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ORIGINAL ARTICLE

ASSESSMENT AND COMPARISON OF RATINGS OF PERCEIVED EXERTION RESPONSES AND BLOOD LACTATE CONCENTRATION, DURING AN OFFICIAL KARATE COMPETITION

AVALIAÇÃO E COMPARAÇÃO DAS RESPOSTAS DA PERCEPÇÃO SUBJETIVA DE ESFORÇO E CONCENTRAÇÃO DE LACTATO EM UMA COMPETIÇÃO OFICIAL DE KARATE

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ABSTRACT
Several physiological indicators can be used to assess the intensity of exertion, such as heart rate (HR), oxygen consumption (VO2), blood lactate [BLa^-] and rating of perceived exertion (RPE). This study aimed to assess and compare RPE and [BLa^-] responses during an official karate competition. Seven athletes participated in an interstate competition, where [BLa^-] and RPE variables were measured through two scales, Borg 6-20 (RPE_{6-20}) and CR-10 $_{(RPECR-10),}$ to estimate the intensity of exertion. The mean values ± standard deviation were: $[BLa^-]_{peak}$ = 7.6 ± 1.4 mM, RPE_{6-20} = 12 ± 3 and RPE_{CR-10} = 3 ± 1. Strong correlations were found between RPE_{CR-10} and $[BLa^-]_{peak}$ (r = 0.82) and moderate correlations between RPE_{6-20} and $[BLa^-]_{peak}$ (r = 0.62). Based on such results, it is observed that both scales, presented at different moments, can be applied efficiently to measure the exertion made by karate athletes during the competition.
Keywords: Competition. Exertion. Karate.

INTRODUCTION

In karate, it is difficult to determine the mechanical work performed by the athlete. In sports activities with such limitation, it is suggested the measurement of physiological variables, in order to infer the amount of energy required by the activity (FRANCHINI et al., 2004). Several physiological indicators can be used to estimate the intensity of exertion, such as heart rate (HR), oxygen consumption (VO2) and blood lactate concentration ([BLa^-]) (GRAEF et al., 2006).

Assessments are usually performed in laboratories, and the measured data serve as reference values, allowing an effective elaboration of the training program (RIBEIRO et al., 2006). Nevertheless, there are variations in the responses obtained in laboratories and in the field, and they can affect the efficiency of the training program, since the environmental differences among the conditions may compromise the ecological validity of the measures (SANTOS et al., 2005). Thus, it is suggested that the assessments should be performed at the competition or training sites of the athletes.

Because [BLa^-] has been successfully used as an indicator of the contribution of the anaerobic glycolytic via (DEUTSCH et al., 1998) and the anaerobic power and capacity of fighters (YOON, 2002), various studies involving karate have been using this variable as a protocol that simulates training (IMAMURA et al. 1999; IMAMURA et al. 1997) and as an objective measure of intensity of exertion during competitive simulations (BENEKE et al., 2004; IIDE et al., 2008) and the *kata* situation, in which athletes perform sequences of predetermined and standardized movements of attack and defense for technique demonstration (FRANCESCATO; TALON; DI PRAMPERO, 1995).

Despite that, [BLa^-] measurements require relatively sophisticated equipment and experienced evaluators. Moreover, the procedure used for the collections do not please most individuals, for being invasive (IRVING et al., 2006). On the other hand, the adoption of rating of perceived exertion scales (RPE) to determine the intensity of the exertion has been widely accepted by researchers, sports training professionals and athletes, since it is a non-intrusive, relatively accurate, safe, practical and low operating cost method (NEGAMINE et al., 2007).

RPE scales were created to establish an indirect way to quantify, via the performer's perception of the exertion and / or fatigue sensation, the external load or the physiological stress he is subjected to (NAKAMURA et al. 2005). The use of such scales is based on the premise that the physiological adjustments promoted by physical exertion produce afferent sensory signals able to alter the RPE (BERTUZZI et al., 2006). Alternatively, Marcora (2009) defends that RPE is produced from corollary stimuli to the motor impulses, in form of efference copy from the motor to the sensory cortex. This response could also be modulated by mental activity and favorable or adverse psychological states (MARCORA; STAIANO; MANNING, 2009).

