.01	**−0.60***	−0.04	−0.17	**−0.58***

*p<0.05; #p<0.005; ¶p<0.0001; **ASET** Aviation Synthetic Efficiency Test; **FFM** free fat mass; **TBW** total body water; **ECW** extracellular water; **FM** fat mass; **BCM** *body cell mass;* **MM** muscle mass; **BH** body height; **BM** body mass

Table 6. Correlation between body composition components and physical fitness tests in group B (pilot cadets, n = 14) in examination II.

Physical fitness test [points]	Body composition component [indicator]							
	FFM [kg]	TBW [kg]	ECW [kg]	BCM [kg]	FM [kg]	MM [kg]	BH [cm]	BM [kg]
pull-ups on the bar	−0.15	−0.15	−0.42	0.25	−0.52	0.20	−0.27	−0.46
run 10x10 m	−0.08	−0.08	−0.24	0.14	−0.09	0.11	0,36	−0.10
run 16.5 m	**−0.53***	**−0.53***	−0.45	−0.34	**−0.78§**	−0.38	0.05	**−0.84¶**
forward bends	0.06	0.06	0.09	−0.007	0.25	0.001	−0.07	0.21
ASET	−0.13	−0.13	−0.31	0.13	**0.74#**	0.10	0.14	**−0.6***
total physical fitness	−0.21	−0.21	−0.37	0.09	−0.51	0.05	−0.02	−0.48

*p<0.05; #p<0.005; §p<0.002; ¶p<0.0001; **ASET** Aviation Synthetic Efficiency Test; **FFM** free fat mass; **TBW** total body water; **ECW** extracellular water; **FM** fat mass; **BCM** *body cell mass;* **MM** muscle mass; **BH** body height; **BM** body mass

Starosta [19] observed that exceeding the optimal physical load in the formation of motor skills can reduce the level of motor coordination. Similarly, it was found in the author's research that cadets who achieved maximum results in the 1,000m, 100m run and pull-ups on the bar obtained worse results in ASET [14]. In group A, there was no significant correlation between total fitness and FM. Such correlations are related to a higher level of training intensity (in the aerobic transition zone), as shown in earlier studies [5]. In group B, total physical fitness scores correlate significantly with FM in examination I and non-significantly in examination II, which may be related to weight loss. In group A, an apparent change of correlation signs "+" to "**−**"between body composition components and physical fitness tests in examination II compared to examination I may indicate a high intensity of the training process in the zone of aerobic metabolism, causing a shift in body composition components. In group B, among the labelled body composition components, the author found a change in the correlation sign "+" to "−" only in the MM component in correlation with physical fitness tests, which confirms lower intensity of the training process in the zone of aerobic metabolism and the training emphasis on strength capacity.

Fat-free body mass strongly influences strength and endurance performance [20]. Judging by the background of the shifts in body composition components in group A, it can be concluded that in group B a problem regarding endurance has become apparent, which is probably at a lower level, as indicated by the increase in FM. Endurance training in pilots is still a subject of discussion and research [21, 22]. FM increased in group A with a higher intensity of the training process compared to group B, suggesting an adjustment in diet and exercise intensity.

The present examination may also point to overweight in some judo practitioners and pilot cadets. This problem was highlighted in the examination by Maciejczyk et al. [24] and Gażdżińska et al. [23] in their examination, also pointed out that weight gain regardless of component composition can reduce aerobic capacity. In group A (judo practitioners), the changes in the direction of growth of the components of body composition shown in examination II in comparison with group B (pilot cadets) may indicate that the period of special training should be at a higher level of intensity, bringing the judo practitioners to the zone of anaerobic metabolism. In examination II, no significant increase in body composition components was observed compared to examination I. Palka et al [25] observed that specific training of judo practitioners develops anaerobic fitness.

In conclusion, the difference shown between the test group and the control group and the internal group correlations between physical fitness tests and body composition components indicated a need to change a diet which will be better suited to the exercise load. It should be emphasised that the body composition components FFM, MM, BCM and TBW and even a minor shift under the influence of physical exercise in groups A and B may have a genetic basis, indicating a predisposition to a physical activity. Such observations are in line with previous observations by Mala et al [26]. The dynamics of changes in physiological processes under the influence of specific physical exercises is very high. Therefore, diet and dietary supplementation should be matched to the intensity and load of exercise as an important factor in regulating body weight.

The present examination is important for future research regarding dietary habits, changes in body hydration and changes in the direction of body composition components in order to achieve optimum motor ability and maximum fitness necessary for judo practitioners and pilot cadets. In sport and working environment of the pilot, body weight should be regulated via body composition components.

The discussion of these unique studies on the application of judo elements in the training of military pilots cannot fail to reflect on the application possibilities of the new, developing sub-discipline of science of martial arts [27]. In this new applied science, judo occupies a special place, and the symbolic moment of recommending judo as a system of universal physical and moral education is Jigoro Kano's lecture during the 1932 Olympic Games in Los Angeles [28]. Meanwhile, judo is recognized in the modern world almost exclusively as an Olympic sport, the first of Asian origin [29].

