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Effect of tapering on anaerobic power and capacity of tae-kwon-do athletes

Efeito de um período de polimento na potência e capacidade anaeróbia de atletas de tae-kwon-do

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Abstract – The aim of the study was to analyze the effect of a tapering period on anaerobic power and capacity of tae-kwon-do athletes. Thirty-one male tae-kwon-do participants of the Brazilian Championship were selected in a non-probabilistic way. Subjects were randomly divided into two groups, namely: experimental group (EG, n = 15) and control group (CG, n = 17). Both groups followed the same training protocol up to the tapering stage. CG was submitted to training loads contained in the last two weeks of the macrocycle. Only EG was submitted to tapering. Tapering had 2 weeks duration, adopting the linear tapering method. Taekwondo Anaerobic Test was performed by athletes before the start of the season, which was named as pre-intervention, and the last week of each mesocycle [Prep I, Prep II and Tapering (only EG)]. Group vs. time effect interaction (p < 0.01) was identified for alactic anaerobic power, with an increase only in EG in tapering (p = 0.01). A significant group vs. time interaction (p <0.01) was revealed to fatigue index, improved anaerobic capacity being checked in EG only after the tapering period (p = 0.01). It was concluded that two weeks of linear type tapering optimized the anaerobic power and capacity of male tae-kwon-do athletes.

Key words: Athletic performance; Martial arts; Muscle strength.

Resumo – *O objetivo do estudo foi analisar o efeito de um período de polimento sobre a potência e capacidade anaeróbia de atletas de tae-kwon-do. Trinta e um atletas de tae-kwon-do do sexo masculino participantes do campeonato brasileiro de tae-kwon-do foram selecionados de forma não probabilística. Os atletas foram separados aleatoriamente em dois grupos, a saber: experimental (GE, n = 15) e controle (GC, n = 17). Ambos os grupos seguiram o mesmo treinamento até a fase do polimento. O GC manteve as cargas de treinamento constantes nas últimas duas semanas do macrociclo. Somente o GE realizou o polimento. O polimento teve duração de 2 semanas, adotando-se o método de polimento linear. O Taekwondo Anaerobic Test foi realizado pelos atletas antes do início da temporada, o que foi denominado como pre-intervenção, e na última semana de cada mesociclo [Preparatório I, Preparatório II e Polimento (somente para o GE)]. Foi identificado efeito de interação grupo vs. tempo (p < 0,01) para a potência anaeróbia alática, com aumento apenas no GE na fase do polimento (p = 0,01). Uma interação significante grupo vs. tempo (p < 0,01) foi revelada para o índice de fadiga, com melhoria da capacidade anaeróbia sendo verificada no GE somente após a fase de polimento (p = 0,01). Concluiu-se que duas semanas de polimento do tipo linear otimizou a potência e capacidade anaeróbia de atletas de tae-kwon-do do sexo masculino.*

Palavras-chave: *Artes marciais; Desempenho atlético; Força muscular.*

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INTRODUCTION

Tae-kwon-do is a combat sport characterized by a high requirement of muscular power in the actions that generate scores[1]. In addition, due to the intensity of effort during combat and the short interval between rounds, the tae-kwon-do athlete is required to demonstrate high anaerobic capacity. Athletes are categorized according to body mass and the combat lasts six minutes (3 rounds of 2 minutes with one minute of interval), and the athlete who reaches the highest score during this period is considered winner[2].

Improvements in power and anaerobic capacity are considered fundamental to success in tae-kwon-do[1]. Therefore, it is important to control the training load of athletes with the premise of planning the phase of the competitive season in which peak performance will be reached[3]. However, the athlete needs to recover adequately to increase competitive performance[4]. It should be noted, therefore, that tapering may be a good alternative to optimize the performance of athletes[5].