The relationship between RPE and [BLa^-] has been widely investigated; however, as other variables also participate, it is difficult to establish a cause and effect relationship between RPE and [BLa^-]. Nevertheless, with certain limitations, current results suggest that [BLa^-] may influence the RPE during high intensity exercises with intervals (PERANDINI et al., 2007), incremental test for swimmers performed in the pool (LIMA et al., 2006) and simulation of judo fights (SERRANO et al., 2001). Thus, the possibility of applying RPE as an indicator of intensity can be especially interesting in sports with features that make it difficult to quantify physiologically the exertion during training or competition situations (SERRANO et al., 2001).

Although RPE data are compatible with [BLa^-] responses, VO_2 and HR in both men (IMAMURA et al., 1999) and women (IMAMURA et al., 2002) during typical training, simulation of 20 fights performed sequentially (IMAMURA et al., 1996), training with a high volume of punches and kicks (IMAMURA et al., 1997; IMAMURA et al., 2003) or fight simulations (IIDE et al., 2008), it was not possible to find, in the scientific literature, reports about application of RPE and its association with other variables during an official karate competition.

In this context, the objectives of this study were to assess and compare RPE responses through Borg 6-20 scales (PE_{6-20}) (BORG, 2000) and modified CR-10 $_{(PECR-10)}$ (FOSTER et al., 2001), and [BLa^-] of karatekas during an official competition.

MATERIAL AND METHODS

The present study counted with seven elite karatekas, state and national levels (four men and three women), whose physical characteristics are displayed in Table 1. The athletes had been training regularly five times a week for at least five years. After receiving information about the purpose and procedures of the study, the participants signed an informed consent. The study was approved by the Ethics and Research Committee Involving Humans of the State University of Londrina, Paraná state (protocol n. 192/07), as established by the Resolution 196/96 of the National Health Board.

Later, during an official karate competition, PE_{6-20} and PE_{CR-10} values were registered and blood samples were collected for [BLa^-] determination. It is important to highlight that the blood samples were collected only at the end of the last fight, while PE_{6-20} values were obtained at the end of each fight. PE_{CR-10} values

were obtained 30 minutes after the end of the last fight.

Anthropometric assessment

In order to characterize the sample, the body mass was obtained by using a digital scale (Filizola, Brazil), with an accuracy of 100g, while the height was determined by using an anthropometer, with an accuracy of 0.1 cm, in accordance with standardized procedures described in the literature (GORDON; CHUMLEA; ROCHE, 1998).

Karate competition

The competition was conducted by official referees and regulated by the World Karate Federation, with athletes from three states: Paraná, Mato Grosso do Sul and São Paulo. It was used the *Shobu* scoring system (difference of eight scores). The size of the area (*koto*) was 8m x 8m. The adopted technique levels were the *Jodan* (head, face and neck) and the *Chudan* (thorax, abdomen, back and sides). The *Jodan* technique involves absolute control. Touches are not allowed. Blows with up to 10 cm of distance were computed as scores. Glove or foot touching the opponent was not considered score. Causing injury on the opponent was considered penalty. The *Chudan* technique allowed light and controlled contact.

During the competition, the athletes performed from one to three fights, determined by the number of entries in each category. The length of the fights was adapted in such a way that all categories had two minutes, during qualifying and final fights. The researchers, at no time, interfered with the schedule adopted by the organizing committee. Each microtubule contained 50 µl of anticoagulant solution (sodium fluoride, 1%). $[BLa^-]$ was determined by using an electrochemical analyzer (YSL 1500 STAT Yellow Spring Co., USA). The highest lactacidemic value was defined as the peak lactate concentration ($[BLa^-]_{peak}$) and the difference between $[BLa^-]_{peak}$ and resting lactate concentration ($[BLa^-]_{rest}$) was defined as $A[BLa^-] = [BLa^-]_{peak} - [BLa^-]_{rest}$, expressed in millimole (mM).