Admittedly, the concept (hypothesis) of Kalina and Marcinik [30] regarding *shime waza* training in increasing tolerance of acceleration of +Gz among military pilots has not yet been empirically verified, although a tool is already available (shime waza test (QASWT [31]), This test belongs to the category of quasi-apparatus [32], so it is cheap and easy to use in training practice and in diagnostics. The reason for the slow implementation of not only professional training of military pilots (e.g. survival [33]) or policemen [34], but many other sensible recommendations into practice can be explained by the apt statement of Jaskólski and Ordyłowski [35] about "educational conservatism".

CONCLUSIONS

In groups A and B, the implemented special training process enhanced the overall physical fitness which was statistically significantly in examination II compared to examination I. The special training process showed a statistically non-significant increase in the values of the body composition components FFM, TBW, BCM, ECW, MM and their decrease in the values of the pilot cadets. The decrease in the values of the body composition components in the cadets had to be matched with the type of exercise, lower intensity of the training process and higher fat burning. The correlative relationship of fat mass with total fitness and ASET was confirmed by the intensity of the training process involving fat burning in judo practitioners and pilot cadets, whose fat burning was faster due to the specificity of the exercises.

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REFERENCES

1. Mathunjwa ML, Djarova-Daniels T, Shaw I et al. Short duration high-intensity interval taekwondo training substantially improves body composition and physical fitness in previously-trained individuals: a proof-of-concept examination. Arch Budo 2020; 16: 221-226.
2. Rutkowski T, Sobiech K, Chwałczyńska A. The effect of 10 weeks of karate training on the weight body composition and FFF index of children at the early school age with normal weight and overweight. Arch Budo 2020; 16: 211-219
3. 3Chwałczyńska A, Rutkowski T, Sobiech KA. Similarities and differences of the body composition and the fat-free fat index between kyokushin karate athletes, swimmers, basketball, soccer, American football players and non-active men. Arch Budo 2021; 17: 349-356
4. Witkowski K, Superson M, Piepiora P. Body composition and motor potential of judo athletes in selected weight categories. Arch Budo 2021; 17: 161-175
5. Wochyński Z, Jędrys R, Stelęgowski A. Methodology of training on Special Aviation Gymnastic Instruments. Dęblin: Polish Air Force Academy; 2010: 43-59 [in Polish]
6. Wochynski Z, Sobiech K. Effect of exercise on Special Aviation Gymnastics Instruments on blood serum levels of selected biochemical indices. Ann Agricul Environ Med 2014; 1: 106-111
7. Wochyński Z, Sobiech K. Post-exercise proteinuria in cadets trained on Special Aerial Gymnastics Instruments. Int J Occup Med Environ Health 2015; 28(5): 863-873
8. Wochyński Z, Sobiech KA. Impact of Special Aviation Gymnastics Instruments training on selected hormones in cadets' blood serum and plasma. Int J Occup Med Environ Health 2017; 30(4): 655-664
9. Wochyński Z. Evaluation of judo practitioners' motor performance in relation to the criterion of targeted fitness of pilot cadets after a six-month training process. Arch Budo 2021; 17: 319-328
10. Wochyński Z, Skrzyńska-Rękawek J, Pilaczyński P et al. The impact of motor predispositions in cadets upon the results of the execution of Aviation-Synthetic Efficiency Test. Arch Budo Sci Martial Art Extreme Sport 2020; 16: 105-117
11. Wochyński Z, Krawczyk P, Cur K et al. An assessment of physical efficiency in cadet pilots before and after the implementation of a program preparing for flights. Int J Occup Med Environ Health 2021; 34(5): 1-12
12. Kłossowski M, Stelęgowski A. Ocena związku między masą i składem ciała a sprawnością fizyczną podchorążych Wyższej Szkoły Oficerskiej Sił Powietrznych. Pol J Aviat Med 2004; 10(1): 35-42 [in Polish]
13. Stelęgowski A, Kłossowski M, Wochyński Z. Wpływ ćwiczeń na lotniczych gimnastycznych przyrządach specjalnych (LGPS) na sprawność motoryczną i skład ciała. Pol Przeg Med Lotn Psychol 2011; 1: 7-19 [in Polish]
14. Wochyński Z, Stelęgowski A, Kłossowski M. Using Special Aviation Synthetic Fitness test for the needs of candidate selection at the Air Force Academy, for multi-role F-16 type aircraft. Pol J Aviat Med 2010; 4: 309-320