Tapering, in turn, is used to reduce psychophysiological stress from training loads[6]. During tapering, the volume of all components of the training sessions is reduced, although intensity is maintained[7]. Tapering is considered a strategy of prescribing the periodization of sports training[8]. Studies have indicated an increase in the performance of athletes after a tapering period[5,9], although such investigations have been conducted with cyclic sports athletes. It should be noted; however, that the tapering prescription does not seem to be unanimous for many coaches[10,11]. Coaches believe that in weeks prior to the target competition, both volume and intensity should be increased[2, 4].

Santos and Franchini[12] reported increased anaerobic capacity after 9 weeks of training in national-level tae-kwon-do athletes. In contrast, Santos et al.[13] analyzed the effect of 3 weeks of resistance training of lower limbs and found no anaerobic power and capacity alteration in tae-kwon-do athletes. However, it should be noted that none of the aforementioned surveys adopted tapering as a training periodization technique.

There is lack of studies analyzing the effect of tapering on power and anaerobic capacity in combat sport athletes. Perhaps, tapering is an effective training periodization strategy to increase power and anaerobic capacity in tae-kwon-do athletes. From the practical point of view, this type of investigation may point to the effect of tapering on anaerobic power and capacity in tae-kwon-do athletes. It is noteworthy that since 2009, to obtain scores, electronic vests with minimum impact calibration are used. Thus, increased power and anaerobic capacity may favor the achievement of scores during the combat for tae-kwon-do athletes. Therefore, the findings may be extremely important for coaches of this sport.

Based on the above, the aim of this study was to analyze the effect of a tapering period on the power and anaerobic capacity of tae-kwon-do athletes. Our hypothesis is that two weeks of tapering will be sufficient to optimize power and anaerobic capacity of tae-kwon-do athletes.

METHODOLOGICAL PROCEDURES

Participants

Thirty-four national-level male tae-kwon-do athletes (18 to 30 years old), participants of the Brazilian tae-kwon-do championship, were selected in a non-probabilistic way to participate in this study. Athletes were randomly divided into two groups: experimental group (EG, n = 17, age = 23.6 ± 1.5 years, training regimen = 10.4 ± 0.8 hours / week, body fat = 15.2 ± 4.40%) and control group (CG, n = 17, age = 24.1 ± 1.7 years, training regimen = 10.5 ± 0.7 years, body fat = 16.3 ± 5, 2%). EG was submitted to two weeks of tapering, while CG maintained the training load in the last two weeks of the training macrocycle. All athletes trained on average two hours per day, with frequency of five times a week.

As inclusion criteria, participants should: (1) to have been a tae-kwon-do athlete for at least three years; (2) systematically train the sport for at least eight hours per week; (3) to be enrolled in the national championship, organized by the Brazilian Tae-kwon-do Confederation and; (4) to undergo anthropometric measurements and perform the physical performance test (Taekwondo Anaerobic Test). Three participants were excluded from the analyses because they missed more than 10% of training sessions during the experimental period (twelve weeks). Therefore, the sample consisted of 31 tae-kwon-do athletes (EG = 15 and CG = 16).

After being clarified about the procedures to which they would be submitted, all participants signed a free and informed consent form. The procedures adopted in this study comply with the norms of the National Health Council for research on human beings, after approval of the Ethics Research Committee of the Federal University of Pernambuco (CAAE - 47571415.9.0000.5208).

Experimental design

Both groups (EG and CG) followed the same training protocol until the tapering phase. The training description can be observed in Table 1. Only EG was submitted to tapering (Table 2). CG kept training loads constant in the last two weeks of the macrocycle (Table 3). Tapering lasted 2 weeks, adopting the linear polishing method[9]. Thus, only the training volume was reduced: 60% for the first and 40% for the second week, according to Mujika, Chaouachi and Chamari[8].

