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Hemodynamic subsequent responses between Muay Thai and wrestling Brazilian professional athletes after a high-intensity round

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Abstract

Background & Study Aim: Despite a large number of competitive activities, the combat sports has been presenting a large growing in several countries. One these modalities are the Muay Thai (MT) and wrestling (WE). MT and WE are characterised as intermittent combat modalities, performing maximal and submaximal strikes and grappling techniques. The purpose of this study is knowledge about the hemodynamic indicators as organisms as the body's response post combats between MT and WE professional athletes.

Material & Methods: This study was composed of 20 subjects (10 male athletes of MT; 10 male athletes of WE) in the preseason with 28.06 ±6.43 years of age. The combat sessions were initiated after 5 min interval post warm-up session. Each pair of athletes (i.e., MT and WE) performed a high-intensity round with the duration of 5 min. The coaches instructed the athletes to implement as many strikes or attacks as possible. The blood pressure (BP) and HR were measured 15 sec (Post), and 10 (P_{10}), 20 (P_{20}), 30 (P_{30}) 40 (P_{40}), 50 (P_{50}) and 60 min (P_{60}) post-combat.

Results: Significant main effects for the group was noted for systolic blood pressure (SBP) ($p = 0.0001$). Post hoc pairwise comparisons showed higher SBP was found significant ($p = 0.009$) under MT versus WE group only at the 10 min post-combat time point. Considering the MT intra-group differences, the SBP significantly increased compared to resting value at 30 min ($p = 0.012$) time point and reduced at 40 min ($p = 0.005$), 50 min ($p = 0.001$), 60 min ($p = 0.004$) time points versus rest value. There were no intra-group differences for SBP under WE group. Additionally, there was no difference intra and inter groups for diastolic blood pressure (DBP).

Conclusions: The results of the present study indicated that MT presented greater SBP and RRP than WE athletes after a high intensity round. Therefore, these results indicated that major combat mode performed by athlete provide specific hemodynamic adaptations and responses post-combat and these measures could be implemented to monitoring the state of the athlete's organism during training programs.

Keywords: combat session • diastolic blood pressure • grappling techniques • heart rate • rate pressure product • systolic blood pressure

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Combat sport – *noun* a sport in which one person fights another, e.g. wrestling, boxing and the martial arts [32].

Martial arts – *plural noun* any of various systems of combat and self-defence, e.g. judo or karate, developed especially in Japan and Korea and now usually practised as a sport [32].

Muay Thai – *noun* a martial art that is a form of kickboxing, practised in Thailand and across Southeast Asia [32].

Brazilian jiu-jitsu – is a type of fight in which a uniform or gi is used; its main purpose is to project or take your opponent down. Once on the ground, you must seek to control your adversary with different techniques (immobilisations, chokes, joints locks). In the absence of submission at the end of the fight, the winner is declared by the number of points won [33].

Grappling – *noun* (in combat sports such as wrestling and martial arts) the act of holding your opponent to subdue or control them [32].

Technique– *noun* a way of performing an action [32].

Technique – specific procedures to move one's body to perform the task that needs to be accomplished [34].

Sympathetic nervous system – *noun* one of two complementary parts of the nervous system that affects involuntary functions. Compare **autonomic nervous system** (NOTE: It is activated by danger or stress and causes responses such as dilated pupils and a rapid heart rate) [32].

INTRODUCTION

Despite a large number of competitive activities, the combat sports has been presenting a large growth in several countries. One these modalities are the Muay Thai (MT) and wrestling (WE) [1]. The MT and WE are characterised as intermittent combat modalities, performing maximal and sub-maximal strikes and grappling techniques. Each round is ranging from 3 to 10 min with short rest intervals (i.e. 60-90 sec) [2]. Both modalities require a high level of efficiency involving the glycolytic and oxidative pathways to generate energy [3]. Thus, physical fitness components such as muscular endurance, strength, speed and agility are also essential to achieve a great performance level [4].

