Acute response in changes in blood pressure and heart rate after punching and kicking in *muay thai*

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Abstract

Background and Study Aim: It was observed that the increase in blood pressure (BP) and heart rate (HR) is associated with the size of the recruited muscle mass due to increased peripheral vascular resistance. However, some studies which analyzed this issue did not show any effect. The aim of the study was knowledge about the systolic (SBP) and diastolic (DBP) blood pressure and heart rate between two types of *muay thai* strikes (sequences of punches and kicks with sequences of kicks and punches).

Material and Methods: Thirteen men, *muay thai* experienced practitioners, with 30.08 ±2.36 years, made two visits with 48-hour interval between them, the first with alternating punches and kicks (PPK) and the second being kicked and then punched (PKP). Measurements were made of BP and HR at rest and after warming up and interventions.

Results: A significant difference in relation to changes in SBP, only PPK compared to rest at $p<0.05$. There was not significant difference between HR and the PPK as well as between PKP with the respective values at rest and warm up.

Conclusion: The results obtained in the sample, the punch sequence and kick, and kick and punch, alter the responses of HR, but not similarly alter the BP. However, an increase in systolic post punch and kick with respect to rest. This result may suggest care in practicing these techniques when performed by people with heart disease and the need of recovery intervals for any practitioner. Thus, further studies are recommended to women and other martial arts to verify the results found here.

Key words: 1RM • acute physical exercise • combat sports • hemodynamic • martial arts

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Introduction

Physical exercises provide a certain level of acute stress on the various organic systems because while practicing these exercises occurs breaking of organic homeostasis developing the need for supplying this new metabolic demand [1]. Among the physical activities that generate such adjustments, can be highlighted the fighting activities. This type of activity has been gaining fans with different objectives, namely physical fitness, performance and self-defense.

One of the activities that arouse interest in practitioners of physical exercises in gyms is *muay thai*. This type of activity is a fight that has characteristics of an intermittent physical activity stress, whose intensity varies between maximal and submaximal with small intervals recovery, which involves the glycolytic and oxidative pathways [2].

The cardiovascular system, among organic systems, is one that suffers most changes during the practice of physical exercises, since it is responsible for the greater supply of blood to active muscles influencing blood pressure (BP) and heart rate (HR) [3, 4] being directly related to the type, intensity and duration of exercise [5-8].

It was observed that the increase in blood pressure is associated with the size of the recruited muscle mass due to increased peripheral vascular resistance [9, 10]. However, some studies that analyzed this issue did not show any effect [3, 11].

Battagin et al. [12] and MacDougall et al. [9] found the behavior of blood pressure after resistance exercise using different muscle groups. The study Battagin et al. [12] found no difference in BP between the muscle groups analyzed. However the study by MacDougall et al. [9] observed a significant increase in blood pressure in resistance exercises for the legs when compared to resistance exercises for the upper body.

Martial arts has been the subject of several studies [13-17], however the answers on the variations of HR and BP involving different muscle groups are scarce in the literature. However, it is necessary to investigate possible changes in hemodynamic variables to better suit the prescription of training for *muay thai* and increase the safety margin of the given activities.

The aim of the study was knowledge about the systolic (SBP) and diastolic (DBP) blood pressure and heart rate (HR) between two types of *muay thai* strikes (sequences of punches and kicks with sequences of kicks and punches).

Hemodynamics – principles governing blood flow in the cardiovascular system.

Muay thai – or *thai boxing*, originates from southern Asia (not only from Thailand, but also from Burma, Cambodia, Vietnam and Malaysia). It was inspired by fighting skills used on battle fields during wars conducted by the Thais in the twelfth and thirteenth century AD. Apart from a fight with use of various weapons, during hand-to-hand fighting warriors used *kaad chuek* (wrappings around hand and forearm) which were hardened and studded with gravel to cause the greatest damage possible martial art originally from Thailand characterized by the combined use of fists, elbows, knees, shins and feet [26].

Strike in combat sports and martial arts – can be strike weapons (fencing, kendo, etc.), hands (*boxing*), legs (*savate*), arms and legs (*karate, kick-boxing, taekwondo, muay thai*, etc.); in terms of the general strike hand to "punch" and synonyms, strike his leg a "kick" and synonyms [27].

Jab – punch used in martial arts performed with the front arm base position until it is fully extended.

1RM – individual's maximal strength or 1 repetition maximum [28].

Motor safety – is consciousness of the person undertaking to solve a motor task or consciousness the subject who has the right to encourage and even enforce from this person that would perform the motor activity, who is able to do it without the risk of the loss of life, injuries or other adverse health effects [29].

