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ANTROPOMOTORYKA / KINESIOLOGY

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Effects of strength and endurance training in the mesocycle in the performance in judokas / Wyniki treningu siłowo-wytrzymałościowego w mezocyklach na podstawie wyników dżudoków

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The main objective of this study is to determine the effect of two innovative ways of organizing the training of strength (S) and aerobic capacity (A) (concurrent training) to improve the performance and reduce training time in judokas. For that, three groups of *judoka beginner*, between 19 and 22 years old, participated voluntarily in this study. Every group attended sessions in three days a week for 12 weeks. The S group just trained strength [explosive force (EF) and resistance (R)] in the session (n=7 men and 1 woman, age: 19.63±0.74; height: 171.87±7.77; weight: 66.95±11.51). The S-A(1) group trained aerobic capacity, explosive force and resistance in the same session (n=7 men and 1 woman, age: 22.29±1.38; height: 178.07±7.26; weight: 71.73±13.25). The innovation was that advantage was taken of the rest period between the first and second strength exercises to execute an aerobic capacity circuit. The S-A(2) group (n=4 men and 4 women, age: 20.88±0.64; height: 168.25±8.82; weight: 68.00±10.51) carried out the same training as S-A(1) separating the work of A from S in two sessions separated by a 6-hour rest. Before and after the training period, maximum power (MP) was determined in relation to different loads (12, 22 and 32kg) in bench press, one repetition maximum (1RM) in bench press, rowing and athletic press, VO_2max and specific performance through the Special Judo Fitness Test (SJFT).

The results revealed all the groups significantly increased MP developed in the bench press in every load analyzed (p<0.01). The training used by the three groups produced a significant rise in 1RM in bench press between the pretest and postest (S: 22.75%, P=0.001; S-A(2): 28.47%, P=0.001 and S-A(1): 19.49%, P=0.002 respectively). Group S showed a highly significant increase in 1RM in rowing (27%, P=0.001), which was less significant in group S-A(2) followed by group S-A(1) (11.40%, P=0.04). The training carried out by the three groups studied caused a significant increase in 1RM in athletic press between pretest and postest. (S: 42.74%, P=0.001; S-A(2): 47.81%, P=0.001 and S-A(1): 32.61%, P=0.002 respectively). VO_2max was significantly increased (p<0.01) in the groups who worked concurrently over those who only trained strength [7.93% in S; 17.06% in S-A(2) and 19.71% in S-A(1)]. The SJFT did not show significant changes in the effect of the training period (p>0.05).

Introduction

Judo is an individual sport where each fight usually lasts 5 minutes, although in reality it can last less when there is an ippon, for disqualification or abandonment due to injury. The combat can last longer if we take into account the pauses where the encounter can take up to 7 minutes or occasionally even longer, according to the data of authors such as Degoutte *et al.* [2003]; Dopico [2002]; Iglesias & Dopico [2002]; Sáez *et al.* [2002]. This occurs in 80% of the cases.

Throughout the time of the combat, work and rest periods follow one another so that the effort is discontinuous and of variable intensity. This sport involves two essential physical qualities: strength and aerobic capacity. The former is the decisive factor both in learning and performing, since certain technical actions or methods of training cannot progress without a certain level of strength [Solé 1991]. Aerobic capacity is essential in intermittent exercises, because higher aerobic contribution is required to synthesize ATP [Tabata *et al.* 1997] and PCr [Balsom *et al.* 1994 quoted by Franchini 2001; Jansson *et al.* 1990 quoted by Franchini *et al.* 1999]. Aerobic capacity enables the fighter to support a high volume of technical-tactical training and accelerates recovery because fatigue is a limiting factor for performance and, therefore, determines success in the combat.

The importance in judo of the different types of strength and power systems is well-known. This study analyzes the viability of two innovate methods of strength and aerobic capacity training to obtain the best results in competition. It is based on the fact that a muscle can apply force for a given time according to its aerobic capacity. This enables the fighter to maintain a certain intensity throughout the given period so increasing the capacity to support loads in training or competitions; to recover quickly between the phases of effort and to improve the action and concentration in sports of greater technical demands [Navarro 1998]. However, the disadvantage of this methodology is, basically, in the physiological adaptations derived from aerobic capacity and strength training, because they are different and, in many cases, antagonistic [Leveritt *et al.* 1999]. In sports, interference is crucial when investing substantial time and resources to maximize training adaptations and competitive efficiency [Davis *et al.* 2008]. Current research has been carried out in endurance runners [Johnson *et al.* 1997], competitive rowers [Haykowsky *et al.* 1998], basketball players [Balabinis *et al.* 2003], soccer players [Kotzamanidis *et al.* 2005], competitive cyclists [Paton *et al.* 2005], professional handball players [Marques *et al.* 2006], volleyball players [Marques *et al.* 2008] but until now no research have been done with judokas.

Therefore, this study seeks:

– To evaluate the influence of two methodologies of concurrent training on strength.
– To evaluate the influence of two methodologies of concurrent training on aerobic capacity.
– To assess whether the SJFT is effective in evaluating physical fitness of judoka beginner.

METHOD

Participants

The experiment involved a total of 23 participants; all students in the subject of Judo in the Faculty of Science of Physical Activity and Sport of Granada University with one year of experience in this sport (table 1 sets out the biometric characteristics of the participants).

Table 1. Value, sample size and standard deviation of the three training groups setting out the mean age, height and weight / Wartości, liczebność i odchylenia standardowe trzech grup treningowych z uwzględnieniem średniego wieku, wysokości i masy ciała.