Rating of perceived exertion responses (RPE) through Borg 6-20 $_{(RPE6-20)}$ and CR-10 scales (RPE_{CR-10})

At the end of each fight, the athlete immediately visualized the number referring to the intensity of exertion, indicated on the Borg 6-20 scale. The mean values registered during the fights were set as the RPE_{6-20} response. On the other hand, the PE_{CR-10} determination was obtained on the CR-10 scale, 30 minutes after the last fight, assessing, in this way, the exertion related to the whole competition.

Statistical analysis

Initially, the Shapiro Wilk test was used to analyze the data distribution. Having confirmed the normality, the results were expressed in mean values ± standard deviation (SD). For comparisons among genders, it was used the Student t test for independent samples. The Pearson product-moment correlation analysis was used for analyzing possible associations among the methods. The significance level for all analyzes was 5%. The data were processed by using SPSS for Windows, version 13.0.

RESULTS

Blood lactate concentration response ($[BLa^-]$)

After the last fight of each athlete, during the 1st, 3rd, 5th, 7th, 9th and 11th minutes, 25 µL of blood were collected from their earlobe for $[BLa^-]$ dosage.

The samples were immediately put in polyethylene micro tubes, Eppendorff brand, with capacity for up to 1.5 mL, and stored at -70ºC, for posterior dosage.

The individual physical characteristics of the karatekas are shown in Table 1.

Female karatekas presented mean values higher than those of male athletes for $[BLa^-]_{peak}$, RPE_{6-20} and RPE_{CR-10}; however, these values were not statistically significant (Table 2).

RPE_{CR-10} presented strong correlation with $[BLa^-]_{peak}$ (r= 0.82, P=0.02), and moderate with the $\Delta[BLa^-]$ (r = 0.61, *P* = 0.14), while RPE_{6-20} presented moderate correlation with $[BLa^-]_{peak}$ (r = 0.62, *P* = 0.14) and $\Delta[BLa^-]$ (r = 0.55, *P* = 0.21) (Table 1). Strong correlation was found between RPE_{CR-10} and RPE_{6-20} (r = 0.89, *P* < 0.01).

Mean values of $[BLa^-]_{peak}$ (7.6 ± 1.4 mM), that occurred on average at 5 ± 3 minutes, remained above the resting levels until the eleventh minute, as illustrated in Figure 1.

Table 1 – Individual physical characteristics of karatekas of both genders (n = 7).

Subjects (n)	Age (years)	Height (cm)	B. Mass (kg)	B. Fat (%)	
S1	16		156	45.4	6.8
S2	30		182	88.7	15.6
S3	22		158	56.4	13.5
S4	21		164	60.2	16.8
S5	20		159	51.6	16
S6	17		160	47.4	10
S7	19		165	56	17.9
Mean	20.7		163.4	58	13.8
SD	4.6		8.8	14.5	4.0

* Body mass (B. Mass), Body fat (B. Fat).

Table 2 – Individual results of rating of perceived exertion (RPE) obtained through the Borg 6-20 $_{(RPE6-20)}$ and CR-10 (RPE_{CR}-10) scales, and of peak lactate concentration [BLa-], separated by gender, men (n=4) and women (n=3)

Subjects	PSE_{6-20}	PSE_{CR-10}	$[Lac]_{pico}$	Subjects	PSE_{6-20}	PSE_{CR-10}	$[Lac]_{pico}$
Men				**Women**			
S1	11.7	2	6.63				
S2	10	2	6.33	**S5**	11	3	9.36
S3	13	4	8.91	**S6**	13.7	3	7.26
S4	6	1	5.94	**S7**	15.5	5	8.77
Mean	10.2	2.3	7.0	**Mean**	13.4	3.7	8.5
SD	3.0	1.3	1.3	**SD**	2.3	1.2	1.1

Perceived exertion through 6-20 (PE_{6-2}0) scale, Perceived exertion through CR-10 (PE_{CR-10}) scale and Peak lactate concentration $[BLa^-]_{peak}$

Table 3 - Correlation among PE_{CR-10} and PE_{6-20} scales with the values of $[BLa^-]_{peak}$ and Δ $[BLa^-]$.