Effort safety – is consciousness of the person who starts physical effort or consciousness of the subject who has the right to encourage or even enforce from this person the physical effort of a certain intensity and duration, who it is able to do so without risking life or health [29].

Material and methods

Participants

The study included 13 thirteen healthy men, *muay thai* practitioners with minimal practice time a year and often two to four times a week (Table 1).

Table 1. Participants characteristics

	Age (years)	Body mass (kg)	Height (m)
Mean	30.08	76.31	1.76
SD	2.36	5.99	0.05
Maximum	34.00	89.00	1.86
Minimum	27.00	66.00	1.67

As inclusion criteria, were adopted: being normotensive, nonsmokers and not display any metabolic or musculoskeletal disease. As exclusion criteria, were adopted: present limb lesions, make use of any medication that could alter the results, make use of caffeine or alcohol and physical activity on the days of collection.

The research complied with the Declaration of Helsinki [18] where all subjects were informed of the study procedures and signed a free and informed consent prior to realization.

Protocol

It used the device to measure BP and HR digital 7200 (OMRON) [19] and dressers of punches and kicks and gloves (Fight Brazil). In order to enable the research, each volunteer was individually evaluated every other day.

HR resting (HRR) and BP resting (BPR) was presented by average of three measurements. Soon after it, conducted a warming up (WU) with joint movements of shoulder, elbow, spine, hips and knees, stretching to the muscles of the upper limbs, lower limbs and spine, in a traditional *muay thai* class, by the methods of static stretching and loosening per three minutes. Each volunteer had his BP and HR measured immediately after WU and immediately after the intervention so that the time between the activity and the measurement do not exceed 20 seconds.

The first intervention was made through the application of 10 straight punches, five jabs and

Table 2. Values of BP at rest (Rest), warming up (WU) and post punch and kick (PPK) in mm/Hg.

	Rest		WU		PPK	
	SBP	DBP	SBP	DBP	SBP	DBP
Mean	129.7	83.4	133.3	83.8	**140.7***	85.1
SD	13.1	7.9	11.1	8.5	9.3	8.9
Maximum	152.6	98.6	152.0	99.0	158.6	98.3
Minimum	110.3	64.6	115.0	67.6	119.0	65.6

* significant difference compared to the rest value, p<0.045

Table 3. Values of blood pressure at rest, warming up and post kick and punch (PKP) in mm/Hg.

	Rest		WU		PKP	
	SBP	DBP	SBP	DBP	SBP	DBP
Mean	128.6	83.8	133.7	84.3	139.0	84.9
SD	12.8	9.1	12.7	9.9	11.4	9.0
Maximum	147.0	97.3	145.0	97.3	160.6	96.6
Minimum	104.3	65.0	107.3	63.3	111.6	65.0

Table 4. Values of heart rate (HR) at rest, warming up (WU) and post punch and kick (PPK) and post kick and punch (PKP) in bpm.

		PPK			PKP	
	Rest	WU	Post	Rest	WU	Post
Mean	73.92	**80.1***	**88.76* †**	63.1	**78.76 ‡**	**86.1‡ §**
SD	5.8	6.4	7.0	4.9	6.13	7.51
Maximum	88.6	98.6	107.3	87.0	97.0	106.0
Minimum	68.0	73.0	81.0	69.0	72.0	79.0

* significant difference from the rest, p<0.05 and p=0.001; † significant difference from WU, p<0.05. ‡ significant difference from the rest, p<0.05. § significant difference from WU, p<0.05

five direct performed sequentially alternated (PPK), i.e., right-handed: with the left jabs and straight right hand side, followed by 10 shots low uninterrupted, totaling 20 with high intensity performed strokes, measured by the Borg scale [20] between eight and ten (scale of 0 to 10) of the maximum capacity of each.

The second intervention occurred after 48 hours, where the same procedures were realized reversing the order of strokes that began by applying kicks (PKP).

Statistical Analysis

For the statistical analysis we used the Statistical Package for Social Sciences (SPSS), version 20 for Windows, watching all the basic standards which guarantee its scientific. Data are presented descriptively as mean and standard deviation of the results of HR and BP. The normality and homogeneity of variance of the sample data were analyzed using the Shapiro–Wilk and Levene's tests, respectively, determining whether data is parametric. ANOVA with repeated measures was applied, followed by Bonferroni's post hoc test to identify any possible differences. The study adopted the level of p<0.05 for statistical significance.

Results

Noticed a significant increase in systolic blood pressure (SBP) when compared to the rest. Diastolic blood pressure (DBP) showed no significant differences (Table 2). In the sequence of PKP systolic blood pressure (SBP) showed no significant differences. The same happened with DBP (Table 3). No differences were found in SBP and DBP when compared the two sequences of blows (PPK vs. PKP).