	Group	N	Mean	SD
AGE (years)	**S**	8	19,63	0,74
	S-A(2)	8	20,88	0,64
	S-A(1)	7	22,29	1,38
	TOTAL	23	20,87	1,42
HEIGHT (cm)	**S**	8	171,87	7,77
	S-A(2)	8	168,25	8,82
	S-A(1)	7	178,07	7,26
	TOTAL	23	172,50	8,66
WEIGHT (kg)	**S**	8	66,95	11,51
	S-A(2)	8	68,00	10,51
	S-A(1)	7	71,73	13,25
	TOTAL	23	69,43	12,38

Protocol

The study was intrasubject. Before initiating the work, the conditions of the tests to be applied in the experiment were explained orally and in writing. All the subjects signed written consents accepting the established terms. The three groups undertook treatment over 12 weeks (17 weeks including the previous training to establish the base line, 1 week for recovery and the retest) (figure 1–2). Group S worked only on strength (explosive force and resistance by means of bench press, rowing and athletic press. Table 2–3). A second group S-A(2) trained aerobic capacity (table 4), following the same strength work as group S, with a 6-hour rest period between both sessions. Finally, the third group executed the training designed for group S-A(2), although in the same session (in this way, we could lessen the working time and dedicate it to other aspects (table 5–6).

Before and after the training period, MP was determined in relation to different loads [12, 22 and 32 kg (JLML I+D)] in bench press; 1RM in bench press, rowing and athletic press; VO_2max [initial velocity of 7 km/h and increasing this by 1km every minute until exhaustion (POWERJOB-EG30)] directly, and special performance through the SJFT [Sterkowicz 1995]. For MP the loads were increased by 10 by 10 kg until each participant achieved MP. For 1RM in bench press we used twice the load with which MP had been achieved and we applied the test of progressive loads. Finally 1RM was obtained indirectly by applying the Brzycki's formula [1993 quoted by Tous 1999]. In rowing we followed the guidelines of Chirosa (2003) and them used Earle's protocol [1999], increasing the load by between 5–10%. We also applied Brzycki's formula to establish 1RM indirectly. In athletic press the participants began by moving a load equal to their body weight, increasing by 15–20% following Earle's protocol. After applying Brzycki's formula 1RM was obtained indirectly. Starting from this data both EF and resistance R could be trained.

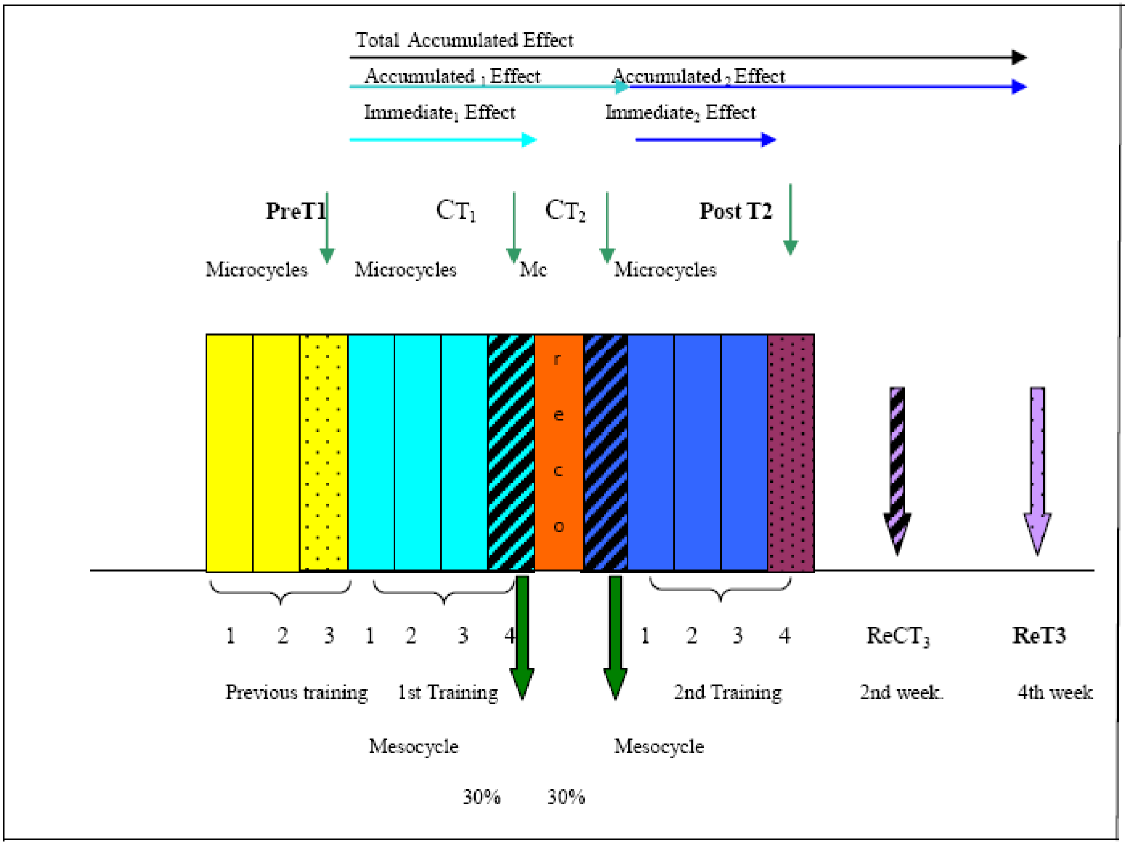

Figure 1. Structure of training. PreT1: Pretests, CT_1: Complementary $Test_1$, CT_2: Complementary $Test_2$, PostT2: posttest, $ReCT_3$: Complementary T_3 y ReT3: Final test./Struktura treningu. PreT1: Pretesty, CT_1: Uzupełniający $Test_1$, CT_2: Uzupełniający $Test_2$, PostT2: posttest, $ReCT_3$: Uzupełniający T_3 i ReT3: Final test.

