ORIGINAL ARTICLE

Evaluation of judo practitioners' motor performance in relation to the criterion of targeted fitness of pilot cadets after a six-month training process

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Abstract

Background and Study Aim: The degree of physical load and the assessment of the effects of motor skills is the most important aspect of motor preparation of judo practitioners and pilots. Due to the type of physical preparation of judo practitioners and pilot cadets, the comparison of fitness between these groups can contribute to the verification of the training programme in terms of load optimization. The aim of this paper is knowledge about an effect of a six-months training on the motor fitness of judo practitioners compared to a group of pilot cadets (control group).

Materials and Methods: The research covered male cadets, mostly aged 19 who are students at the Air Force Military Academy in Dęblin. The cadets were divided into two groups. Group A was made up of students practising judo in a sports section, whereas group B was made up of pilot cadets who follow the programme of pilot training. The students underwent fitness tests before (examination I) and after (examination II) a six-month training period: Aviation Synthetic Efficiency Test (ASET); 1,000 m run,100 m run, pull-ups on the bar and a 'Rotational Test'. All the students had their heart rate (HR), blood pressure (BPS, BPD) measured prior to and after completing the ASET.

Results: In group A in examination II, there was a statistically significant increase in the ASET performance ($p<0.0001$), 1,000 m run, ($p<0.0001$) and the 'Rotational Test' ($p<0.0001$) in relation to examination I. In group B, in examination II, there was a statistically significant increase in the ASET performance ($p<0.01$), in the 1,000 m run ($p<0.01$) and pull-ups on the bar ($p<0.02$) in examination II in relation to examination I. In group B, the HR, BPS, BPD findings were significantly higher before and after completing the ASET than in group A.

Conclusions: A six-month training period for the judo practitioners significantly improved the performance in the ASET, in the 1,000 m run and in the 'Rotational Test'. Thus, judo is an important element in supporting the fitness of future military pilots, however, judo training is a more useful method of physical and mental preparation for survival.

Key words: Aviation Synthetic Efficiency Test • non-apparatus test • 'Rotational Test' • survival

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INTRODUCTION

The motor skills that play a crucial role in the physical preparation of the judo practitioners and pilot cadets are strength, speed, endurance and balance. Due to the type of a physical preparation of judo practitioners and pilot cadets, the comparison of fitness between these groups can contribute to a verification of the training programme in terms of load optimization. The application of fitness tests in judo practitioners, which have so far been used in relation to pilot cadets in monitoring targeted physical fitness might bring a lot of tangible benefits as a reference point. The nature and requirements of judo make its practitioners stand out with regard to a harmonious and comprehensive development of physical fitness, and a harmonious body build. By examining their performance and comparing them to pilots, the judo practitioners can enhance their training model and demonstrate an optimal performance in such abilities as strength, speed, endurance, motor coordination and balance. In the process of an optimum preparation for sports competitions, judo athletes should be characterized by adequate speed, strength, endurance, a good technique of performing *ukemi waza*, throwing techniques and a high level of body balance. The more important issues of fitness preparation of cadet pilots for flights in military aviation include an increase in tolerance to overloads, an achievement of adequate habituation with regard to the eye-hand coordination, as well as a spatial orientation and balance. These features undoubtedly affect the efficiency of the pilots' operational and physical performance during airborne tasks. A synthesis of all the activities that a pilot should master during the execution of air missions entails specific motor and fitness requirements for his body.