However, these two combat modes have different specific features. The major sporting technique of MT is characterised by using of upper and lower limbs for attack or defence, through direct contact using punches, forearms, elbows, arms, and knees techniques [5]. On the other hand, the WE is a domain combat mode, which is based on levers and twists to subdue opponents through withdrawal by applying a tap out (finishing), not being allowed punching, kicking, kneeing or elbow strikes [6].

These different skills also require a complex management of physical fitness and specific abilities and techniques to be training during conditioning programs in a time-efficient manner [7]. In WE the isometric force is essential to immobilise and control the opponent, on the other hand, the dynamic strength and power output are crucial for MT athletes, considering the strike characteristics of this sport [8]. These specific skills may promote different physiological and hemodynamic responses during training and combats. Previous evidences indicated that the increase in peripheral vascular resistance caused by occlusion of arterial vessels in the region of contracting muscles during static exercises promoted an augmentation in systolic blood pressure (SBP) versus rest value and also promoted an increase in heart rate (HR) and rate pressure product (RPP) due to the greater performance of the sympathetic system [9]. However, during dynamic contractions, an increase in blood volume has been associated with high systolic volume and cardiac output [10]. Additionally, the size of the muscular group exercised also influenced these responses. When considering the greater use of the legs, the MT athletes may provide a peripheral concentration of blood volume when compared to WE athletes.

In this sense, during this combats, the hemodynamic variables such as systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and rate pressure product (RPP) are extremely affected to achieve the cardiovascular demand required during the high-intensity tasks performed [11]. However, the magnitude of these responses is influenced not only by the intensity and duration of the combats exercise but also due to the biomechanical and physiological characteristics of the combat mode enjoyed [12]. Several studies have evaluated the hemodynamic responses in combat sports [13-16].

Lira et al. [17] observed a progressive increase in HR responses until 20 min post-session, after three boxes rounds of 2 min composed by 10 combined strikes with 1 min rest between rounds. Carneiro et al. [18] noted similar results investigating 14 athletes of grappling and Brazilian jiu-jitsu submitted 10 min combat. Silva et al. [19] noted that the muscle group size promoted significant differences comparing kicks and punches sequences with MT athletes. There is still limited evidence comparing the hemodynamic responses of MT [19, 20] and WE [21, 22] athletes during real combat conditions, respectively.

This evidence may be useful for coaches, athletes and conditioning professionals during the preparation pre-competition, providing specific evidence regarding each combat modality (i.e. WE and MT). Furthermore, this evidence may help conditioning coaches and rehabilitation professionals during the controlling of training intensity and training load during the evaluation of the combat performance.

The purpose of this study is knowledge about the hemodynamic indicators as organisms as the body's response post combats between MT and WE professional athletes.

MATERIAL AND METHODS

Participants

This study was composed of 20 subjects, being 10 male athletes of MT, and 10 male athletes of WE in the preseason with 28.06 ±6.43 years of age. The athletes were separated in pairs according to the weight category determined by the international federations of each sport. The inclusion criteria were: a) to be graduated in their martial arts (combat sports); b) to present a weekly frequency of three days sessions for at least one year; c) taking part in national competitions for at least two years. The exclusion criteria were: a) to use steroids and/or thermogenic substances; b) to present some kind of injury, pain or discomfort in any joint; c) being a smoker; d) make use of any medication which could alter the results; e) to use of caffeine or alcohol; f) to perform any type of exercise one day before the data collection.

This research was conducted in accordance with the Resolution 466/2012 of the Brazilian National Health Council [23] and the Declaration of Helsinki [24] on human research. Subjects were informed of all procedures of the study and signed a consent form and informed prior to the procedures.

Procedures

Hemodynamic measurements

The BP and HR were measured using and the digital device OMRON 7113 (Omron Corporation, Kyoto-Shi, Japan) [25]. The measurement procedure was carried out as follows: a) the volunteer sat at rest for 5 min in a chair with back support, feet flat on the floor, arm kept at heart level; b) The cuff was positioned 2.5 cm from the lower end and the antecubital fossa of the right arm; The average of BP and HR rest value was obtained through three measures at 1 min intervals between. The mean arterial pressure MAP was computed as: MAP = SBP + [(DBP x 2)/3] [26]. The RPP was computed as SBP × HR [26].