GROUPS	SESSIONS	M	T	W	TH	F	SAN	ST
S	afternoon	JUDO	S	JUDO	S	S	-	-
S-A(2)	morning	-	E	-	E	E	-	-
S-A(2)	afternoon	JUDO	S	JUDO	S	S	-	-
S-A(1)	afternoon	JUDO	S-A	JUDO	S-A	S-A	-	-

Figure 2. Training plan. S: strength (EF and R), AC: aerobic capacity, -: rest./Plan treningowy: S - siła, AC – wytrzymałość, - - odpoczynek.

Tabla 2. Strength training with 3 series (EF: explosive force, R: resistance). In both cases the participants worked with a percentage of repetition maximum (1RM)./ Trening siły w 3 seriach (EF- siła eksplozywna, R - opór). W obydwóch przypadkach oni wykonywali pracę wynoszącą % max.

TIPES OF FORCE	VELOCITY (m/s)	SERIES (ser)	REPETITONS (rep)	RECOVERY (min)	EXERCISES
EF % 1RM	MÁXIMUM	2 (1st - 2nd)	6-8	5m PASSIVE	ATHLETIC PRESS (60-70% 1RM) BENCH PRESS } 40-50% ROWING } 1RM
R % 1RM	MÁXIMUM	1 (3rd)	15-20	3m PASSIVE	ATHLETIC PRESS } BENCH PRESS } 40-50% ROWING } 1RM

Table 3. Strength training with 4 series (EF: explosive force, R: resistance). In both cases the participants worked with a percentage of repetition maximum (1RM)./ Trening siły w 4 seriach (EF- siła eksplozywna, R - opór). W obydwóch przypadkach oni wykonywali pracę wynoszącą % max.

TIPES OF FORCE	VELOCITY (m/s)	SERIES (ser)	REPETITONS (rep)	RECOVERY (min)	EXERCISES
EF % 1RM	MÁXIMUM	2 (1st- 2nd)	6-8	5m PASSIVE	ATHLETIC PRESS (60-70% 1RM) BENCH PRESS } 40-50% ROWING } 1RM
R % 1RM	MÁXIMUM	2 (3rd - 4th)	15-20	3m PASSIVE	ATHLETIC PRESS } BENCH PRESS } 40-50% ROWING } 1RM

Table 4. Aerobic Circuit comprised of judo technical tasks. AT: Aerobic Threshold, HR: Heart Rate, BPM: Beats Per Minute/ Obwód aerobowy obejmował wykonanie zadań technicznych z judo. AT: Próg anaerobowy, HR: częstość skurczów serca, BPM: uderzenia na minutę.

AEROBIC CIRCUIT	TURNS	TIME WORK (min)	RECOVERY (min)	EXERCISES
30'- 40' CONTINUOUS AEROBIC WORK	5	5m	3m PASSIVE	CIRCUIT: *UCHI-KOMI (IPPON)* *UCHI-KOMI (UCHI-MATA)* *UCHI-KOMI (IPPON)* *ROPE JUMP* } AT (60%) HR (140-160bpm)

Table 5. Combined Training in S-A(1) in a block of 3 series/ Trening łączony S-A (1) w 3 seriach.

1St serie **Athletic Press**	⊤ 6 RP*	+	◇ ***5m ACT RC.***
2nd serie **Athletic Press**	⊤ 6 rp*	+	3m Pas rc.
3rd serie **Athletic Press**	⊤ 15 rp*	+	3m Pas rc.
1st serie **Bench Press**	⊤ 6 rp*	+	◇ ***5m Act rc.***
2nd serie **Bench Press**	⊤ 6 rp*	+	3m Pas rc.
3rd serie **Bench Press**	⊤ 15 rp*	+	3m Pas rc.
1st serie **Rowing**	⊤ 6 rp*	+	◇ ***5m Act rc.***
2nd serie **Rowing**	⊤ 6 rp*	+	3m Pas rc.
3rdserie **Rowing**	⊤ 15 rp*	+	3m Pas rc. + ◇ ***5m Act rc.***

* Between each repetition there is a 2s pause./ Czas trwania przerwy między powtórzeniami wynosił 2 sekundy.
Where ⊤ = **force exercises**, ◇ = circuit, rp: repetitions, Pas rc.: passive recovery, Act rc.: active recovery./gdzie: ⊤ = ćwiczenia siłowe, obwód; rc = odpoczynek, rp: powtórzenia, P rc.: odpoczynek bierny, A rc.: odpoczynek czynn.

Table 6. Combined Training in S-A(1) in a block of 4 series/ Trening łączony S-A (1) w 4 seriach.

