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KINESIOLOGY & COACHING

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Eight weeks of progressive pre-competition training has positive effects on physical performance and mental stability in junior judokas

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Key words: martial arts, training program, physical fitness, performance anxiety, athletic performance

Abstract
Background. Competition-specific training programs must consider both the physical benefits and their effects on pre-competition psychological mental stability.
Aim. To analyse the effects of applying a pre-competition judo training program on the level of pre-competition psychological stability (SCAT) and special judo fitness test (SJFT) in junior athletes.
Methods. Sixteen male junior judokas (17±1.4 years; 8±2.2 years of judo experience) participated in an 8-week training program. The program-controlled variables included volume and load intensity, Stagnos' Training Impulse indicators and perceived exertion. SJFT was used to determine a specific level of fitness in pre- and post-training judo. The Sports Competition Anxiety Test was used to assess the level of pre-competition anxiety and mental stability before the training program and before the first combat in a competition. A control group participated in normal training sessions.
Results. The intensity of the load gradually increased during the microcycles (70-90% of the maximum load), allowing an increase in aerobic capacities, a positive adaptation to training loads and an increase in physical performance. As the competition approached,

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the training content approached the effort-pause ratio required in a competition (90-100% of the maximum load; pause:20 seconds after-repetitions; 60 seconds after-series). This training program showed statistically significant improvements in the SJFT (13.4±0.3 pretraining vs.

12.7±0.4 posttraining; p<0.001) and the state of psychological preparation (20.4±3.6 pretraining vs. 19±1.4 post-training, p<0.001), which did not occur in the control group.

Conclusions. The proposed training program had a positive effect on the mental stability and specific performance of junior judokas.

Introduction

Judo is a popular Olympic combat sport in the world, in which both physical and psychological preparation situations for athletes should receive attention [Miarka *et al.* 2016]. In recent years, many studies have focused on explaining the combat actions in different weight divisions, sex and age categories of judokas [Franchini *et al.* 2005; Miarka *et al.* 2016; Miarka *et al.* 2010]. In addition, other studies have investigated different characteristics of judo combat, such as approach, gripping [Calmet *et al.* 2010; Barreto *et al.* 2019] attacks, defences and counterattacks [Brito *et al.* 2017], penalties and their causes, score ratios obtained through throw and ground techniques [Ahmedov 2020], and duration times per combat [Ahmedov *et al.* 2021]. Achieving high results in judo with both physical and technical-tactical skills [Franchini *et al.* 2011] requires a high level of training of athletes [Franchini *et al.* 2008]. Therefore, to improve judoka's integral training through methods that increase physical, technical, tactical and mental aptitude, as well as to adapt to competition conditions, specialists have carried out studies with simulated combat – *randori* [Franchini, Takito 2014].

In recent years, there has been an increase in official judo competitions [Sikorski 2011]. Along with the increase in the number of competitions, there is a problem of fixing stable results in these competitions, constantly maintaining athletic performance, and stabilizing physical, technical, tactical, and mental training [Garatachea *et al.* 2012]. Additionally, this question indicates the need to develop suitable training programs for coaches and athletes based on modern sports theory [Issurin 2008; Issurin 2010]. The most important condition for organizing the training of judokas and coaches and achieving high results is to determine the optimal form of these training loads. Currently, we believe that our scientific knowledge, modern approaches and experience in the organization of training are not at a level that fully meets the real needs of athletes. Furthermore, training without scientific knowledge does not achieve the maintenance of sporting performance and can also negatively affect athletes' health and judoka's results [Meeusen *et al.* 2013].

