EFFECTS OF DISCONTINUOUS TRAINING METHODS IN COLOMBIAN COMBAT ATHLETES

EFECTOS DE LOS MÉTODOS DE ENTRENAMIENTO DISCONTINUO EN ATLETAS DE COMBATE COLOMBIANOS

EFEITOS DOS MÉTODOS DE TREINAMENTO DESCONTÍNUO NOS ATLETAS DE COMBATE COLOMBIANOS

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ABSTRACT

Objective: To determine the effectiveness of the discontinuous training of the VO_2Máx, in a competitive period, in combat athletes who live and train in Medellín-Colombia, with national or international sports level. Method: A convenience sample of 42 subjects was selected: 15 women and 27 men, 21 of them judo athletes, 9 fenders, 6 taekwondo athletes, and 6 fighters, from the selections of Antioquia in the Absolute Category, with age = 21.26 ± 3,98 years, size: 1.69 ± 0.09 m, weight = 65.70 ± 12.05 k, and sports experience of 8.54 ± 4.27 years. They were randomly distributed in two experimental groups and one control group. Experimental groups trained endurance for 4 weeks, with 4 stimuli per week, before the National Games, the maximum sports competition in Colombia. One experimental group trained with the interval method and the other with the intermittent method. The control group did not perform a specific endurance training, maintaining the strength training and the technical-tactical components, similarly to the subjects integrating the experimental groups. Results: Significant differences between the pre-test and the post-test for the intermittent group ($p < 0.05$), and not for the interval or the control groups, were found. Conclusions: Endurance training, based on the intermittent method, produced significant differences in VO_2Máx in combat athletes from Antioquia, during the final phase of its preparation. Likewise, it was found that the number of workouts carried out during a concentrated block of specific endurance training significantly influenced the changes that occurred in VO_2Máx.

KEYWORDS: endurance, combat sports, interval training, intermittent training.

RESUMEN

Objetivo: determinar la efectividad del entrenamiento discontinuo en el VO_2Máx., en período competitivo, en atletas de combate que viven y entrenan en Medellín-Colombia, con nivel deportivo nacional o internacional. **Método**: se seleccionó, a conveniencia, una muestra de 42 sujetos: 15 mujeres y 27 hombres, de ellos 21 judokas, 9 esgrimistas, 6 taekwondokas y 6 luchadores, de las Selecciones Antioqueñas de la Categoría Absoluta, con edad= 21,26±3,98 años, talla: 1.69±0.09 m, peso= 65.70± 12.05 k. y experiencia deportiva de 8.54±4.27 años. Fueron distribuidos aleatoriamente en dos grupos experimentales y un grupo control. Los grupos experimentales entrenaron la resistencia durante 4 semanas, con 4 estímulos por semana, antes de ir a los Juegos Nacionales, máxima competencia deportiva en Colombia. Un grupo experimental entrenó con el método interválico y el otro con el método intermitente. El grupo control no realizó un entrenamiento específico de la resistencia, manteniendo el entrenamiento de fuer-

za y de las componentes técnico-tácticas en forma semejante a la de los sujetos que integraron los grupos experimentales. **Resultados**: se hallaron diferencias significativas entre el pre-test y el pos-test para el grupo intermitente (p<0,05), no así para el interválico ni el control. **Conclusiones**: el entrenamiento de la resistencia basado en el método intermitente, produjo diferencias significativas en el VO_2Máx. en atletas Antioqueños de Combate, durante la fase final de su preparación. Igualmente, se encontró que el número de entrenamientos realizados durante un bloque concentrado de entrenamiento de la resistencia específica influyó de manera significativa en los cambios que se produjeron en el VO_2Máx.

PALABRAS CLAVE: resistencia, deportes de combate, entrenamiento intermitente, entrenamiento interválico.