The optimal training process of the pilot cadet is also oriented towards on preparing him to perform an anti-strain maneuver (L-1) in the +Gz axis. A properly executed maneuver of tensing the skeletal muscles (anti-strain maneuver), on average, increases the tolerance of 1-2 G [1]. On the basis of electromyographic testing they include m. latissimus dorsi, m. intercostalis, m. buccinator m. sternocleidomastoideus, diaphragma, m. pectoralis major [2] and m. flank femoris, m. flank at m. erector rotationalae [3]. Since the Aviation Synthetic Efficiency Test (ASET) significantly correlates with 1,000 m run, 100 m run and with pull-ups on the bar [4], it may be helpful in determining the optimization of the motor emphasis in the training process of judo practitioners. Due to the diagnosticity of the ASET with regard to the complexity of motor skills, it has been applied in the environment of the cadets' preparation for flights [5]. While the ASET had previously been used for pilot cadets to determine their physical preparation for flights and to optimize motor load in the training process, it has not yet been used in any other sport, including judo.

Therefore, the aim of this paper is knowledge about an effect of a six-months training on the motor fitness of judo practitioners compared to a group of pilot cadets (control group).

A hypothesis was made that judo practitioners, after a six-month training process, will be able to statistically significantly improve their motor skills and balance (in fact: the body balance disturbation tolerance skills) but insignificantly compared to the control group.

MATERIAL AND METHODS

Participants

Twenty-eight cadets (males) were tested in two groups. Group A (tested, n = 14) was made up of cadets who trained in a judo sports section and who were preparing for the Polish Military Championships and group B (control, n = 14) made up of pilot cadets who were following a physical preparation programme for flights. Group A was aged 19.40 ±0.69 years and had the following somatic characteristics: body height 181.70 ±8.38 cm, body weight 79.68 ±12.01kg, BMI 24.05 ±2.53 $kg \cdot m^{-1}$.Group B was aged 20.57 ±0.51 years and had the following somatic characteristics: body height 176.21 ±4.22 cm, body weight 75.35 ±7.93kg, BMI 24.17 ±1.97 $kg \cdot m^{-1}$. Based on the comparison of the two groups, no intergroup differences were observed for age ($p = 0.51$),body height ($p = 0.46$), body weight ($p = 0.99$) or BMI ($p = 0.51$).

Study design

Fitness tests: In groups A and B, fitness tests were conducted twice before (examination I) and after the preparatory period (examination II). The following fitness tests were used for the examination: ASET; an analytical test: running at a distance of 1,000 m, 100 m, pull-ups on the bar and a 'Rotational Test' [6].

Load – *noun* **1.** a weight or mass which is supported **2.** the force that a body part or structure is subjected to when it resists externally applied forces **3.** the amount of something, usually weight, that a body part can deal with at one time [31].

Ukemi waza – safe fall technique.

Throwing techniques – in judo terminology ***nage-waza***

Randori – sparring in judo in which both participants practice attacking and defending [32].

Non-apparatus test – that motoric test (exercise endurance test) of the required reliability (accurate and reliable), which use does not require even the simplest instruments [33, see also 34, 35]

Physiological examination: All students were examined for the heart rate (HR), systolic blood pressure (BPS) and diastolic blood pressure (BPD). The checkup was performed with an electronic device of Microlife AG type before and after the ASET execution, prior to and on completion of the preparatory period.

Ethical issues

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

Procedures

Judo practitioners preparation programme for the Polish Military Championships

The training process involved judo technique exercises (*ukemi waza*, throwing) with low-load strength exercises. The strength exercises were combined with speed exercises. Speed was shaped after endurance loads. During the preparatory period, endurance exercises (running), strength exercises, technique and speed exercises were used. The following methods were exploited in the preparation of judo practitioners for sports combat: repetition, interval, stream and continuous, as well as practice fighting (*randori*). The workouts were performed in the aerobic and anaerobic metabolic zone. In group A, the length of practising as a competitor was on average 4 years. The training sessions were held 3 times a week, 90 minutes each.

Targeted physical preparation programme for pilots

The pilot's training process included field athletics, gymnastics on instruments and exercises on equipment designed to develop strength. During field athletics classes, pilot cadets performed general fitness exercises with an emphasis on endurance and speed using short and long running games and their variations. Instrument gymnastics classes included exercising gymnastic patterns on a bar, gymnastic handrails and free exercise patterns. On the strength equipment, the pilot cadets exercised those muscle parts which were involved in an anti-strain maneuver. The following methods were used in the physical preparation of the pilot cadets: repetition, interval, stream and continuous running. The workouts were performed in the aerobic and anaerobic metabolic zone. The classes were held 3 times a week, 90 minutes each.