1st serie Athletic Press	T 6 RP*	+	◇ *5m ACT RC.*
2nd serie Athletic Press	T 6 rp*	+	3s Pas rc.
3rd serie Athletic Press	T 15 rp*	+	3s Pas rc.
4th serie Athletic Press	T 15 rp.*	+	3s Pas rc.
1st serie Bench Press	T 6 rp*	+	◇ *5s Act rc.*
2nd serie Bench Press	T 6 rp*	+	3s Pas rc.
3rd serie Bench Press	T 15 rp*	+	3s Pas rc.
4th serie Bench Press	T 15 rp.*	+	3s Pas rc.
1st serie Rowing	T 6 rp*	+	◇ *5s Act rc.*
2nd serie Rowing	T 6 rp*	+	3s Pas rc.
3rd serie Rowing	T 15 rp.*	+	3s Pas rc.
4th serie Rowing	T 15 rp.*	+	3s Pas rc. + ◇ *5s Act rc.*

* Between each repetition there is 2s pause./**Czas trwania przerwy między powtórzeniami wynosił 2 sekundy.**
Where T = force exercises, ◇ = circuit, rp: repetitions, Pas rc.: passive recovery, Act rc.: active recovery/ gdzie: T **= ćwiczenia siłowe, obwód; rc = odpoczynek, rp: powtórzenia, P rc.: odpoczynek bierny, A rc.: odpoczynek czynn.**

RESULTS

The results were analyzed by SPSS 12.0. Therefore, the training of all three groups shows a significant increase in MP from pretest to postest. When the weight used was 12kg, group S obtained a greater increase (38.56%), followed by S-A(2) (31.71%) and S-A(1) (17.02%) respectively. For 22kg, group S-A(2) obtained the best performance (39.38%), followed by group S (24.26%) and S-A(1) (28.08%). Finally, the greatest benefits with 22kg were obtained by group S-A(1) (28.08%), then group S (25.08%) and finally S-A(2) (21.51%) (figures 4, 5, 6).

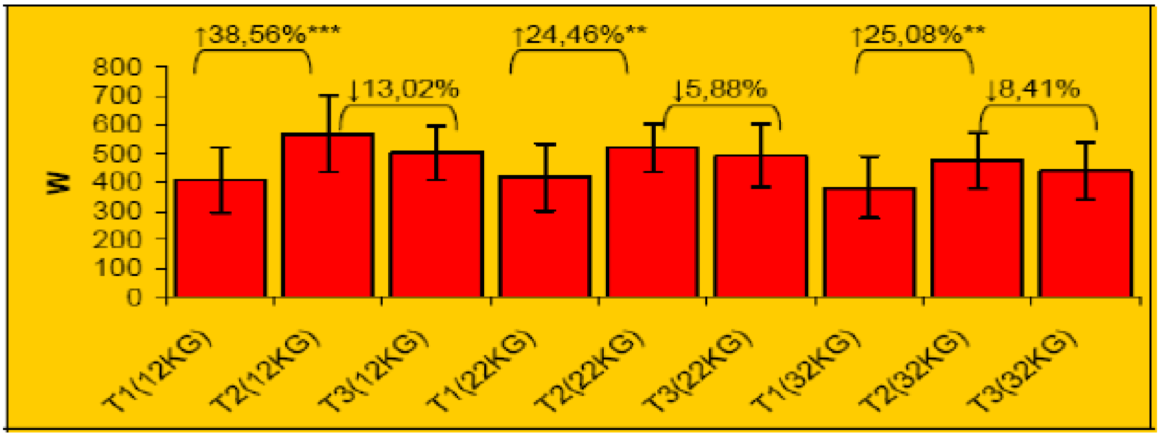

Figure 4. Training effects in S group expressed in % and significance levels between T1 (pre), T2 (post) and T3(re). ↑ increment and ↓ reduction training, *** P<0.001, ** P<0.01. / Efekty treningowe w S, w grupach S-A(2) i S-A(1) wyrażone % i poziom różnic między pomiarami T1 (pre), T2 (post) and T3(re). ↑ przyrost and ↓ obniżka, *** P<0.001, ** P<0.01.

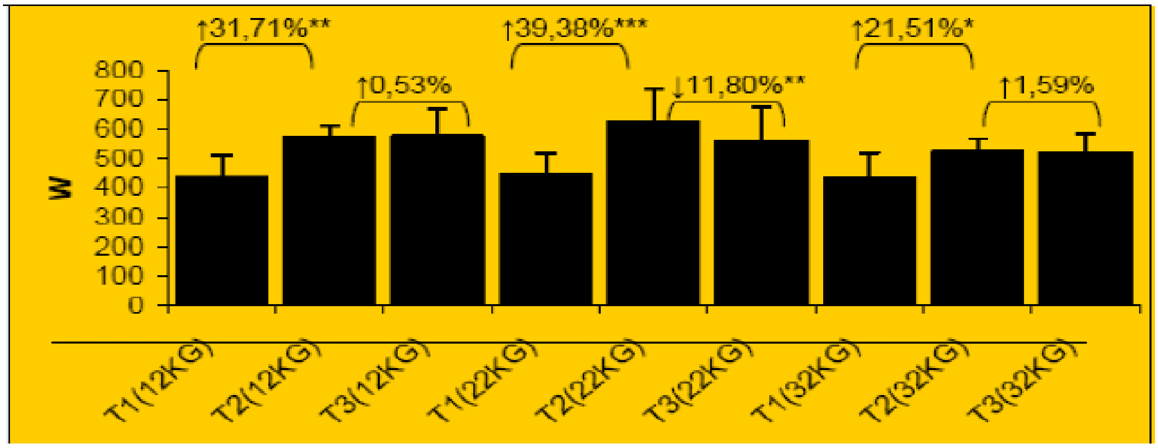

Figure 5. Training effects in S-A(2) group expressed in % and significance levels between T1 (pre), T2 (post) and T3(re). ↑ increment and ↓ reduction training, *** P<0.001, ** P<0.01 / Efekty treningowe w grupie S-A(1) wyrażone w % i poziom istotności między pomiarami T1 (pre), T2 (post) and T3(re). ↑ przyrost and ↓ obniżka, *** P<0.001, ** P<0.01.