Warm up

Firstly, after a 10 min sitting rest, the blood pressure (BP) and HR of each athlete was measured (on figures: Rest) by experienced research. Then, each participant performed a warm-up protocol, which was composed by 10 min of low-intensity exercises, consisted of joint mobility exercises of the shoulders, elbows, spine, hips, and knees and dynamic stretching exercises of upper limbs, lower limbs and spine in a randomised order between subjects. The BP and HR were measured after immediately the warm-up session (POSTW).

Combat sessions

The combat sessions were initiated after 5 min interval post warm-up session. Each pair of athletes (i.e., MT and WE) performed a high-intensity round with the duration of 5 min. The coaches instructed the athletes to implement as many strikes or attacks as possible. The BP and HR were measured 15 sec (on figures: Post), and 10 (P_{10}), 20 (P_{20}), 30 (P_{30}) 40 (P_{40}), 50 (P_{50}) and 60 min (P_{60}) post-combat.

Statistical analysis

Descriptive statistics were presented as the mean and standard deviation of the dependent variables. The Shapiro-Wilk test was used to verify the normality of each data. To compare the hemodynamic variables inter groups (MT vs WE) was applied a multivariate analysis of variance (MANOVA). To compare the intra-group values between time points was applied one way ANOVA for repeated measures. Post hoc of Bonferroni was adopted to compute the multiple comparisons when necessary. The SPSS software version 20.0 (Chicago, IL, USA) was used for statistical analysis, adopting a critical level of significance of 5% ($p<0.05$).

RESULTS

Significant main effects for the group was noted for SBP (p = 0.0001). Post hoc pairwise

Training intensity – the effort of training. A number of methods are used to establish training intensities which give maximum benefits. These include the lactic acid method, minute ventilation method, and target heart-rate [35].

Training load – "A simple mathematical model of training load can be defined as the product of qualitative and quantitative factor. This reasoning may become unclear whenever the quantitative factor is called 'workload volume' or 'training volume' interchangeably with 'volume of physical activity'. Various units have been adopted as measures, i.e. the number of repetitions, kilometres, tons, kilocalories, etc. as well as various units of time (seconds, minutes, hours) (...) As in the real world, nothing happens beyond the time, the basic procedure of improvement of workload measurement should logically start with separation of the time factor from the set of phenomena so far classified together as '***workload volume***'. (...) Due to the fact that the heart rate (HR) is commonly accepted as the universal measure of workload intensity, the product of effort duration and HR seems to be the general indicator of ***training load*** defined as the amount of workload. It is useful in analyses with a high level of generality. (...)In current research and training practice, the product of effort duration and HR was referred to as conventional units', or further calculations have been made to convert it into points." [31, p. 238].

comparisons showed higher SBP was found significant (p = 0.009) under MT group versus WE group only at 10 min post-combat time point (see Figure 1). Considering the MT intra-group differences, the SBP significantly increased compared to resting value at 30 min (p = 0.012) time point and reduced at 40 min (p = 0.005), 50 min (p = 0.001), 60 min (p = 0.004) time points versus rest value. There were no intra-group differences for SBP under WE group. Additionally,