Procedure for conducting the tests

1. The ASET embraced 16 practice stations over a distance of 60 m [4, 7, 8, 5].

The examined person stands on the starting line and on the command READY enters stand 1, taking the following position: "plank – both feet in the internal circle, the torso in the direction of the axis of the track"; the time is measured from the signal START:

- stand 1 – moving the body in the plank position on the external circle to the left or right by approx. 360°; the feet do not exceed the internal circle;
- stand 2 – plank sideways on the left hand in a circle, moving the torso on the feet, in a supported position, 360°, in the anti-clockwise direction;
- stand 3 – plank sideways on the right hand in a circle, moving the torso on the feet, in the supported position, 360°, in the clockwise direction;
- stand 4 – lying on the edge of the mattress, the head held perpendicularly to the track axis to the left, the hands straight along the long axis of the body above the head, rolling the torso to the right along the long axis of the body;
- stand 5 – lying on the edge of the mattress, the head held perpendicularly to the track axis to the right, the hands straight along the long axis of the body above the head, rolling the torso to the left along the long axis of the body
- stand 6 – sitting on the edge of the bench, the hands interlaced at the neck of the torso, triple-shift of the body with feet on the bench towards its other end along the track axis;
- stand 7 – rolling forwards on a mattress;
- stand 8 – running on the reversed bench outside the further support of the bench with a minimum of a double feet contact;
- stand 9 – rolling backwards on a mattress;
- stand 10 – changing the position of 3 kg medicine balls arranged at a distance of 3 m from each other, perpendicular to the track axis;

- stand 11 – running with 2 weights of 17.5 kg around the stands which are set up along the track axis at a distance of 4 m, and placing the weights on the previously marked spot;
- stand 12 – jumping over 3 hurdles, feet together;
- stand 13 – jumping over the first hurdle (feet together), going under the second hurdle and jumping over the third hurdle, feet together;
- stand 14 – running ahead, then rolling forwards on 4 elements of the box;
- stand 15 – running "on all fours" towards the finish line;
- stand 16 – hand standing at the wall – towards the finish line means switching off the time.

The structure of the ASET is described in detail in previous scientific papers [4, 7, 8, 5]. The evaluation criteria for the ASET were as follows: 43s – very good grade; 45s – good grade; 47s – satisfactory grade. The speed was measured with an electronic timer with an accuracy of 0.01s.

2. The 1,000 m run was conducted at a stadium from a high start in sports shoes; the speed was measured with an electronic timer with an accuracy of 0.01s.

3. The 100 m run was conducted at a stadium from a low start in sports shoes; the speed was measured with an electronic timer with an accuracy of 0.01s.

4. The pull-ups were performed as an over grasp on the horizontal bar; the exerciser performing the pull-ups had to place his chin over the bar and then to lower the body to straighten the upper limbs in the elbow joints and repeat the cycle.

5. The balance was assessed using the 'Rotational Test' [6] (non-apparatus version). The student, standing on the line, was supposed to jump up with a full rotation in the air, alternately clockwise and counter-clockwise, repeated 3 times, and land with both feet on the line in approx. 12 s in a constant rhythm. Several training jumps were permitted. The accuracy of landing and maintaining the balance was scored (0 – clean jump, 1 – one foot off line, 2 – both feet off line, 3 – lost balance with hand support) and totalled for all 6 jumps (score range from 0 – excellent to 18 – unsatisfactory). Criteria of an individual level assessment determined by the 'Rotational Test' are as follows: very high (0-1), high (2-3), average (4-9), low (10- 12), very low (13-15), insufficient (16-18).