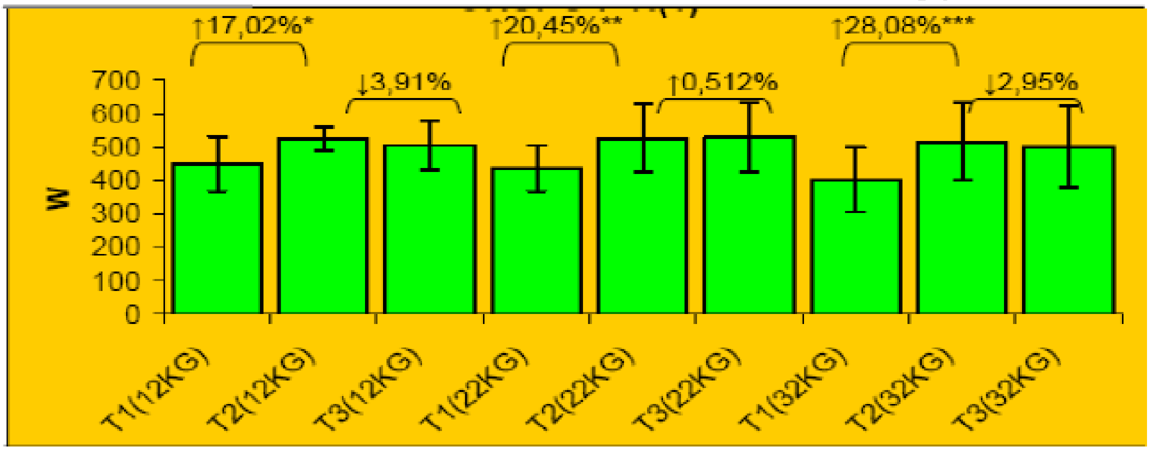

Figure 6. Training effects in S-A(1) group expressed in % and significance levels between T1 (pre), T2 (post) and T3(re). ↑ increment and ↓ reduction training, *** P<0.001, ** P<0.01 / Efekty treningowe w grupie S-A(1) wyrażone w % i poziom istotności między pomiarami T1 (pre), T2 (post) and T3(re). ↑ przyrost and ↓ obniżka, *** P<0.001, ** P<0.01.

Training produced a significant increased in 1RM in all groups in bench press between pretest and postest (S: 22.75%, P=0.001; S-A(2): 28.47%, P=0.001 and S-A(1): 19.49%, P=0.002 respectively) (figure 7).

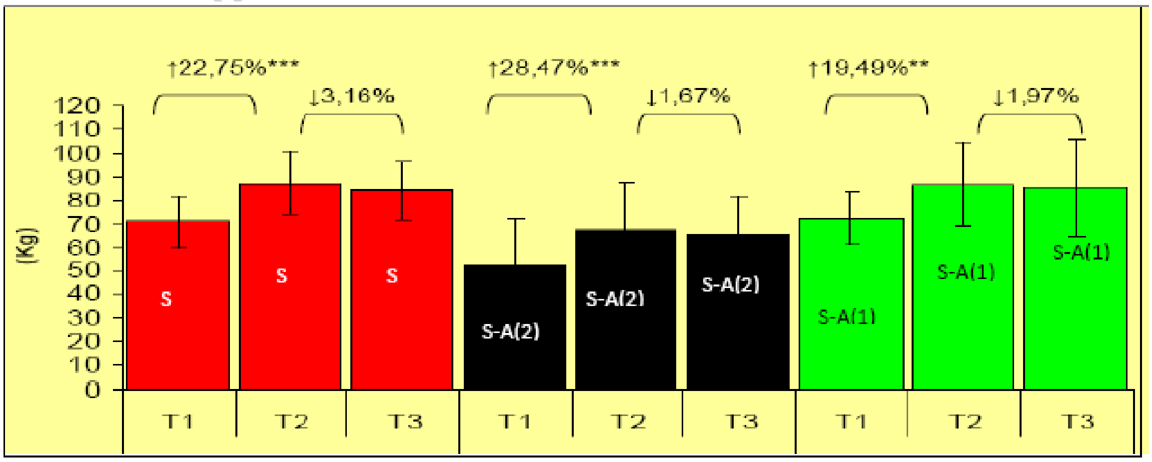

Figure 7. Training effects in S, S-A (2) and S-A(1) group expressed in % and significance levels between T1 (pre), T2 (post) and T3(re). ↑ increment and ↓ reduction training, *** P<0.001/Efekty treningowe w grupie S-A(1) wyrażone w % i poziom istotności między pomiarami T1 (pre), T2 (post) and T3(re). ↑ przyrost and ↓ obniżka, *** P<0.001** P<0.01.

In rowing group S showed a highly significant increase in 1RM (27%, P=0.001), being a less significant in S-A(2) (19.08%, P=0.01) followed by S-A(1) (11.40%, P=0.04) (figure 8).