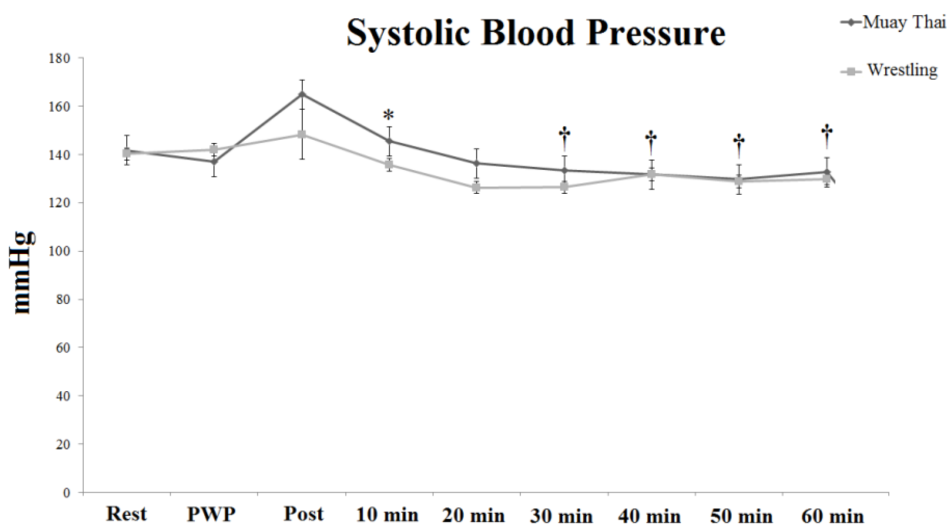

Figure 1. Systolic blood pressure responses at rest, post-warm up, post-combat, 10-, 20-, 30-, 40-, 50- and 60 min between moments and groups (*significant difference for wrestling group; †significant difference for rest value between MT and WE groups; PWP post warm up).

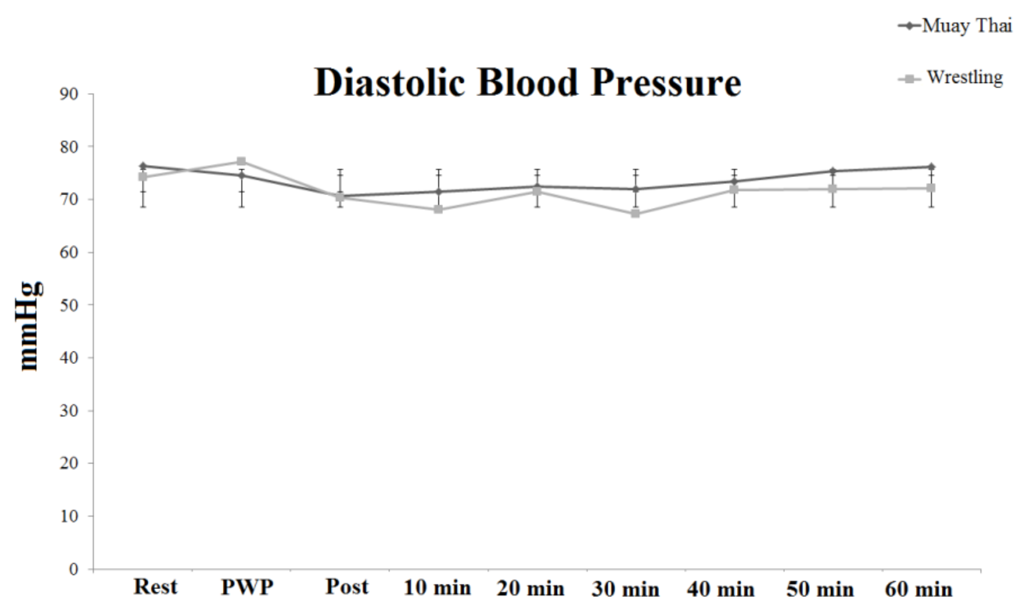

Figure 2. Diastolic blood pressure responses at rest, post-warm up, post-combat, 10-, 20-, 30-, 40-, 50- and 60 min between moments for MT and WE groups (PWP post warm up).