	$[Lac]_{pico}$ (mM)		Δ[Lac] (mM)	
	R	*P*	R	*P*
PSE_{CR-10}	0,82*	0,02	0,61	0,14
PSE_{6-20}	0,62	0,14	0,55	0,21

Peak lactate concentration ($[BLa^-]_{peak}$), difference among concentrations of peak lactate and resting lactate (Δ $[BLa^-]$), perceived exertion through 6-20 (PE_{6-20}) scale and perceived exertion through CR-10 (PE_{CR-10}) scale.

P< 0.05.

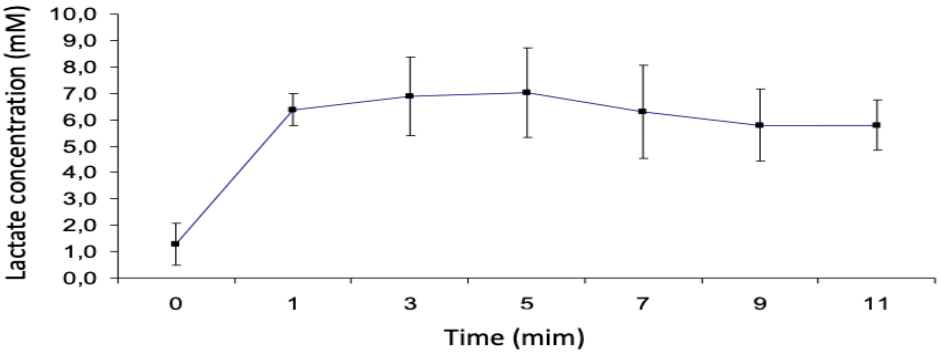

Figure 1 – Lactate concentration [BLa-] during the recovery time after the last fight.

DISCUSSION

According to information available in the literature until the present moment, studies that have assessed [BLa^-] response related to karate directed their investigations to protocols that simulate training (IMAMURA et al., 1999; IMAMURA et al. 1997; IMAMURA et al. 2003). Although these studies involve the same modality, they included different methodologies and lengths, resulting in [BLa^-] responses below 3.0 mM.

The results of the present study regarding $[BLa^-]_{peak}$ values (see Table 2) were superior to the aforementioned studies, and are similar to what was observed by Beneke et al., (2004), who evaluated 10 karatekas during a competition with simulated fights, finding $[BLa^-]_{peak}$ values of 7.7 ± 1.4 mM. From this, it is possible to state that some studies (IMAMURA et al., 1999; IMAMURA et al., 1997; IMAMURA et al., 2003) which analyzed blood lactate concentration responses in different training situations and found values lower than 3 mM, used tasks distant from the actual demands of the fights. Thus, the values of blood lactate concentration measured in the present study are two times higher than those reported in training situation (IMAMURA et al., 1999; IMAMURA et al., 1997; IMAMURA et al., 2003), which may suggest that the activities performed in typical karate sessions do not overload the glycolytic system appropriately to that imposed in fighting situation.

From the [BLa^-] response, analyzed until the eleventh minute (see Figure 3) after the last fight of each athlete, it was verified that intervals of such magnitude are not sufficient for the [BLa^-] to return to the resting value when the recovery is passive, suggesting that the recovery process was not complete. The World Karate Federation has not established a minimum interval time to be respected between one fight and another, during qualifying and final fights. Members of the temporary board of referees, in turn, have been respecting a time of three minutes of interval between the semifinal and final fights. Acidosis caused by accumulation of H + dissociated from the lactic acid may interfere with the athletic performance, which has been observed before in football players, who had an exponential increase in reaction time in [BLa^-] above 6 mM (CHMURA; NAZAR ; KACIUBA-USCILKO, 1994).

Although there are many women practicing karate, most studies involving such modality is directed to male athletes (FRANCESCATO; TALON; DI PRAMPERO, 1995; IMAMURA et al., 1999; IMAMURA et al., 1997; BENEKE et al., 2004; IIDE et al., 2008). Considered an exception, a study conducted by Imamura et al., (2003) has verified in black-belt female karatekas, after performing one thousand kicks, [BLa^-] responses of 3.0 ± 0.9 mM and RPE_{6-20} of 15.7 ± 1.0. A previous study used the same exercise protocol in a sample with male karatekas and found [BLa^-]

and RPE_{6-20} responses of 1.3 ± 0.4 mM and 14.2 ± 1.2, respectively. The present study carried out investigations with karatekas of both genders in fighting situations, different from those aforementioned studies, in which karatekas presented higher mean values, although such differences have not been statistically significant (Table 2).