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

Statistical analyses

The author used descriptive statistics to analyse the results of the examination by calculating mean and standard deviations (±) for all study variables. The difference (Δ) between the values before and after the training process in the groups studied was calculated. A normal distribution of the variables was checked by means of the Kolmogorov-Smirnov test. The assessment of the equality of variances was conducted by means of Levene's test.

The difference between the dependent variables in the study groups and between the groups before and after the training process was calculated by using an analysis of variance (MANOVA) with repeated measurements and Tukey's Honest Significant Difference (HSD) test for post hoc comparisons in pairs.

The values of effect size variables were calculated for dependent and independent groups using Cohen's d test in the adopted criteria: small (d = 0.20 to 0.49), moderate (d = 0.50 to 0.79) and large (d>0.80) [9]. The statistical analysis of the study was performed by means of Statistica 13.3 statistical software. The differences between mean values were considered significant when the p value was smaller than 0.05.

RESULTS

Found in group A a statistically significant difference between examination I and examination II in overcoming the ASET, 1,000 m run and a 'Rotational Test' (fewer errors), indicating better fitness results (Table 1). In group A, there was a statistically significant decrease in HR before the ASET execution in examination II against examination I and a significant increase in HR after the

ASET execution in examination II, as compared to examination I (Table 1). Group B showed statistically significant better fitness in examination II compared to examination I in the ASET, 1,000 m run and pull-ups on the bar (Table 1).

Examination I showed statistically significant better fitness in group B rather than in group A in the ASET, 1,000 m run, pull-ups on the bar (Table 2). In group B, in examination II, a statistically significant better result was observed in pull-ups on the bar than in group A (Table 2). Group B also in examination II showed a statistically significant higher HR before the ASET execution compared to group A. In the same group, in examination I and II, there was a statistically significant increase in HR after the ASET and BPS execution prior to and on completion of the ASET as compared to group A (Table 2). In group A, there was a higher statistically significant BPD after the ASET completion in execution II compared to group B. No significant result values were found in the other indicators.

In group A, examination II showed a statistically significant correlation between the ASET, 1,000 m run and pull-ups on the bar. In group B, in examination II, a high correlation was observed only between the ASET and pull-ups on the bar (Table 3). In group A, the highest effect size values calculated by Cohen's d test were recorded in the ASET, 1,000 m run and the 'Rotational Test'. Group B showed large effect size values in the ASET, 1,000 m and pull-ups on the bar (Table 1).

DISCUSSION

The fitness tests demonstrated that in both groups, in examination II, there was an improvement in physical fitness compared to examination I with the used training programmes. In examination I, both groups found that motor performance as measured by the ASET was below the lower limit of the performance standard. Examination II showed an improvement in the ASET execution in group A on a good level and in group B on a very good level. It was observed that the value of Cohen's d effect size value in overcoming the ASET in group A was higher than in group B. This fact is due to the significance of difference in the ASET, in examination I, in favour of group B (control). Similarly, the 1,000 m distance test revealed a statistically significant performance improvement in examination II in both groups, although in examination I the significance was demonstrated to be in favour of the control group.

The examination conducted by Wochyński et al. [4] indicated that achieving maximum scores in individual competitions such as 1,000m run, 100m run and pull-ups on the bar resulted in a simultaneous deterioration in performance in the ASET execution. This is confirmed by Starosta's observations [10], which indicate that emphasising the development of conditioning abilities may impair the enhancement of coordination abilities. Coordination abilities are more strongly genetically determined. Moreover, the development of strength and endurance abilities may be a disrupting factor. T heir rapid development may inhibit or reduce the development of almost all coordination skills. The fact that the load is exceeded in the formation of general physical fitness (e.g. in endurance exercises) may be closely related to a decrease in the level of motor skills and motor abilities necessary for the judo practitioners and for pilots. The relationship between the load values and the diminished movement coordination was also observed in other scientific works [11-13].