Many studies have analysed the influence of training on the technical, tactical and physical levels of successful judokas in competitions [Kuvacic *et al.* 2017; Krstulovic, Sekulic 2013; Koga *et al.* 2013; Brito *et al.* 2011]. However, there are few studies on the influence of judoka training on the level of psychological stability in preparation for competition [Ziv, Lidor 2013; Campos *et al.* 2001; Han 1996]. Thus, to the best of our knowledge, little has been reported about the development of specific training programs for competitions, observing their effectiveness in a competitive nature and their effect on pre-competition (psychological) mental stability, especially in junior athletes. In this context, the aims of this study are to develop an eight-week pre-competition training program for junior athletes and to determine the positive impact of that training program on the level of pre-competition psychological stability and special judo fitness tests. We hypothesize that a training program based on the gradual increase in load intensity during microcycles will allow for an increase in specific judo aptitude and a higher level of mental stability, as the training characteristics will resemble what occurs in competition.

Materials and methods

Experimental Approach

Junior athletes were screened at the pre-competition training program. Initially, fitness level and competitive anxiety were evaluated. The Special Judo Fitness Test (SJFT) was used to assess fitness level [Sterkowicz 1995], and pre-competition anxiety was assessed using the Sport Competition Anxiety Test (SCAT) proposed by Martens [1977]. After performing the measurements, the suggested training program was applied to the judokas in the experimental group, while the control group attended normal training sessions. After eight weeks of training sessions, the measures were performed again. No changes were made in the nutritional or hydration status of participants. The Local Ethical Committee approved the research procedures (Protocol number N4323-10, 02.11.2018). Before the experiment, participants attended a briefing meeting. This study included participants ≤18 years of age; therefore, the parents signed an informed consent form authorizing the participation of athletes. Fig. 1 shows the study design.

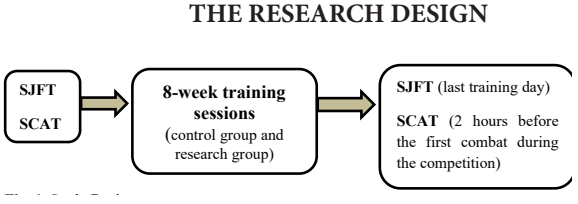


Fig. 1. Study Design

Participants

The inclusion criteria for this study were as follows: a) male competitive judo athlete; b) cadet athlete (16-17 yrs); c) ≥ 6 yrs training; d) no injury that compromises participation in training and tests. Those who did not complete all stages of the study or wished to withdraw from the study were excluded. Sixteen well-trained male judokas took part as volunteers in this study (experience: 8.0±2.2 yrs). The simple random sample method was used before dividing the control and research groups. All participants chose hidden numbers (1 to 16). The judokas who chose the odd numbers (1, 3, 5, 7, 9, 11, 13, 15) were assigned to the control group (CG; n: 8, age: 17±0.8 yrs; weight: 74.3±2.4 kg; height: 177.2±5.3 cm), and who chose the even numbers (2, 4, 6, 8, 10, 12, 14, 16) were assigned to the experimental group (EG; n: 8, age: 17±0.2 yrs; weight: 75.1±3.6 kg; height: 178.1±4.1 cm).

The Training Program

The proposed training program can be seen in Table 1.