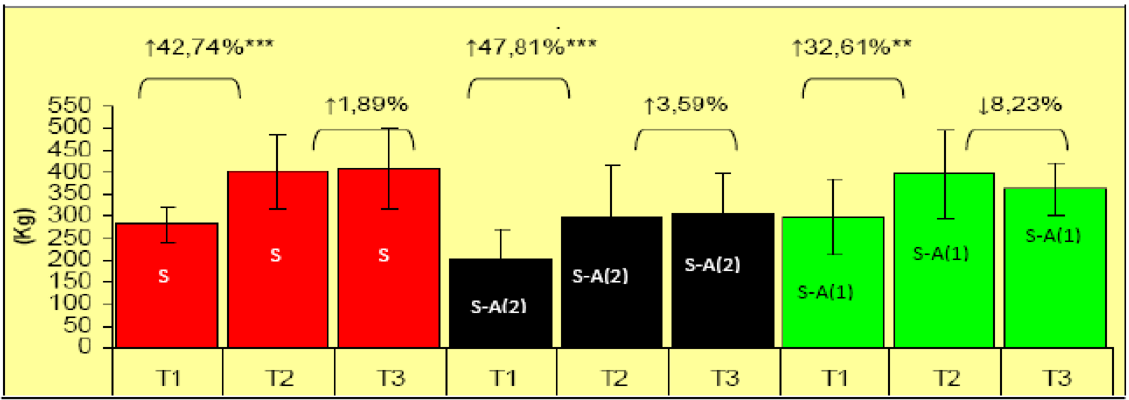

Figure 8. Training effects in S, S-A (2) and S-A(1) group expressed in % and significance levels between T1 (pre), T2 (post) and T3(re). ↑ increment and ↓ reduction training, *** P<0.001/Efekty treningowe w grupie S-A(1) wyrażone w % i poziom istotności między pomiarami T1 (pre), T2 (post) and T3(re). ↑ przyrost and ↓ obniżka, *** P<0.001

Equally training caused a significant increase in 1RM in all groups in athletic press between pretest and postest (S: 42.74%, P=0.001; S-A(2): 47.81%, P=0.001 and S-A(1): 32.61%, P=0.002) (figure 9).

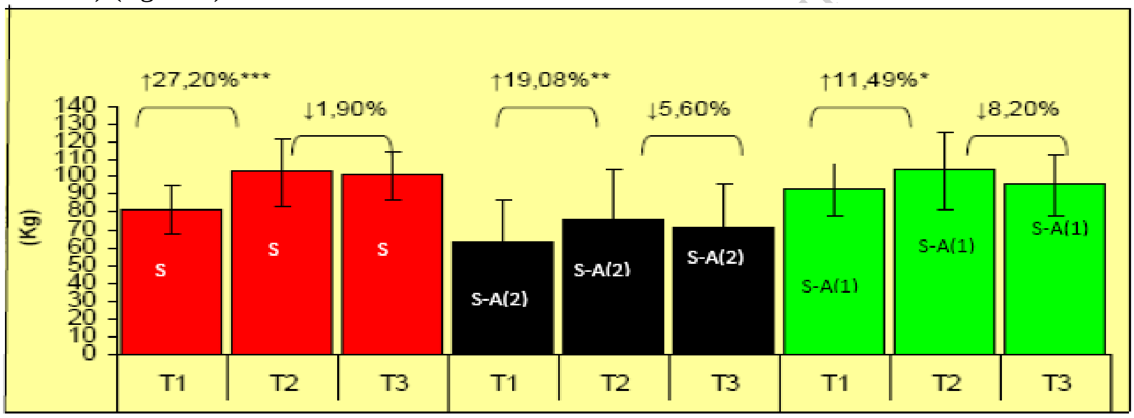

Figure 9. Training effects in S, S-A (2) and S-A(1) group expressed in % and significance levels between T1 (pre), T2 (post) and T3(re). ↑ increment and ↓ reduction training, *** P<0.001/Efekty treningowe w grupie S-A(1) wyrażone w % i poziom istotności między pomiarami T1 (pre), T2 (post) and T3(re). ↑ przyrost and ↓ obniżka, *** P<0.001, P<0.01.

There was a significant increase in VO_2max (P<0.01) in S-A(1) and S-A(2) groups in relation to S group who only trained strength (19.71% in S-A(1), 17.06% in S-A(2) and 7.93% in S) (figure 3).

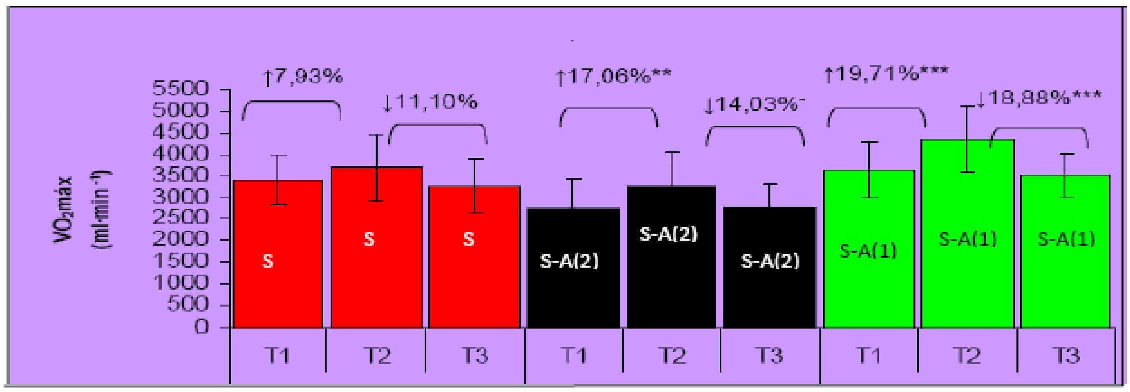

Figure 10. Training effects in S, S-A(2) and S-A(1) groups expressed in % and significance levels between T1 (pre), T2 (post) and T3(re). ↑ increment and ↓ reduction training, *** P<0.001, ** P<0.01./ Efekty treningowe w S, w grupach S-A(2) i S-A(1) wyrażone % i poziom różnic między pomiarami T1 (pre), T2 (post) and T3(re). ↑ przyrost and ↓ obniżka, *** P<0.001, ** P<0.01.