RESUMO

Objetivo: determinar a efetividade do treinamento descontínuo e verificar se é possível melhorar o VO_2Máx no período competitivo de atletas de combate que vivem e treinam em Medellín- Colômbia, com nível desportivo nacional ou internacional. **Método**: Selecionou-se uma amostra a conveniência de 42 sujeitos 15 mulheres e 27 homens , deles 21 judocas, 9 esgrimistas , 6 lutadores e 6 taekwondokas das Seleções antioqueñas da categoria absoluta, com idades = 21,26 ± 3, 98 anos; tamanho: 1,69 ± 0,09 m; peso = 65,70 ± 12,05 k. e 8,54 ± 4,27 anos de experiência esportiva. Eles foram distribuídos aleatoriamente em três grupos: dois grupos experimentais e um grupo controle. Os grupos experimentais treinaram resistência por 4 semanas com 4 estímulos por semana antes de irem aos Jogos Nacionais para a competição máxima de esportes na Colômbia. Um dos grupos experimentais baseou seu treinamento no método intervalado e o outro no método intermitente. Por sua vez, o grupo controle não realizou nenhum treinamento de resistência específico, mantendo o treinamento de força e os componentes técnico-táticos de forma semelhante aos sujeitos que integraram os grupos experimentais. **Resultados:** Diferenças significativas foram encontradas entre o pré-teste e o pós-teste para o grupo intermitente (p <0,05), mas não para o grupo intevalado nem para o grupo controle. **Conclusão**: o treinamento de resistência com base no método intermitente produz diferenças significativas no VO_2Máx em atletas combate antioqueños durante a fase final de sua preparação. Também descobriram que o número de treinos realizados durante um bloco concentrado de treino da resistência específica influenciou significativamente as mudanças que ocorrem no VO_2Máx.

PALAVRAS-CHAVES: Resistência, esportes de combate, treinamento intermitente, treinamento intervalado.

INTRODUCTION

Endurance is the physical capacity that supports other components of physical performance (Platonov, 2001). In combat sports, endurance is used to optimize athletes' attentional, metabolic and coordination processes (Harre, 1989; Zintl, 1991; Weineck, 2005), and maximize recovery time between fights, which are critical success factors to achieving sporting excellence. According to Gummerson (1993), "Only those who appropriately develop endurance will succeed in the martial arts". García (2012) argues that "aerobic endurance is an essential component of judo although the adequate VO_2Máx. value hardly exceeds 60 ml/kg*min-1".

The appropriate VO_2Máx. value to efficiently evaluate the specific development of endurance, which is defined as the highest rate of oxygen (O_2) that can be absorbed, transported and consumed during a given physical activity that uses a considerable amount of body mass usually through incremental exercise (Viru, 2001; Jiménez, 2007; ACSM, 2014), is typically expressed as an absolute rate (L/min), or relative to body weight (mL/kg/min) (Wilmore & Costill, 2007; Gorostiaga & López, 1999). It is worth noting that VO_2Máx. values are the most widely accepted indicator for measuring an athlete's endurance performance.

VO_2Máx. values can be predicted directly in the laboratory using a spirometer, or through methods such as the Luc Léger test (PACER test), which has significant correlations with the direct measurement of VO_2Máx. ($r= 0.93$ y $p< 0.05$) (Paradisis et al., 2014). This method has been widely used in Physical Education research (García et al., 1996; Martínez, 2008), despite the fact that measurement errors of up to 10% can occur (Viru & Viru, 2001).

A study by Taylor & Brassard (1981) found VO_2Máx. values of 44-64 in male judo athletes, and 43-53 in female judokas. These values coincide with those found in Spanish judo athletes (52.5 for women, and 58.7 for men) (García, 2012). Rabadán

(2009) found VO_2Máx. values of 49-57.9 in male wrestlers, and a study conducted in Medellín-Colombia, found VO_2Máx. values of 50.6-67 in wrestlers and taekwondo athletes (Caldas et al., 1995). On the other hand, a study on fencing found VO_2Máx. values of 53.3-63.7 (Iglesias, 1999).

The fact that the search for alternatives of integral evaluation in judokas continues (Krstulovic et al., 2019) that include specific tests and their respective valuations, does not mean that finding the value of the endurance even by indirect methods does not allow to reach important conclusions on the performance of combat athletes, as it happens in a study carried out with 15 Colombian judokas, 8 women and 7 men, that compete internationally (Monterrosa et al., 2019) or in Mixed Martial Arts (Chernozub et al., 2018).

Several studies show that both continuous training (Gollnick et al., 1973; Hickson et al., 1977; Hickson et al., 1982; Chesley et al., 1996; Spina et al., 1996; Helgerud et al., 2001) and interval training programs (MacDougall et al., 1991; Tabata et al., 1996; Rodas et al., 2000; Gibala & McGee, 2008; Guzmán & Jiménez, 2013; Delgado & Jiménez, 2013) performed by non-athletes and middle-performance athletes, can significantly improve VO_2Máx values when performed over periods of 2-12 weeks.

The present study aimed to investigate the effects of two different endurance training programs (intermittent and interval training) on VO_2Máx. values in Colombian combat athletes during the competition period, which could lead to greater difficulty in raising VO_2Máx. levels due to a decrease in the training potential and the occurrence of the saturation phenomenon (Viru & Viru, 2001).

The study intended to evaluate whether discontinuous training can improve VO_2Máx. by using concentrated load of endurance during an athlete's competition period, in order to demonstrate the effectiveness of intermittent training programs and provide coaches and athletes with relevant information in this regard.