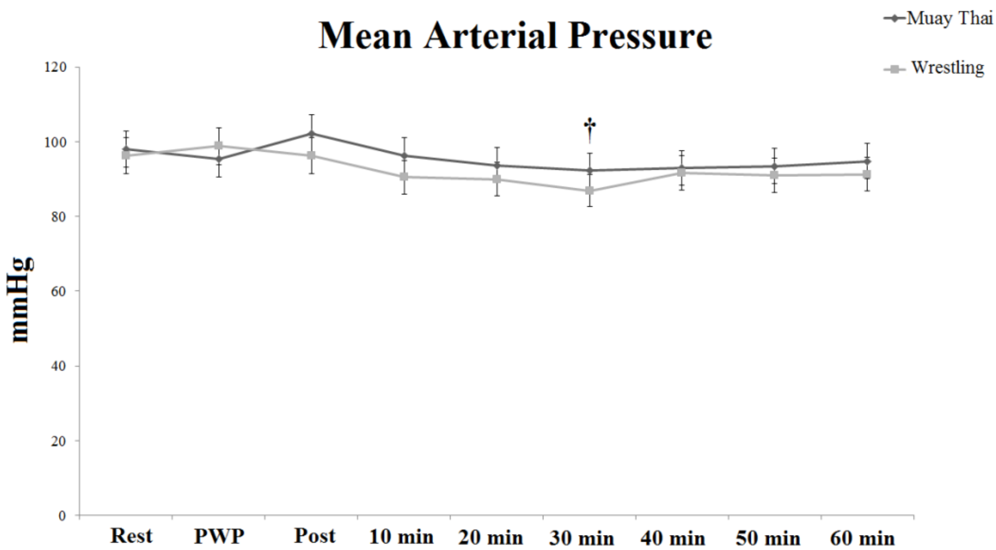

Figure 3. Mean arterial pressure responses at rest, post-warm up, post-combat, 10-, 20-, 30-, 40-, 50- and 60 min between moments and groups (PWP post warm-up; †significant difference for rest values between MT and WE groups).

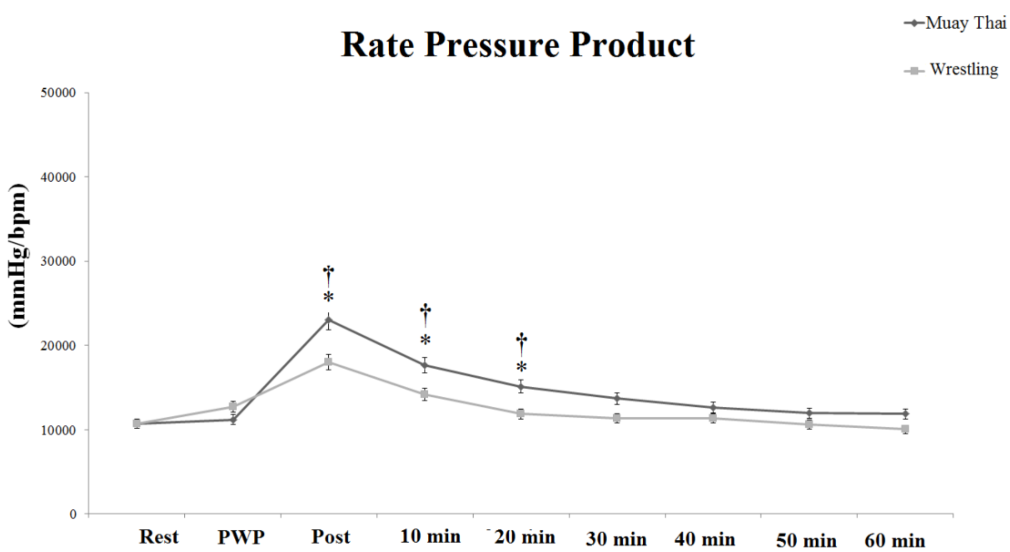

Figure 4. Rate pressure product responses at rest, post-warm up, post-combat, 10-, 20-, 30-, 40-, 50- and 60 min between moments and groups (PWP post warm-up; *significant difference between MT and WE groups; †significant difference for rest values).

there was no difference intra and inter groups for DBP (see Figure 2).

No main effects for the group were noted for the MAP (p>0.05; see Figure 3). However, for both MT (p = 0.003) and WE (p = 0.026) groups, there was a significant reduction in the MAP at 30 min time point versus resting value.