The training load was quantified by adopting the daily mean of the perceived subjective effort (PSE-session) method[14]. After 30 minutes from the end of each training session, athletes answered the following question: “How was your training?”. The athlete was asked to demonstrate the session intensity perception based on the 10-point Borg scale (0 = rest to 10 = maximum effort), according to method developed by Foster et al.[14]. The product of values demonstrated by the PSE scale and the duration in minutes of each session was calculated, thus expressing the internal load of the training session. The weekly training load was calculated after each microcycle. The weekly training load was obtained from the sum of the daily loads divided by five (number of weekly training sessions). The load of each mesocycle (preparatory I, preparatory II and tapering) was calculated from the sum of the respective weekly loads and divided by four (amount of microcycles per mesocycle), according to methodology adopted in another research [15]. It is noteworthy that athletes were familiar with the PSE-session method for a period of fifteen days prior to the beginning of this survey. The internal load of each mesocycle of EG and CG is shown in Tables 2 and 3, respectively.

Table 1. Description of training mesocycles of tae-kwon-do athletes

	EG			CG		
Micro	Physical	Technical	Tactical	Physical	Technical	Tactical
1 to 4	8 x RT	8 x KI	6 x DT	8 x RT	8 x KI	6 x DT
	5 x AC		7 x OT	5 x AC		7 x OT
	5 x CAT			5 x CAT		
	6 x AG			6 x AG		
	4 x POW			4 x POW		
5 to 8	6 x RT	5 x KI	8 x DT	6 x RT	5 x KI	8 x DT
	4 x AC		10 x OT	4 x AC		10 x OT
	4 x CAT			4 x CAT		
	8 x AG			8 x AG		
	6 x AR			6 x AR		
	6 x POW			6 x POW		
9 to 12	4 x RT	4 x KI	6 x DT	6 x RT	5 x KI	8 x DT
	3 x AC		8 x OT	4 x AC		10 x OT
	2 x CAT			4 x CAT		
	6 x AG			8 x AG		
	5 x AR			6 x AR		
	4 x POW			6 x POW		

Micro = Microcycles; EG = Experimental group; CG = Control group; RT = resistance training; AC = aerobic circuit; CAT = continuous aerobic training; AG = agility; POW = alactic anaerobic power; AR = anaerobic resistance; KI = Kick; DT = defensive tactical training; OT = offensive tactical training.

The Taekwondo Anaerobic Test was performed by athletes before the start of the season, which was called as pre-intervention, and in the last week of each mesocycle [Preparatory I, Preparatory II and Tapering (EG only)].

Taekwondo Anaerobic Test

The Taekwondo Anaerobic Test consists of kicking a punching bag as many times as possible at maximum intensity for thirty seconds[16]. It should be noted that all athletes participating in the present study were familiar with the test. Athletes started the protocol with their dominant leg, alternating the kicking leg. The test was developed in a 2 x 2 m area and the kicks

Table 2 - Training periodization for the experimental group

Meso	Preparatory I				Preparatory II						Tapering	
Micro	1	2	3	4	5	6	7	8	9	10	11	12
Volume (%)	80	90	100	60	70	80	90	60	90	90	60	40
IL (A.U.)	6.228,71 (±224.04)				7.862,91 (±302.53)[a]						5.833 (±286.59)[a, b]	

Meso = Mesocycle; Micro = Microcycle; IL = internal training load (mesocycle); A.U. = Arbitrary units; ap <0.05 in relation to preparatory period I; bp <0.05 compared to preparatory period II.

Table 3 - Training periodization for the control group

Meso	Preparatory I						Preparatory II					
Micro	1	2	3	4	5	6	7	8	9	10	11	12
Volume (%)	80	90	100	60	70	80	90	60	90	90	80	80
IL (A.U.)	6.275,01 (±255,34)				7.703,65 (±241,39)[a]				7.576 (±328,70)[a]			

Meso = Mesocycle; Micro = Microcycle; IL = internal training load (mesocycle); A.U. = Arbitrary units; ap <0.05 in relation to preparatory period I.