METHODOLOGY

The sample consisted of 42 elite Colombian athletes (15 women, 27 men) recruited through the Institute of Physical Education and Sport at Universidad de Antioquia (Colombia). Participants underwent routine physical examinations in order to receive medical approval / certification from a sports medicine physician of Indeportes, a regional sports authority. The study received approval from the Institute of Physical Education's Research Ethics Committee as stated in the Act No. 005 of 27 September 2015.

As we worked with 4 different sports simultaneously, the importance of the coaches, co-researchers of the project, who exercised as physical trainers in the available schedules of the athletes, was decisive for the success of the intervention, the achievement of the results, and the conclusions of the study (see aknowledgments).

To meet the objective, the main difficulty was to have available athletes and coaches that allowed to apply additional stimuli at the time prior to the main competition, which was a relevant achievement of the study, since stimuli were applied with two training plans for resistance with discontinuous methods: intermittent and interval, to verify its effect in full competitive stage. Table 1 shows experimental protocols used in the study.

The interval training group did 4 repetitions of 5 minutes at race pace in order to achieve the greatest possible distance in each repetition. 2 minutes micro breaks were performed between repetitions, so the total duration of the protocol was 26 minutes (20 minutes training sessions and 6 minutes rest breaks). This protocol would require keeping track of the distances traveled in each interval as well as the total distance traveled. The tests took place in the athletics track at the Atanasio Girardot Sports Complex in Medellín-Colombia.

Table 1. Experimental protocols implemented over a 4-week period using Modelamiento (Agudelo, 2012).

Parameters	Interval training protocol	Intermitent training protocol	Control group
Daily training	4sx5'/2'	20sx3ej./20":20"	No endurance training was performed
Actual daily volume (min)	20'	20'	
Total daily volume (min)	26'	40'	
Stimuli per week	4	4	
Number of weeks	4	4	
Actual duration of the training program (min)	320'	320'	
Total duration of the training plan including breaks (min)	416'	640'	

The intermittent training group performed 3 exercises consisting of a 6 meters run, 2 meters lateral spread displacements, and a technical task in a specific sports discipline according to the coaches' recommendation. Exercises were performed for 20 seconds straight followed by a 20 seconds rest over a period of 40 minutes, for a total training time of 20 minutes and a rest period of 20 minutes. The intensity level was set at 20":20" (1:1).

The protocol also used the Borg Scale of Perceived Exertion.

Assessment methods

Participants were evaluated before and after the intervention via the 20 meters Luc Léger Test, which involves running back and forth across a 20 meters distance with speeds increasing 0.5 km/h every minute. A synchronized pre-recorded audio track indicates the beginning and end of each run. The test ends when the athlete fails to reach the line before the beep. The speed of the final phase completed in full is taken as the score. The results obtained from this method allowed to calculate the VO_2Máx.

for each participant by using an age-based formula (García et al., 1996).

Statistical analysis

Data were analyzed using the IBM SPSS Statistics 23 software. Test results were analyzed through the Wilcoxon signed-rank test for related samples. A nonparametric statistical method was used for n=14 in each group in order to get more accurate results (Berlanga & Rubio, 2012).

The significance level was set up at $p < 0.05$ meaning it has a reliability of 95%. The sample power is 99% with a standard deviation of 0,63 to detect a difference of 1 ml/kg* min-1, based on an unpublished study on international-level judo athletes who performed a 5 month endurance training program.

RESULTS

Tables 2 and 3 show the longitudinal assessment of initial and final VO_2Máx values in professional athletes of disciplines such as judo, fencing, taekwondo and wrestling who were preparing to compete in the 20th edition of Juegos Deportivos Nacionales 2015. The participants were randomly assigned into one of the following groups: the control group, the interval training group and the intermittent training group. The training sessions were performed on a regular basis twice a day, five days a week.

Table 2. Average initial VO_2Máx. values ($ml/kg*min^{-1}$)

Average initial VO_2Máx	Intervalic training group	Intermittent training group	Control group
Females	45.5	44.5	43.3
Males	54.2	55.5	51.9
Total	50.5	50.3	49.7

Table 3. Average final VO_2Máx. values (ml/kg*min^{-1})

Average final VO_2Máx	Intervalic training group	Intermittent training group	Control group
Females	48.4	45.7	43.3
Males	56.0	59.2	52.2
Total	52.8	52.5	50.1

Table 4 shows VO_2Máx. values for each group, as well as the percent of improvement and the significance level in the Wilcoxon signed-rank test. The results show differences in pretest and posttest scores as follows: 4.55% for the interval training group, 4.37% for the intermittent training group, and 0,80% for the control group. Although these changes were not statistically significant ($p > 0.05$) for the control and the interval group, there were significant changes in the intermittent training group ($p<0.05$).