Table 1. Description of the progressive eight-week training program

Microcycles	Specific Judo Exercises	Repetitions and time durations	Rest time between and post exercises	HR during the exercises
I-II (Developmental)	Warm-up	12 minutes	60 seconds between and after the repetitions; 5 minutes between *randori* exercises	HR 150-160 bpm/min.
	Ne-waza	2x2 minutes		
	Uchikomi	2x3 minutes		
	Yaku-soku-geiko	2x3 minutes		
	Randori	4x5 minutes		
III-IV (Peaking)	Warm-up	12 minutes	30-45 seconds between the repetition; 60 seconds after repetition; 5 minutes between *randori* exercises	HR 180-190 bpm/min.
	Ne-waza	2x2 minutes		
	Uchikomi	5x30 seconds		
	Yaku-soku-geiko	4x1 minute		
	Randori	4x5 minutes		
V (Regeneration)	Warm-up	12 minutes	60 seconds between and after the repetitions; 5 minutes between *randori* exercises	HR 60-170 bpm/min
	Ne-waza	2x2 minutes		
	Uchikomi	4x1 minute		
	Yaku-soku-geiko	1x5 minutes		
	Randori	4x5 minutes		
VI-VII (pre-competition)	Warm-up	12 minutes	30 seconds between the repetition; 60 seconds after repetition; 5 minutes between *randori* exercises	HR 180-190 bpm/min
	Ne-waza	3x2 minutes		
	Uchikomi	6x20 seconds		
	Yaku-soku-geiko	4x2 minutes		
	Randori	4x5 minutes		
VIII (Competitive)	Warm-up	12 minutes	20 seconds between the repetition; 60 seconds after repetition; 5 minutes between *randori* exercises	HR ≥ 190 bpm/min
	Ne-waza	3x1 minute		
	Uchikomi	6x15 seconds		
	Yaku-soku-geiko	3x1 minute		
	Randori	4x5 minutes		

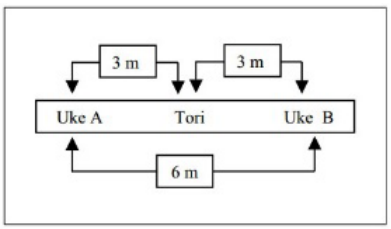
HR – heart rate.

Each group of judokas participated in 3 sessions days/week (Monday, Wednesday and Friday) for 8 weeks, totalling 24 sessions. Each training session ranged between 80-90 minutes, and every training session was planned by the researchers. The training sessions included 12.0±2.1 minutes of warm-up (light running, stretching and other exercises), 12.1±4.5 minutes of specific judo training *(uchikomi, ne-waza, yaku-soku-geiku*), 20 minutes of *randori* exercises and 10 minutes of recovery exercises. Each athlete had a minimum of 4 contests (≈ 5 minutes each), and additional contests were optional. In the application process of the proposed training program, the load volume (in minutes), Stagnos' Training Impulse (TRIMP) indicators [Stagno *et al*. 2007], load intensity (% HRMAX) and perceived exertion rating (PER) scales [Foster *et al*. 2017] were verified, and their correlation was based on the Pearson correlation method in both groups.

Measures

Special Judo Fitness Test (SJFT) – During this test, the evaluated athlete is called *tori,* and the other two partners are called *uke*. Before the test, both *ukes* are separated from each other by 6 m, and the *tori* is positioned in the middle of them, 3 m away from each *uke.*

This test is composed of three effort moments (15 seconds x 30 seconds x 30 seconds) with a 10 second break between them. On a signal, the *tori* sprints to one of the partners and employs the throwing technique called *ippon-seoi-nage* and then sprints to the second partner to throw down him with *ippon seoi nage*. Consecutively, *tori* must complete as many throws as possible within each effort moment using this technique. The total frequency of completed throws during each period was recorded, and the *tori*'s heart rate (HR) was measured immediately after and 1 minute after the test (Polar RS800®, Polar, FIN). Finally, the SJFT index was calculated by the formula [Index = (HR after + HR 1 min after) / total number of throws]. This specific judo test was performed and classified according Franchini *et al.* [2009]. Based on the SJFT result classification, the lower index is the better than high.



Sport Competition Anxiety Test (SCAT) – All participants responded to a special questionnaire designed by Martens two hours before the first fights in the competition process [Martens 1977]. The responses to the 15 questions were never, sometimes and often. The highest score is 30, and the lowest is 10. A low score indicates

a low anxiety level, while a high score indicates a high anxiety level. The SCAT contains 15 items, 10 of which measure symptoms associated with anxiety, with 5 others that are not scored included to reduce the likelihood of an internal response-set bias. The scores for the 10 items are summed to provide an overall measure, with a high score reflecting a greater tendency to experience competitive anxiety. A score of less than 17 indicates a low level of anxiety, 17 to 24 an average level of anxiety, and more than 24 a high level of anxiety.