The correlation between the ASET and the analytical test shows that the judo group should improve their speed in order to achieve correlation at the 100 m distance. In group B, the correlation between the ASET and pull-ups shows a definite advantage of strength exercises in the training process at the expense of a reduction in endurance and speed.

The performance findings with regard to body equilibrium in the study groups measured by the 'Rotational Test' are quite interesting [6]. It was observed that group A showed a significant improvement in performance in the 'Rotational Test' in study II compared to study I. This was probably due to the effect of the judo practitioners' training programme on the vestibular organ and the specificity of judo exercises. There was also a significant improvement in balance in group B. Balance plays a special role for judo athletes and pilots.

So far, Tomczak (also with co-authors) has fully investigated the sensitivity of the 'Rotational Test' (just in a non-apparatus version, meaning: without measuring the test execution time) to the impact of the environment on the human in which it operates [14-17]. In his latest monograph [18], he stated that 'Rotational Test' was the most sensitive

Table 1. Difference in HR, BPS, BPD and physical fitness (mean and standard deviation) between examination I and II in groups A (judo practitioners n = 14) and B (pilot cadets n = 14).

Group	Examination I	Examination II	Cohen's d test	Δ (post-pre)	P
ASET (s)					
Group A	50.17 ±0.84	43.38 ±1.19	5.71	−6.79	**<0.0001**
Group B	47.01 ±0.55	42.63 ±1.07	4.68	−4.38	**<0.01**
Run 1000m (s)					
Group A	237.35 ±13.21	217.28 ±8.48	1.38	−20.07	**<0.0001**
Group B	228.28 ±8.47	219.00 ±8.45	0.89	−9.28	**<0.01**
Run 100m (s)					
Group A	13.32 ±0.43	13.20 ±0.31	0.24	−0.12	0.43
Group B	13.37 ±0.65	13.19 ±0.46	0.24	−0.18	0.41
Pull-ups on the bar (amount)					
Group A	11.14 ±2.10	11.57 ±1.50	0.18	0.43	0.54
Group B	13.14 ±2.10	15.42 ±2.53	0.82	2.28	**<0.02**
'Rotational Test' (pts)					
Group A	4.64 ±1.82	2.07 ±0.82	1.34	−2.57	**<0.0001**
Group B	3.57 ±1.94	2.42 ±1.98	0.48	−1.15	0.13
HR before execution ASET (beat·min^{-1})					
Group A	70.35 ±3.58	67.64 ±2.64	0.67	−2.71	**<0.05**
Group B	72.35 ±6.34	71.50 ±5.61	0.11	−0.85	0.70
HR after execution ASET (beat·min^{-1})					
Group A	141.42 ±15.06	160.71 ±6.32	1.22	19.29	**<0.001**
Group B	168.85 ±8.76	167.28 ±7.08	0.15	−1.57	0.60
BPS before execution ASET (mm Hg)					
Group A	124.21 ±2.63	122.50 ±2.44	0.54	−1.71	0.08
Group B	129.42 ±5.85	127.00 ±3.65	0.37	−2.42	0.19
BPS after execution ASET (mm Hg)					
Group A	167.85 ±4.68	170.00 ±3.55	0.40	2.15	0.18
Group B	174.92 ±6.77	172.85 ±5.39	0.26	−2.07	0.37
BPD before execution ASET (mm Hg)					
Group A	79.57 ±5.01	78.42 ±4.87	0.18	−1.15	0.54
Group B	82.71 ±4.66	81.00 ±3.16	0.33	−1.71	0.26
BPD after execution ASET (mm Hg)					
Group A	96.35 ±5.49	95.35 ±5.49	0.14	−1	0.63
Group B	93.57 ±4.38	91.35 ±3.17	0.45	−2.22	0.13

ASET Aviation Synthetic Efficiency Test; **HR** heart rate; **BPS** blood presure systolic; **BPD** blood presure diastolic; **pts** points; **s** seconds.