Table 4. Wilcoxon signed-rank test results

Group	VO_2Máx. (ml/kg*min^{-1})		Difference (ml/kg*min^{-1})	Percent of improvement	Wilcoxon signed-rank test	
	Pretest	Posttest			Significance level	
Interval	50,5	52,8	2,3	4,55	0,112	
Intermittent	50,3	52,5	2,2	4,37	0,015	*
Control	49,7	50,1	0,4	0,80	0,887	

**Significant ** Highly significant*

Table 5 shows that the number of interventions plays a crucial role in improving VO_2Máx. levels since p-value $p=0.01$ ($p<0.05$) remains the same for both training methods making this variable statistically significant in endurance training as stated by classic authors.

Table 5. Importance of the number of interventions for each training method and evaluation through the Wilcoxon signed-rank test

Group	Wilcoxon signed-rank test	
	Significance level	
Intervalic	0,01	**
Intermittent	0,01	**

**Significant ** Highly significant*

DISCUSSION

The present study, which aimed to determine the effectiveness of discontinuous training during the competition period in national-level combat athletes, showed that concentrated loads of intermittent endurance training can improve athletic performance. The authors found statistically significant improvements in VO_2Máx. (p=0.015) in athletes exposed to intermittent endurance training methods. However, the authors don't rule out the possibility that interval training methods may lead to improvements in VO_2Máx. values since the p-value is close to the margin of significance (p=0.112) which differs considerably from that observed in the control group (p= 0.887).

The study provides evidence that intermittent endurance training methods that are performed for up to 4 weeks, 4 times a week, can lead to significant improvements. It also supports previous findings from a study conducted in Spain which involved soccer players who performed interval and intermittent training for 6 weeks providing significant improvements for both methods (Rodríguez et al., 2014). Similar results were obtained in a study involving professional soccer players who performed the same training methods for 10 weeks (Dupont et al., 2004), and a study conducted in Norway with well-trained cyclists who performed block periodization for 4 weeks thus achieving a superior training response (Rønnestad, 2013).

The study suggests there is sufficient evidence that intermittent training is not only effective but also easy to implement since it can be carried out by the coach directly in the training arena with the advantage that it can significantly reduce the time needed to improve VO_2Máx. in elite athletes when performed 4 or more times per week in the form of a block periodization method.

Despite a relatively small sample size, which is a factor that can hinder intergroup assessment, in addition to other factors such as the lack of spirometric measurements, the fact that the participants underwent stimulation only for 4 weeks during the pre-competition period, that the sample consisted of athletes from a single region of Colombia, and important aspects such as nutrition were left out, there is sufficient evidence to conclude that the study can positively impact the way how endurance training programs are performed.

After having demonstrated that intermittent training can significantly improve athletic performance in elite combat athletes, and considering that further studies using similar measures and methods continue to be carried out, as those involving heavy endurance training (IHRT) conducted in Australian soccer players (Inness et al., 2016), we can conclude that intermittent training has proven to be effective since it can significantly improve VO_2Máx. in combat athletes during the competition period.

CONCLUSIONS AND RECOMMENDATIONS

Results suggest that concentrated loads of intermittent endurance training can help improve VO_2Máx. values. The study showed that the interval training method is also effective in helping maintain VO_2Máx. levels and perform intensive combat training. Planning by Modelamiento is efficient in concentrating endurance loads in this training phase.

Although female athletes tend to achieve better results through interval training rather than through intermittent training (VO_2Máx. values went from 45.5 in the pre-test, to 48.4 in the posttest scores when performing interval training vs. 44.5 to 45.7 through intermittent training), while male athletes who performed intermittent training experienced increases in VO_2Máx. values which went from 55.5 to 59.2 vs. 54.2 to 56 as a result of interval training, gender-related differences are not statistically significant. Therefore, a valid conclusion that can be drawn from this experiment is that elite combat athletes tend to improve performance in the pre-competition period through intermittent training rather than through interval training.

Results suggest that the number of interventions is statistically significant when it comes to improving VO_2Máx. values through any of the aforementioned discontinuous training methods. It is therefore worth noting that timely and regular attendance as well as the intensity of the stimuli applied play a key role in implementing interventions (Agudelo, 2012).

It is advisable to conduct further studies that include other sporting disciplines, a greater number of participants, different stages of the preparation period, other stages of the athletic career, as well as relevant factors such as nutrition, lab tests, and psychological variables, in order to draw more decisive conclusions.

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