In the PPK sequence, there is a significant increase in heart rate HR when compared HRR and PPK, compared to WU and HRR. In the sequence of PKP strikes, similar significant increases were also recorded, following the same rest ratio, heating and after intervention. No significant differences were found in HR when compared the two sequences of strikes: PPK vs. PKP (Table 4).

Discusion

It is believed that at the end of a sequence of strokes using lower limbs, there major changes in the cardiovascular system, with respect to BP, for the case of a larger grouping in relation to the upper limbs. However, according to the results obtained in this research, we found that there was no significant difference in BP variations in the comparison between the punches and kicks interventions versus kicks and punches used in *muay thai*, conferring with other studies [21, 22].

However, this investigation observed a significant difference in increasing SBP by comparing the time of rest with the PPK, corroborating with studies that observed a rise in blood pressure associated with the size of the recruited muscle mass due to increased peripheral vascular resistance [9, 11, 23].

Battagin et al. [12] found no significant difference in blood pressure behavior for a random progressive resistance exercise session between the femoral quadriceps, latissimus dorsi and biceps in women with controlled systemic hypertension (SH). Blood pressure measurements were obtained at all visits at rest, immediately after each series of exercise and after 5 minutes of recovery. The results contradict the findings in this study which found an increase in SBP following PPK blows to *muay thai* athletes men.

Gonçalves et al. [16] evaluated the heart rate, systolic and diastolic blood pressure and behavior of oxygen consumption by the myocardium while performing resistance exercises acutely with different intensities for knee extensors and flexors of the elbow. Two resistance training protocols were applied on different days with random order of performance: endurance protocol (2 sets, 20 reps and 40% of 1RM) and strength protocol (2 sets, 8 reps and 80% of 1RM). All measurements were made immediately after the execution of protocols. There were significant differences in all study variables compared to the rest. These results differ from the findings of this study, which found significant differences in SBP values compared to rest only in the wake of PPK strokes performed by *muay thai* athletes. However, this study used an intermittent activity, which may explain the different results, since after resistance training happens a physiological hypertrophy in the wall of the left ventricle, caused by intermittent increase in BP keeping the volume of the ventricular cavity, thus affecting minimally diastolic and systolic function [24].

MacDougall et al. [9] verified the responses of blood pressure in elbow flexion exercises, single and double-leg with 80, 90, 95 and 100% of 1RM in weight lifters. The largest SBP values were observed during the double-leg, corroborating the finding of the present study also found higher responses in SBP after sequences of PPK. However, MacDougall et al. [9] used a capture probe attached to a catheter into the brachial artery causing a Valsalva maneuver, the latter possibly influenced the condition of the observed increase in blood pressure.

Regarding the HR, there was significant difference in the comparisons between rest and warm up, rest and intervention and warm up and intervention, corroborating with other research [22] that observed similar changes, however in resistance exercise.

Other studies show that the BP and HR, in a given oxygen uptake, are higher during working with arms compared with working with legs [11, 25] confronted with the results found in this study. Even so, it is possible to believe that this issue should be addressed in greater detail trying to find more exact answer, because they are rare researches dealing with issues related to cardiovascular stress, whether or not closely linked to the size of muscle mass recruited.

The subjects of this study were instructed to perform the movements in maximum speed, but this situation can't be measured. This could change the variation of the hemodynamic aspects, becoming a limitation of the study.

In our opinion, these findings contribute important information enhancing the knowledge about improving effort safety [29] not only people practicing *muay tai,* but also combat sports involving mutual hitting the athletes [27]. Bolach et al. [26] emphasize that *muay thai* is a very offensive combat sport based on strikes made with maximum force and during nearly continuous

attack. Many of *muay tai* athletes participated in training or competitions with untreated injury (57%) or overload (90%). Therefore well-founded is the postulate that concern effort safety and motor safety should belong to the core tasks of the coaches and the doctors supervising training of combat sports athletes, especially such as: *muay tai, boxing, karate, kick-boxing, taekwondo, etc.*

Conclusion

A better understanding of cardiovascular responses during exercise or during the training process can increase the safety margin of the given activities. Therefore, in order to improve the theoretical/practical reference on the prescription of *muay thai* classes, especially regarding the combination volume and intensity, we tried through this study, to understand how the cardiovascular system behaves in relation to the order of sequences of *muay thai* moves, and so detect possible risks in beginners or even hypertensive.

It can be concluded that the results obtained in the sample, the punch sequence and kick, and kick and punch, alter the responses of HR, but not similarly alter the BP. However, an increase in systolic post punch and kick with respect to rest. This result may suggest care in practicing these techniques when performed by people with heart disease and the need of recovery intervals for any practitioner. Thus, further studies are recommended to women and other martial arts to verify the results found here.

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