As no studies were found with the RPE_{CR-10} scale to quantify the intensity of karate exertion, comparisons among the information produced by this study and the data available in the literature were limited to the analysis of the behavior verified by the RPE_{6-20} scale. In fact, some studies conducted by Imamura et al. (1997, 1999, 2003) used the RPE_{6-20} scale, but, as previously mentioned, those studies used exercise protocols predefined by the researchers that simulated training, not real fighting situations, which have considerably shorter length. On the other hand, in a study carried out by Iide et al. (2008), that evaluated 13 male karatekas in situations that simulated fights of two and three minutes, the RPE_{6-20} results for fights with two minutes were higher (13.5 ± 1.8) than those obtained in the present study for male karatekas (Table 2).

The positive correlations among $[BLa^-]_{peak}$ and RPE_{CR-10} (r=0.82), $[BLa^-]_{peak}$ and RPE_{6-20} (r=0.62), $O[BLa^-]$ and RPE_{CR-10} (r=0.61), $O[BLa^-]$ and RPE_{6-20} (r=0.55) and RPE_{CR-10} and RPE_{6-20} (r=0.89) could not be contrasted with other findings in the literature, due to the lack of studies about karate, because, when the studies were methodologically similar, they differ in relation to the modality. On the other hand, within the context of martial arts, Franchini et al. (1998) evaluated judokas of different categories during fighting situations and observed that RPE_{6-20} response seems not to be an efficient way to identify the intensity of fighting, since it was found a strong correlation (r = 0.80) between RPE_{6-20} and $[BLa^-]$ only in the first fight. In contrast, Serrano et al. (2001), during a simulated competition with 13 male judokas, verified moderate correlations among $[BLa^-]_{peak}$ values with RPE_{6-20} (r = 0.63) and RPE_{CR-10} (r = 0.53), both presented 30 minutes after the exertion sessions.

In the present study, the scales presented at different moments correlate with each other and with $[BLa^-]$ response, but the relationship between RPE and $[BLa^-]$ should be viewed with extreme caution. In high-intensity intermittent exercise, Green et al., (2006) found a low correlation between $[BLa^-]$ and RPE_{6-20} (r = 0.22, P <0.05), but Coutts et al., (2009), when evaluating football players during training in reduced field, found moderate and significant correlation between $[BLa^-]$ and RPE_{CR-10} (r = 0.63, P <.05). Although these results, during sports practice, help to estimate the intensities of the exertion through non-intrusive measures such as RPE, alternative descriptions, besides $[BLa^-]$ response, have been used to explain RPE response.

It is noteworthy that the study has some limitations, such as the number of fights, which differ among athletes, as well as the small number of subjects. Nevertheless, it is important to emphasize that during an official competition the number of fights is determined according to the number of entries in each category. The relatively low number of subjects in the sample is a fact that has often been observed in studies with karatekas (n <10) (BENEKE et al., 2004; NUNAN, 2006; FRANCESCATO et al., 1995; IMAMURA et al . 1999; IMAMURA et al. 2003). This fact seems to be fully justifiable, since in karate athletes are categorized according to their age and weight, so the elite teams usually count with only one athlete per category. Despite such restrictions, there is a clear need for studies that include a larger number of fights and subjects.

CONCLUSION

Based on the results found in this study, it is observed that there is a significant participation of the lactic anaerobic metabolism during the karate competition, and that

intervals inferior to 11 minutes are insufficient for [BLa^-] to return to resting values. Moreover, both scales, presented at different moments, can be efficiently applied to measure the exertion of karatekas during the competition; however, the relationship between RPE and [BLa^-] should be viewed with caution, since other factors contribute to RPE response. Further studies are needed in order to include a larger number of fights and subjects to be investigated.

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