Significant main effects for group was noted for RPP (p = 0.001). Post hoc pairwise comparisons showed greater RPP was noted under MT versus WE group at post (p = 0.030), 10 min (p = 0.006), 20 min (p = 0.015), 30 min (p = 0.041) time points (figure 4). Considering the intra-group difference, the RPP significantly increased at post (p = 0.0001), 10 min (p = 0.0001) and 20 min (p = 0.010) time points versus rest under MT group. In the WE group, greater RPP increased was noted at post (p = 0.001) and 10 min (p = 0.031) time point versus rest value.

DISCUSSION

The results showed that the values for the SBP, MAP, and RPP were significantly higher in MT group versus WE athletes post a high intensity round. These data suggested that combat mode adopted may provide specific adaptations in hemodynamic responses post-combat.

In the present study, greater RPP was noted under MT versus WE group at the post, 10 min, 20 min, 30 min time points. Considering the intra-group difference, the RPP significantly increased at the post, 10 min and 20 min time points versus rest under MT group. In the WE group, greater RPP increased was noted at the post and 10 min time point versus rest value. Ouergui et al. [20] investigated the physiological responses in twenty strike athletes of regional and national level post combats. Heart rate was measured throughout rounds of 1, 2, and 3 five minutes each. The participants executed jabs, kicks, roundhouse kicks, and others striking techniques. The authors observed a significant increase in HR compared to post warm-up value (p<0.001). Similar results were noted in the studies conducted by Crisafulli et al. [2] and Silva et al. [19], who also found a significant increase in HR post-striking combat sessions.

Post hoc pairwise comparisons in the current study showed higher SBP was found significant under MT group versus WE group only at the 10 min post-combat time point. Prado and Lopes [27] investigated the influence Brazilian jiu-jitsu combats in the hemodynamic responses. Eight-fight trained athletes performed 4 rounds of 5 min with 1 min rest. They noted an increase in the SBP immediately post-combat (124.3 ±6.3 mmg/Hg) when compared to rest value (116.6 ±11.1 mmg/Hg) followed by a progressive reduction versus rest values until 60 min (107.5 ±13.5 mmg/Hg) post-combat, suggesting a hypotensive effect. This subsequent reduction in BP measures post-combat may be explained by the decrease in sympathetic activity and vasodilation caused by increased concentration of NO2 (nitrogen dioxide) induced by the high level of power and endurance muscular performance required during the combats [28].

Regarding the MT intra-group differences, the SBP significantly increased compared to the resting value at the 30 min time point and reduced at 40 min, 50 min, 60 min time points versus rest value. There were no intra-group differences for SBP under WE group. Considering the of WE combat, a high level of vasoconstriction caused by isometric muscle action may provide a significant increase in SBP [29]. However, the results of this study do not corroborate this assumption; therefore, there was no significant difference in SBP and DBP among WE MT athletes, respectively.

In the context, the movement time analysis (MTA) is tool commonly adopted to assess the intensity during combats. Del Vecchio et al. [30] reported that the MT has a relationship between a strike effort (E) and preparation (P) of 2:3, which means that every two seconds of strikes have at least three seconds of preparation. In WE, the relationship of effort (E) and preparation (P) reported 2:1. This study suggested that possibly the WE would present higher values of hemodynamic indicators when compared to MT; however, the results obtained by the present study did not corroborate this MTA hypothesis.

This study has a few limitations such as the lack of metabolic and fatigue markers to determine the association with hemodynamic responses. However, the methodological procedures adopted in the current study can be easily applied in combat sports training centres, and these results may help conditioning professionals during the controlling and prescription of training programs. Further studies could investigate the heart rate variability, hemodynamic and metabolic responses of MT and WE athletes with different levels of trainability during real combat situations.

CONCLUSIONS

The results of the present study indicated that MT presented greater SBP and RRP than WE athletes after a high intensity round. Therefore, these results indicated that major combat mode performed by athlete provide specific hemodynamic adaptations and responses post-combat and these measures could be implemented to monitoring the athlete's evaluation during training programs.

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