The data show that on the SJFT index the same improvement did not take place in any of the groups studied (figure 10).

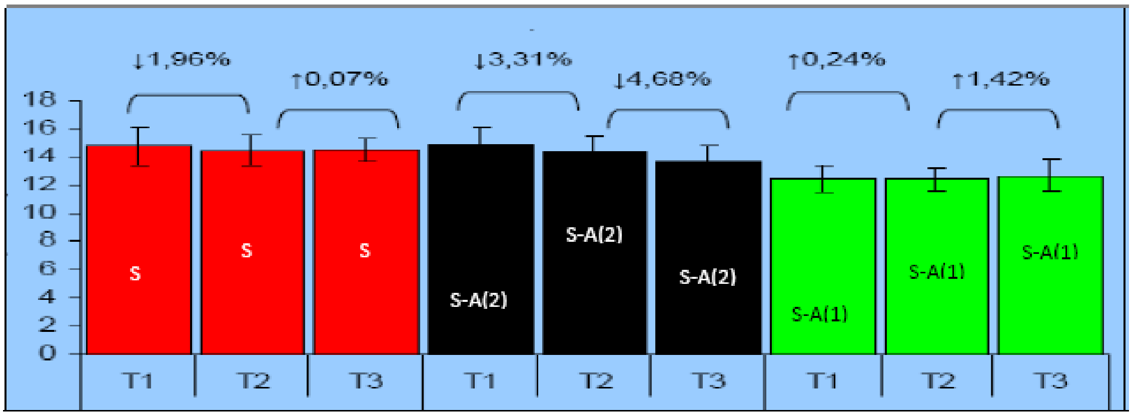

Figure 11. Training effects in S, S-A(2) and S-A(1) groups expressed in % and significance levels between T1 (pre), T2 (post) and T3(re). ↑ increment and ↓ reduction training, *** P<0.001, ** P<0.01./Efekty treningowe w grupach S, S-A(2) i S-A(1) wyrażone w % i poziom istotności między pomiarami T1 (pre), T2 (post) and T3(re). ↑ przyrost and ↓ obniżka, *** P<0.001, ** P<0.01.

DISCUSSION

Concurrent training increased MP in these two groups [S-A(1-2)]. The power concept has to be integrated in relation to the levels of load used, since the athlete develops different degrees of power based on the endurance needed to win [González-Badillo, Ribas 2002].

This statement is confirmed in the data collected in this work. There is a high statistical significance in MP by group S (38.56%), with a load corresponding to 20% of the maximum force (MF). As the load increases (around 31–45% of the MF), very significant increases were recorded, although rather less than with lower loads (24.24% and 25.98% respectively).

In group S-A(2) the gains are very significant (31.71% and 39.38%), with loads between 23% and 43% of MF, with lower increases in power when the load is heavier.

In addition, the complementary work of endurance did not impose an obstacle to the development of power. Nevertheless, in group S-A(1) higher MP is obtained with 44.09% of maximum force with significantly higher results (28.08%), whereas with inferior loads (20% and 30% of MF) the benefits are reduced. As in group S-A(2), endurance training did not affect the increase in power. According to different authors, the recommendations to increase power vary between loads 30% to 45% of 1MR [Newton *et al.* 1997; Toji *et al.* 1997] or 30% of maximum isometric force.

Finally, and as was to be expected, all groups showed a decrease in MP after concluding the training period.

In 1RM group S showed a highly significant increase in the exercises made, as expected (figure 7–8 and 9) because the work carry out focused on developing this quality. We should remember that this group only trained strength, and therefore there was no interference from any other type of training. S-A(2) group demonstrated a highly significant increase in 1RM, it being noteworthy that no was interference in the aerobic capacity as proved by increase VO_2máx.

This type of training, based on working on both capacities has been analyzed by different researchers, although the data are not conclusive for various reasons. Among them it is necessary point out that the type of design employed, which in our case did not use extreme training since the tests were not at the ultimate level and were able to avoid interference in the development of strength [Deakin 2004; González-Badillo 2000; Kraemer *et al.* 1995].

Another factor that could contribute to this improvement in strength is the order in which strength and aerobic capacity were trained, [S-A(2) first trained aerobic capacity followed by strength training. Deakin [2004], Chtara *et al.* [2005] and Leveritt *et al.* [1999], proved that in a sequence where strength was trained before aerobic capacity, greater recuperation time was needed. However, Bell [1988] quoted by García [1996] confirmed that training aerobic capacity first and then strength was more efficient for sports were the levels of strength are very important, as in the case of judo.

In our protocol as carried out by group S-A(2), both strength and aerobic capacity were increased, so that training strength first appears to be the correct sequence.