Table 2. Difference in HR, BPS, BPD and physical fitness between group A (judo practitioners) and B (pilot cadets) in examination I and II.

Group	Group A n = 14	Group B n = 14	Cohen's d test	F	p
ASET (s)					
Examination I	50.17 ±0.84	47.01 ±0.55	3.41	136.33	**<0.0001**
Examination II	43.38 ±1.19	42.63 ±1.07	0.53	3.06	0.09
Run 1000m (s)					
Examination I	237.35 ±13.21	228.28 ±8.47	0.62	4.67	**<0.0001**
Examination II	217.28 ±8.48	219.00 ±8.45	0.16	0.28	0.59
Run 100m (s)					
Examination I	13.32 ± 0.43	13.37 ±0.65	0.07	0.05	0.81
Examination II	13.20 ±0.31	13.19 ±0.46	0.02	0.009	0.92
Pull-ups on the bar (amount)					
Examination I	11.14 ±2.10	13.14 ±2.10	0.77	6.30	**<0.02**
Examination II	11.57 ±1.50	15.42 ±2.53	1.64	23.99	**<0.0001**
'Rotational Test' (pts)					
Examination I	4.64 ±1.82	3.57 ±1.94	0.46	2.25	0.14
Examination II	2.07 ±0.82	2.42 ±1.98	0.22	0.38	0.54
HR before execution ASET (beat·min^{-1})					
Examination I	70.35 ±3.58	72.35 ±6.34	0.34	1.05	0.31
Examination II	67.64 ±2.64	71.50 ±5.61	0.81	5.40	**<0.05**
HR after execution ASET (beat·min^{-1})					
Examination I	141.42 ±15.06	168.85 ±8.76	1.68	34.65	**<0.0001**
Examination II	160.71 ±6.32	167.28 ±7.08	0.81	6.69	**<0.02**
BPS before execution ASET (mm Hg)					
Examination I	124.21 ±2.63	129.42 ±5.85	1.06	9.23	**<0.01**
Examination II	122.50 ±2.44	127.00 ±3.65	1.26	14.65	**<0.001**
BPS after execution ASET (mm Hg)					
Examination I	167.85 ±4.68	174.92 ±6.77	1.05	10.31	**<0.01**
Examination II	170.00 ±3.55	172.85 ±5.39	0.54	5.80	**<0.05**
BPD before execution ASET (mm Hg)					
Examination I	79.57 ±5.01	82.71 ±4.66	0.52	2.94	0.09
Examinat	78.42 ±4.87	81.00 ±3.16	0.48	2.73	0.10
BPD after execution ASET (mm Hg)					
Examination I	96.35 ±5.49	93.57 ±4.38	0.44	2.19	0.15
Examination II	95.35 ±5.49	91.35 ±3.17	0.67	5.55	**<0.05**

ASET Aviation Synthetic Efficiency Test; **HR** heart rate; **BPS** blood presure systolic; **BPD** blood presure diastolic; **pts** points; **s** seconds.

Table 3. Pearson correlation between the ASET results, analytic test results and 'Rotational Test' in group A (n = 14) and B (n = 14) in examination I and II.

Correlation: r-Pearsona ASET (m·s^{-1})				
	Group A		Group B	
Variable	Examination I r	Examination II r	Examination I r	Examination II r
Run 1000m (m·s^{-1})	−0.09	**0.61****	0.07	0.28
Run 100m (m·s^{-1})	−0.20	−0.04	0.45	0.30
Pull-ups on the bar (amount)	−0.38	**−0.53***	−0.39	**−0.90*****
'Rotational Test' (pts)	0.20	−0.24	0.27	−0.07