Statistical analysis

The statistical tests were processed in SPSS software (version 20.0; SPSS, Inc., Chicago, IL, USA), and a significance level of $p \leq 0.05$ was used for all analyses. The Kolmogorov–Smirnov test (K-S) was applied to determine the normal distribution of data. Descriptive data are presented as the mean and standard deviation (M±SD), and Student's t-test was used to assess statistical significance. Pearson correlation coefficient was conducted to assess the relationship between the variables, and the following criteria were used: 0.7 to 0.9 positive or negative indicates a strong correlation; 0.5 to 0.7 positive or negative indicates a moderate correlation; 0.3 to 0.5 positive or negative indicates a weak correlation; 0 to 0.3 positive or negative indicates a non-correlation.

Results

Physical Load Characteristics

The physical load characteristics of the training program are described in Table 2. In the first two microcycles, a load exceeding the intensity was achieved, and the variations in the mean values of load volume, Stagnos' TRIMP, load intensity and the rating of perceived exertion (RPE) were similar between the control and experimental groups. In the third and fourth microcycles, there was a maintenance of the load volume, increased load intensity and RPE, in addition to differentiation between the groups for Stagnos' TRIMP (CG= 174.7-161.0 vs. EG= 192.7-188.0, $p<0.0021$). In the 5th microcycle, a relative decrease in the intensity of the load was observed, and a "regeneration" microcycle was used in the experimental group. In this microcycle, an increase in load volume compared to the intensity and a decrease in the proportion of specialized exercises were achieved. The sixth and seventh training microcycles were characterized as pre-competition. In the competitive microcycle (VIII), the experimental group reached higher values for Stagnos' TRIMP (CG= 127.6 vs. EG= 254.7) and on the RPE scale (CG= 8 vs. EG= 9, peak of EG) than the control group.

Table 2. Load volume, Stagnos' TRIMP, %HRMAX and PER scales during the training in control and experimental group judo athletes.

Microcycles	Groups	Load volume (minutes)	Stagnos' TRIMP	%HRMAX	RPE
I	CG	59.0±10.5	60.2±18.1	70-80	6
	EG	58.3±13.6	58.2±30.9	70-80	6
II	CG	54.3±6.9	42.5±12.4	70-80	6
	EG	53.5±6.9	49.0±18.7	70-80	6
III	CG	54.5±0.8	174.7±14.2	90-100	8
	EG	53.5±2.0	192.7±25.4	90-100	8
IV	CG	56.3±1.5	161.0±23.2	80-90	8
	EG	55.3±3.4	188.7±35.3	90-100	8
V	CG	58.5±4.2	157.5±18.3	80-90	8
	EG	64.6±9.2	118.7±66.1	80-90	7
VI	CG	58.1±3.3	182.7±21.4	90-100	8
	EG	55.5±5.8	195.1±17.3	90-100	9
VII	CG	55.3±5.6	179.7±14.2	90-100	9
	EG	54.8±5.7	204.6±31.9	90-100	9
VIII	CG	58.3±13.2	127.6±9.4	80-90	8
	EG	57.0±0.0	254.7±34.7	90-100	9

% HRMAX – load intensity; RPE – rating of perceived exertion; CG – control group; EG – experimental group.

Table 3 shows the correlations between Stagnos' TRIMP and RPE results of the control and experimental groups. The control group showed a low correlation, while the experimental group showed a strong correlation between parameters.

Table 3. Correlation relationship %HRMAX, RPE and Stagnos' TRIMP

Variables	Control Group (n=8)		Experimental Group (n=8)	
	%HRMAX	RPE	%HRMAX	RPE
RPE	0.54	-	0.93	-
Stagnos' TRIMP	0.53	0.62	0.98	0.94

% HRMAX – load intensity; RPE – rating of perceived exertion.

Table 4. Pre- and post-test results of SJFT and SCAT of the control and experimental groups.