15. Wochyński Z. Special Aviation Synthetic Fitness test modified by Wochyński. In: Sokołowski M, editor. Morphofunctional conditioning of military service. Monograph. Vol 8. Warszawa: Polskie Towarzystwo Naukowe Kultury Fizycznej; 2015: 119-126 [in Polish]
16. Kyle UG, Bosaeus I, De Lorenzo AD et al. Bioelectrical impedance analysis--part I: review of principles and methods. Clin Nutr 2004; 23(5): 1226-1243
17. Stanisz A. Przystępny kurs statystyki z zastosowaniem Statistica PL na przykładach medycyny. Vol 2. Modele liniowe i nieliniowe. Kraków: StatSoft Polska; 2007 [in Polish]
18. Hurley BF, Nemeth PM, Martin WH et al. Muscle triglyceride utilization during exercise: effect of training. J Appl Physiol 1986; 60(2): 562-567
19. Starosta W. Koordynacja ruchowa człowieka. In: Ciechaniewicz W, editor. Human motoricity – its structure, variability and determinants. Poznań: Akademia Wychowania Fizycznego w Poznaniu; 1993: 81-120 [in Polish]
20. Milanese C, Cavedon V, Corradini G et al. Seasonal DXA-measured body composition changes in professional male soccer players. J Sports Sci 2015; 33(12): 1219-1228
21. Kłossowski M, Klukowski K, Markiewicz L. Odrębności treningu wytrzymałościowego pilotów samolotów odrzutowych Med Lotn 1993; 1-2(27): 71-81 [in Polish]
22. Jasiński TL. Znaczenie ukierunkowanego treningu fizycznego w zwiększaniu tolerancji organizmu pilota wojskowego na przyspieszenia +GZ. Studia i Monografie. Kraków-Warszawa: Akademia Wychowania Fizycznego im. Bronisława Czecha; 2005 [in Polish]
23. Maciejczyk M, Wiecek M, Szymura J et al. Effect of body composition on respiratory compensation point during an incremental test. J Strength Cond Res 2014; 28(7): 2071-2077
24. Gaździńska A, Baran P, Skibniewski F et al. Częstość występowania nadwagi i otyłości u studentów lotniczej uczelni wojskowej a poziom ich aktywności fizycznej. Med Pr 2015; 66(5): 653-666 [in Polish]
25. Pałka T, Lech G, Tyka A et al. Wydolność fizyczna i morfologiczna budowa ciała profesjonalnych judoków i nietrenujących mężczyzn. Antropomotoryka 2010; 50: 85-89 [in Polish]
26. Mala L, Maly T, Zahalka F et al. Fitness Assessment: Body Composition. Prague: Karolinum Press; 2014
27. Barczyński BJ, Kalina RM. Science of martial arts – Example of the dilemma in classifying new interdisciplinary sciences in the global systems of the science evaluation and the social consequences of courageous decisions. Proc Manuf 2015; 3: 1203-1210
28. Kano J. The Contribution of Judo to Education. [originally the lecture given at the University of Southern California on the occasion of the 10th Olympiad]. J Health Phys Educ 1932; 58: 37-40
29. Kalina RM, Barczyński BJ. Archives of Budo Science of Martial Arts and Extreme Sports – A reason for this new branch journal. Arch Budo Sci Martial Art Extreme Sport. 2013; 9: 1-9
30. Kalina RM, Marciniak M. Judo w psychofizycznym przygotowaniu pilotów wojskowych. Prz Wojsk Lotn Obr Pow 1997; 11: 84-88 [in Polish]
31. Oleksy M, Kalina RM, Mosler D et al. Quasi-apparatus shime waza test (QASWT) – validation procedure. Arch Budo 2018; 14: 133-147
32. Kalina RM, Jagiełło W. Non-apparatus, Quasi-apparatus and Simulations Tests in Diagnosis Positive Health and Survival Abilities. In: Ahram T, editor. Advances in Human Factors in Sports, Injury Prevention and Outdoor Recreation. AHFE 2017. Advances in Intelligent Systems and Computing. Cham: Springer; 2018; 603: 121-128
33. Tomczak A, Bąk R. Chances of survival in isolation in the case of Polish military pilots – a comparative analysis of the research from 1998 and 2018. Arch Budo Sci Martial Art Extreme Sport 2019; 15: 69-76
34. Kałużny R. Płaczek A. "Declared bravery" of Polish police officers (comparative studies of 1998 and 2010). Arch Budo 2011; 7(4): 247-253
35. Jaskólski E, Ordyłowski M. Konserwatyzm edukacyjny jako główny czynnik konfliktu pokoleń. In: Leczykiewicz T, editor. Proceedings of the conference „Walka i porozumienie. Komunikacja społeczna w zachowaniach obronnych"; 1996 May 28-29. Wrocław: Sekcja Wydawnicza Wyższej Szkoły Oficerskiej im. Tadeusza Kościuszki. Zesz Nauk Poglądy Dośw 1996; 2: 117-120 [in Polish]
36. Dictionary of Sport and Exercise Science. Over 5,000 Terms Clearly Defined. London: A & B Black; 2006
37. Kent M. The Oxford Dictionary of Sports Science and Medicine. Oxford-New York- Tokyo: Oxford University Press; 1994

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