(Bandal Tchagui) hit the punching bag at a height between the umbilical scar and the xiphoid process, demarcated in the punching bag. A triaxial accelerometer with maximum shock capacity of 1000 g was placed over the athlete's dominant ankle. Three preamplifiers were used to amplify the signal, one for each axis (X-antero-posterior; y-bi-lateral; Z-vertical) (Brüel & KjaerTM, model 2635). Each kick cycle was determined by the time interval between two consecutive kicks with the same leg. With the premise of measuring the alactic anaerobic power, the largest peak of impact generated by one leg with the accelerometer was adopted. The number of kick cycles, the average time of kick cycles and the best time among cycles were calculated (only complete cycles were used in the analyses). The fatigue index was calculated according to the following equation[16]: Fatigue index = [(TMI - TMF) / TMF] * 100, where TMI = average time of kick cycles in the initial phase of the test (20%); TMF- average time of kick cycles in the final phase of the test (20%).

Anthropometry

A portable digital scale (Tanita® BC-601, São Paulo, Brazil) and a portable stadiometer (Welmy®, Santa Bárbara do Oeste, Brazil) were used to determine body mass and height. Body mass index (BMI) was determined by the ratio between body mass (kg) and squared height (m). The thickness of triceps, pectoral and subscapular skinfolds was measured using Lange adipometer (Lange ©, Washington, USA) to estimate body density using the predictive equation proposed by Jackson and Pollock[17]. Relative body fat was estimated by the Siri equation[18].

Data analysis

The Levene test was used to test homoskedasticity, while data sphericity was verified by the Mauchly test. When this last assumption was violated, the Greenhouse-Geisser correction was adopted. Due to parametric non-violation, measures of central tendency (mean) and dispersion (standard deviation and standard error) were used to describe the research variables. Factorial Anova of repeated measurements with mixed design was used for comparisons between groups according to the competitive season phase (preparatory I, preparatory II and tapering), inserting the tapering phase as an independent variable. The calculation of the Cohen effect size was adopted for the analysis of the magnitude of differences. For the effect size analysis, the classification proposed by Rhea[19] was adopted: d <0.2 = trivial, 0.2 ≤ d <0.4 = low effect size, 0.4 ≤ d> 0.8 = moderate effect size and d ≥ 0.8 = large effect size. All data were processed using the SPSS 21.0 software and 5% significance level.

RESULTS

No significant difference was found in the comparisons between groups (EG and CG), in the pre-intervention for variables age (p = 0.23), relative body fat (p = 0.25), alactic anaerobic power (p = 0.21) and fatigue index in the Taekwondo Anaerobic Test (p = 0.26).

Table 4 presents the results of comparisons between EG and CG. Group x time interaction (p <0.01) was identified for alactic anaerobic power, with increase in EG only after tapering (p = 0.01, effect size = 0.7). A significant group vs. time interaction (p <0.01) was revealed for the fatigue index, with improvement in anaerobic capacity being verified only in EG after the tapering phase (p = 0.01, effect size = 0.9).

Table 4 - Mean and standard deviation of performance in the Taekwondo Anaerobic Test due to the research stage (preparatory I, preparatory II and tapering)

Variables	EG (n = 15)	CG (n = 16)	Effects	F	p
Pan Alactic (g)					
Pre-intervention	126.2 ±8.4	125.8 ±8.5	Group	47.62	0.01
Preparatory I	129.2 ±7.7	129.3 ±8.5	Time	37.07	0.01
Preparatory II	128.1 ±9.6	129.0 ±9.3	G*T	43.14	0.01

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Variables	EG (n = 15)	CG (n = 16)	Effects	F	p
Tapering	134.6 ±9.4#	128.4 ±9.5			
Δ%	6.51	2.89			
ES	0.7	0.1			
Fatigue Index (%)					
Pre-intervention	12.5 ±1.4	12.2 ±1.6	Group	66.91	0.01
Preparatory I	12.2 ±1.3	12.3 ±1.3	Time	58.23	0.01
Preparatory II	12.7 ±1.4	12.1 ±1.5	G*T	80.57	0.01
Tapering	9.4 ±1.7#	12.5 ±1.4			
Δ%	28.5	1.7			
ES	0.9	0.1			

G * T = group vs. time interaction; Pan = Anaerobic power; EG = experimental group; CG = control group; ES = effect size. Δ% = pre-intervention average - post-intervention average ÷ pre-intervention standard deviation; #p <0.05 vs. CG in the tapering phase.