Recuperation time between two sessions is another element to consider. Leveritt & Abernethy [1999] observed that 30-minute rest between both sessions was insufficient for recovery. In other studies the rest period was increased to 3 hours, being a short time for recuperation [Thornton, Potteiger 2002]. In our case 6 hours was the time needed to recovery and increase strength without interference.

The duration of the training period is another cause that influences interference in concurrent work. Training both qualities cannot be maintained forever since doing so would produce negative effects [García 1996]. It seems that the optimum time to avoid negative effects is between 8–12 weeks [Bell *et al.* 2000; Bishop *et al.* 1999; Dolezal, Potteiger 1998; Gravelle, Blessing 2000], as in this study.

The frequency with which training is carried out is another element that can influence incompatibility. In this sense, most studies have used 3 sessions a week [Bell *et al.* 2000; Gravelle, Blessing 2000] or more [Kraemer *et al.* 1995]; it would seem that 3 days (as in our protocol) is the ideal frequency to prevent interference [McCarthy *et al.* 1995].

Therefore, there are different elements that influence concurrent training, hence the complexity in designing it. In our case the protocol applied has proved to be more effective for the two physical qualities trained.

As mentioned above, then group S-A(1) also made progress in 1RM. Until now no similar studies have been developed for the participants of this group. This progress can be justified in part, by the type of recuperation after intense effort. Thus García [1996] stated that for the athletes to recuperate more rapidly, explosive actions must be combined with active aerobic recuperation (as in this study). In fact the aerobic circuit used in our work as an active recuperation carried out on the aerobic threshold which facilities the elimination of lactate and other residues [Monedero, Donne 2000] and therefore puts the judoka in better conditions for subsequent activity.

Referring to the elements described previously, which can influence the result of concurrent training in group S-A(2), both the type of design, the duration and frequency of training are the same for group S-A(1). All this have had the same influence as in group S-A(2) have succeeded improving performance.

In addition to benefits obtained both in 1RM and VO_2máx, we have been able to reduce the duration of the judoka's physical training time, so achieving one of the aims proposed at the beginning of this experimental.

After a month of inactivity, there were no adverse effects on performance, since the values had not significantly diminished. Abandoning training supposes that athlete can maintain their strength and MP for up to 6 weeks [Wilmore, Costill 2004], while resistance lessens in only 2. Verkhoshansky [2002] assert that, after finishing strength can be increased probably due to the inertia of adaptation or the delayed effect of the body and the compensating recuperation after strength work.

Concurrent training increases VO_2max in two groups (S-A(1) and S-A(2) probably because we used an intensity minimum of work (50%VO_2max) and the duration of training was 12 weeks, similar to other studies on concurrent training.

The definite interruption of training results in a regression of the cardiovascular adaptation, which is inversely proportional to the participant's previous level [Wilmore, Costill 2004]. Thus cardiorespiratory capacity is the most harmed of all since it lessens more than all the other parameters analyzed [Wilmore, Costill 2004].

Concurrent training did not improve the SJFT index. The changes in VO_2max do not necessarily reflect the same magnitude of change in recovery. Probably, these changes in performance did not have a positive transference to the specific actions of judo (*ippon seoi nage*), for which levels of explosive force are needed. This can be obtained by improving MF and/or the speed of muscular contractions.

The problem resides in obtaining optimal commitment of development that can be transferred to sport techniques. If the loads used are of a specific magnitude, the force and speed of contractions will be developed for that particular exercise. Therefore, our recommendation is to use special exercises of MF and exercises with submaximal endurance within each microcycle to develop the specific EF [Kraemer, Häkkinen 2006].

CONCLUSIONS

Concurrent training of strength and aerobic capacity in two separate sessions increases MP, 1RM and VO_2max, obtaining similar results when they are trained in one session alone. In this latter case moreover, we managed to reduce the time dedicated to training. Thus we can state that the methodology applied prevents interference resulting from training strength and aerobic capacity together.

We have also shown that SJFT is only not a good indicator of the physical condition when speaking of inexperienced judokas mainly because they have not automated the technique. Therefore, their speed in performing and the number of throws made is slower, so that the index of the test is worse. The SJFT remains an excellent test for experienced judokas, but, in the light of our research, it is not appropriate for beginners.

PRACTICAL APPLICATIONS

It would be interesting to replicate the study with group of experienced judokas to confirm our results. In this way, applying the methodology proposed for S-A(1) the judoka would have more time to perfect the other parameters in training and so improve competition results.

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Słowa kluczowe: trening równoległy, siła, wydolność aerobowa, dżudocy

STRESZCZENIE

Głównym celem niniejszej pracy jest przedstawienie rezultatów dwóch innowacyjnych sposobów organizowania szkolenia siłowego i wytrzymałościowego treningu równoległego w celu poprawienia dokonań i redukcji czasu szkolenia dżudoków. Szkolenie odbywało się trzy razy w tygodniu przez 12 tygodni (17 tygodni wraz z poprzednim treningiem, odpoczynkiem i ponownym testem). Po przeprowadzonych testach autorzy doszli do wniosku, że rezultaty otrzymane po dwóch oddzielnych sesjach były podobne do tych po jednej sesji, aczkolwiek w drugim przypadku, przy zastosowaniu odpowiedniej metodyki, odnotowano zredukowanie czasu treningu. Autorzy podkreślają, że testy te są bardziej efektywne w przypadku bardziej doświadczonych dżudoków i niezbyt przydatne dla osóbpoczątkujących.