Measures	Groups	Pretest		Post test		t	p	Changes (pretest - post test results) (%)
		M±DP	ν%	M±DP	ν%			
SJFT	CG	13.5±0.4	3.3	13.3±0.5	4.1	0.9	0.26	1.5
	EG	13.4±0.3	2.5	12.7±0.4*	2.9	5.6	0.001	5.6
SCAT	CG	20.1±1.7	8.6	19.8±0.8	3.9	1.7	0.09	1.2
	EG	20.4±3.6	8.6	19.0±1.4*	7.6	10.7	0.001	6.7

SJFT - Special Judo Fitness Test; SCAT – Sport Competition Anxiety Test; CG-control group; EG-experimental group. * p=0.001 vs. Pretest.

Changes in Special Fitness and Pre-competition Psychological Level

Table 4 shows the scores of the SJFT and SCAT test results for the control and experimental groups. After the training program, there was a relative increase in the SJFT and SCAT scores in the experimental group ($p<0.001$), while in the control group, there was no significant increase. At the end of the training program, the judokas in the

experimental group had a 5.6% increase in their specific aptitude and a 6.7% increase in the psychological stability index.

Discussion

The purpose of this study was to develop a pre-competition training program for junior athletes and to determine whether this program had a positive impact on pre-competition psychological stability and SJFT. The main results confirmed that an effectively organized training program for competitions has positive effects on the level of mental stability and special fitness of judo athletes. According to Blumenstein *et al*. [2005], a correctly planned preparation will allow the judoka to achieve peak performance in competitions. To achieve victory, it is essential that the athlete be psychologically prepared, as some techniques applied in judo, need quick responses when opponents attack these techniques. Also, it is important to indicate that effective implementation of different technical combinations and feints is directly connected with athletes' both physiological and psychological preparedness. When the athlete is able to anticipate, the counterattack can be applied efficiently. Just as psychological stability is important, it is also important that the fighter is physically well-prepared. However, to the best of our knowledge, few studies have focused attention on the preparation of judokas in training (i.e., cadets and juniors). Similar to our results, Fukuda *et al*. [2013] observed that 4 weeks of periodized training improved performance in the SJFT by 5.9%.

In the first two microcycles of training, mainly aerobic exercises were used, and the load intensity was lower than that of the other microcycles. In the first microcycles, it was considered that judoka should be adapted to both training loads. For this reason, the first two microcycles were given 60 seconds of recovery time both between and after exercise sessions. The repetition and time durations of each specific judo exercises were equal. This approach ensured the proportionality of the training load and intensity. The load intensity (%HRMAX) was 70-80%. This approach is intertwined with several other studies. It is noted that at the initial stage of training, judoka to increase aerobic capabilities and positive adaptation to training loads is effective mainly when using aerobic exercises [Norris *et al.* 1990; Sozen, Akyldiz 2018]. In the 3rd and 4th microcycles, the load intensity gradually increased. In particular, between an exercise series of 30-45 seconds and after a series of 60 seconds, the recovery time was given, and the load intensity was %HRMAX 80-90%. During this period of preparation, the repetition of the specific judo exercise was multiplied and time durations were shortened. Between the exercises, there was a process of partial and complete recovery after the exercises. As noted in the study [Hesari *et al*. 2014], a gradual increase in physical activity leads to an effective adaptation of the judoka in terms of physical, technical, tactical, and mental performance and effective assimilation of the task set. For this reason, a gradual increase in load intensity and the volume of the loads during the study was also achieved.