DISCUSSION

The present investigation had as premise to analyze the effect of a tapering period on power and anaerobic capacity of tae-kwon-do athletes. The results demonstrated optimization of both power and anaerobic capacity in the EG after tapering, a fact not observed for the CG, corroborating the hypothesis of the present study.

Regarding alactic anaerobic power, the findings of the present study reported maintenance from pre-season to the end of preparatory period II in both groups. In fact, studies have demonstrated maintenance of alactic anaerobic power after phases of training load intensification[1,7], corroborating the results of the present investigation. According to Le Meur et al.[6], the optimization of the alactic anaerobic power occurs due to the increase in the velocity of the creatine kinase enzyme reaction, as well as the increase in the recruitment of fast contraction fibers. However, it is noteworthy that these two adaptations occur only after recovery of the neuromuscular system, considering the principle of supercompensation[20]. Regarding the tapering phase, the results revealed an increase in the alactic anaerobic power in EG, a fact not identified for CG. The moderate effect size found in the tapering phase should also be highlighted, which indicates a reasonable probability of this fact to be true for tae-kwon-do male athletes. According to Mujika et al.[8] and Le Meur et al.[6], the reduction in volume and the maintenance of the training intensity, considered as the primary techniques of tapering prescription, can lead to attenuation of the neurophysiological stress and improvement of neuromuscular functions, which, in a way, can explain the results obtained after the tapering period. Zara et al.[4] demonstrated potentiation in the performance of dart throwing and / or discus throwing in athletic after 2 weeks of high-intensity and low-volume tapering.

Regarding anaerobic capacity (evaluated by the fatigue index), the findings indicated maintenance in both groups until the end of preparatory phase II. Investigations also demonstrated that anaerobic capacity did not improve after the training load intensification phase[21, 22]. According to Pyne et al.[7], increasing the training load without sufficient resting period may prevent the occurrence of some positive neurophysiological adaptations. In other words, the progressive increase of the training load causes an accumulation of neurophysiological stress in athletes, which usually affects the maintenance or deterioration of the anaerobic capacity, thus explaining the results of the present study. Regarding the tapering phase, the findings indicated a reduction in the fatigue index for EG, a fact not reproduced in CG. The high effect size found also stands out, which reveals great probability of this fact to be true for tae-kwon-do male athletes. Studies have pointed to the potentiation of the ability of repeated sprints in athletes after a gradual reduction of the training volume[23, 24]. Mujika et al.[8] reported that the reduction in the training volume leads to an increase in muscle glycogen stores, which, in turn, increase the time that athletes support being at high-intensity physical exercises. Mujika[5] stresses that the reduction in the training volume in a progressive way favors the recovery process of the organic systems, leading to some neurophysiological adaptations, for example: increase in the thickness of fast twitch muscle fibers, synchronization of muscle fiber recruitment, increased velocity of the phosphofructokinase enzyme reaction, in addition to increased muscle oxygenation.

Although the experimental design used in the present investigation is new with tae-kwon-do athletes, it is necessary to mention some limitations. Blood lactate production after Tae-kwon-do Anaerobic Test was not evaluated. Thus, it cannot be said that all athletes performed the test in maximum effort. In addition, the magnitude of athlete motivation was not measured before each Taekwondo Anaerobic Test evaluation. In this sense, the level of motivation for Taekwondo Anaerobic Test may have influenced the findings. Therefore, the results should be interpreted with caution.

CONCLUSION

In conclusion, considering the findings of the present investigation, it was concluded that two weeks of linear tapering optimized power and anaerobic capacity of male tae-kwon-do athletes. From the practical point of view, this study demonstrated that reducing the training volume in the weeks prior to the target competition may be an efficient strategy to improve the performance of tae-kwon-do athletes.

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