ASET Aviation Synthetic Efficiency Test; *p<0.05; **p<0.02; ***p<0.0001; **r** correlation coefficient

diagnostic tool among the coordination tests he used. Witkowski et al. [19] recommend the non-apparatus version ‚Rotational Test' it can be a complement to the International Physical Fitness Test. Bąk [20] correlated the result of the ‚Rotational Test' with the results of the test measuring the susceptibility the body injuries during the fall (STBIDF). He stated: a statistically significant relationship (men r = 0.639, p<0.01; women r = 0.583, p<0.01). Mroczkowski and Sikorski [21] studied 88 children aged 10 to 12 (53 boys and 35 girls) but revealed solely a negative correlation between the results of 'Rotational Test' and global coordination (measured with the use of Starosta coordination test [22]): boys, r = −0.612 and girls, r = −0.578. On the other hand, Maśliński et al. [23] in a review dedicated to original methods and tools used for studies on the body balance disturbation tolerance skills (BBDTS) of the Polish judo athletes from 1976 to 2016, showed that judo training stimulates the development of this very important coordination ability. Kruszewski et al. [24] who used the 'Rotational Test' in their research found that regular, specific physical training improved balance in athletes and soldiers.

Other studies have shown a higher level of stability of the examined participants in the sagittal plane after the Bárány rotational chair test [25]. The author's research has demonstrated that the exercises on the Special Aviation Gymnastic Instruments (SAGI) contribute to increased stability, which may account for significantly statistically better results in the ASET [5]. It is believed that balance in both groups also depends on the optimization of the load and the emphasis of shaping motor skills during the training process.

The highly statistically significant correlation between the ASET and pull-ups on the bar in group B in study examination II and its decrease between the ASET and the 'Rotational Test', compared to group A, is a good example of this correlation. Group B had a significantly higher number of pull-ups on the bar compared to group A because in the final stage of preparations a great deal of emphasis was made on strength and the Valsalva maneuver.

This resulted from the fact that after a period of targeted training, Group B was scheduled to perform an overload maneuver on a G-force centrifuge. According to some authors, the most important pilot's skills are strength and speed. Endurance plays a less important role due to diminished tolerance to G-force [26]. The belief that the pilot has a lower endurance capacity needs to be verified as it has not been confirmed in earlier studies [27]. It has been proved that the selection of candidates for aviation and the fitness preparation of pilot cadets should take into account their motor type [8] and body build [28]. A recent study conducted on a G-strain centrifuge showed that cadets who excel in endurance and strength abilities achieved the longest total rotational time with interval characteristics; worse findings were obtained by the group excelling in speed and strength abilities [27]. It seems that HR, BPS, BPD demonstrated to be statistically significantly higher in group B compared to group A may be related to a higher level of strength ability. The observed increase in arterial pressure may result from the loading of significant muscle groups with heavy weights and the performance of the Valsalva maneuver [29, 30].

Group A had lower HR, BPS and BPD since the load of the motor exercises was optimally distributed compared to group B. The assessment of judo practitioners' performance with regard to the pilot fitness criteria is good and shows a proper level of motor preparation, as evidenced by the ASET findings and the correlations between the ASET exercises, the 1,000 m run and pull-ups on the bar in examination II. The results of the study showed that the ASET plays a key role in the motor preparation of judo practitioners with regard to the use of load optimization in shaping motor skills, similarly to pilot cadets. Of all the tests performed among the judo practitioners, the greatest improvement in performance was observed in the ASET, confirmed by the effect size value of Cohen's d test.

CONCLUSIONS

The six-month period of physical preparation of judo practitioners had a statistically significant influence on the enhancement of targeted fitness as measured by the ASET, 1,000 m run and the 'Rotational Test'. On the other hand, it was insignificant in the 100 m run and pull-ups on the bar. Compared to the control group, the students performed better in the 1,000 m run and the 'Rotational Test'. They performed worse in the ASET exercises and in the 100 m run, however, they were statistically insignificant. The judo practitioners had statistically significantly worse results in the pull-ups on the bar compared to the pilot cadets' group (control). Thus, judo is an important element in supporting the fitness of future military pilots, however, judo training is a more useful method of physical and mental preparation for survival.

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