As the competition approached, the training content, in particular, the load intensity (%HRMAX), the relative ratio of work and recovery time, increasingly approached the requirements of the competition. The results of the study showed that effect-pause parts in judo contests were exchanged [Castarlenas, Planas 1997], and the effect part was defined as lasting an average of 18±8 seconds, while the pause part was defined as lasting 12±4 seconds. In another research [Miarka *et al*. 2011], it was noted that the ratio of pause and episode parts of the combats is determined by the age, gender, and weight category of the judoka, and it is necessary to apply these time characteristics to the training process. For this reason, at the last stage of training, the load intensity was %HRMAX 90-100%, which gave 20 seconds between the exercises' series and 60 seconds of recovery time after series. The load intensity was %HRMAX 90-100%. Among the randori exercises on all microcycles, 5 minutes of recovery time was allocated. Based on the above findings, we can say that the recovery time between exercise sessions at the preparatory stage, which took the competition, should correspond to the characteristics of the time that was spent on the pause part of the judo bouts.

The results shown here are consistent with the findings of previous studies [Fukuda *et al*. 2013; Torres-Luque *et al*. 2016]. It should be noted that an effective organized training system will have a positive impact on a number of competitive characteristics of the judokas. In particular, the level of technical and tactical, physical and psychological training. For this reason, the training process should be organized directly in accordance with the requirements of a competitive activity. It is desirable that the data obtained in the course of the study be used in the training system of judokas. We mention as limitations the small sample size in each group and the absence of direct measures in the competition, which should be explored in future studies.

Conclusion

This study can be used for pre-competition training of judo athletes. Judo coaches can implement the results of this research paper. Additionally, the pre-competition plan of judo athletes should be in accordance with combat activity. This directly connected approach might be effective for planning and organizing the training process of judo athletes.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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Osiem tygodni progresywnego treningu przed zawodami ma pozytywny wpływ na sprawność fizyczną i stabilność psychiczną u młodszych judoków

Słowa kluczowe: sztuki walki, program treningowy, sprawność fizyczna, lęk przed wynikami, wyniki sportowe

Streszczenie.
Tło. Specjalne programy treningowe przed zawodami muszą uwzględniać zarówno korzyści fizyczne, jak i ich wpływ na (psychologiczną) stabilność psychiczną przed zawodami. Cel. Analiza wpływu zastosowania programu treningowego judo przed zawodami na poziom stabilności psychicznej przed zawodami (SCAT) i specjalnego testu sprawności judo (SJFT) u młodszych zawodników.
Metody. Szesnastu juniorów płci męskiej (17±1,4 lat; 8±2,2 lat doświadczenia w judo) wzięło udział w 8-tygodniowym programie treningowym. Zmienne kontrolowane przez program obejmowały wielkość i intensywność obciążenia, wskaźniki impulsu treningowego Stagnosa i postrzegany wysiłek. SJFT został wykorzystany do określenia określonego poziomu sprawności w judo, przed i po treningu. *Test lęku* przed zawodami sportowymi został wykorzystany do oceny poziomu lęku przed zawodami i stabilności psychicznej przed programem treningowym i przed pierwszą walką w zawodach. Grupa kontrolna uczestniczyła w normalnych sesjach treningowych.
Wyniki. Intensywność obciążenia stopniowo wzrastała podczas mikrocykli (70-90% maksymalnego obciążenia), umożliwiając wzrost wydolności tlenowej, pozytywną adaptację do obciążeń treningowych i wzrost wydolności fizycznej. W miarę zbliżania się zawodów zawartość treningu zbliżała się do stosunku wysiłku do pauzy wymaganej podczas zawodów (90-100% maksymalnego obciążenia; pauza: 20 sekund po powtórzeniach; 60 sekund po seriach). Niniejszy program treningowy wykazał statystycznie istotną poprawę w SJFT (13,4±0,3 przed treningiem vs. 12,7±0,4 po treningu; $p<0,001$) i stanie przygotowania psychologicznego (20,4±3,6 przed treningiem vs. 19±1,4 po treningu, $p<0,001$), co nie wystąpiło w grupie kontrolnej.
Wnioski. Zaproponowany program treningowy miał pozytywny wpływ na stabilność psychiczną i specyficzne osiągnięcia młodszych judoków.