

## Jiu-jitsu match elevates myocardial work and causes post-exercise hypotension in master category athletes

### Jiu-jitsu eleva o trabalho do miocárdio e causa hipotensão pós-exercício em atletas da categoria master

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#### ABSTRACT

**Background:** Jiu-jitsu is a sport that involves different techniques to lead the opponent to submission, combats are characterized by intermittent efforts with changes in important cardiovascular variables. **Aim:** to evaluate the acute effects of a simulated jiu-jitsu match on blood pressure (BP) and the double product (DP) of fighters in the master category. **Methods:** The heart rate (HR), BP, and DP of six experienced fighters were measured, before and after the protocol. The combat consisted of four six-minute sessions with intervals of three minutes for recovery and measurement of the variables. Measurements were taken every 15 minutes, after the end of the fight. **Results:** An increase in systolic (SBP) and mean BP (MAP) was observed after the last session. After 30 minutes, there was a decrease in MAP and SBP, until the end of the protocol. Diastolic BP (DBP) decreased after 30 minutes, returning to baseline after 45 minutes post-combat. HR remained high until 30 minutes of recovery. Despite the increase greater than 280% of the DP, verified immediately after the fight, 15 minutes of recovery was sufficient for this index to return to baseline values. **Conclusion:** The study shows that a jiu-jitsu match causes a significant increase in SBP and MAP, HR and PD with subsequent arterial hypotension.

**Key-words:** Cardiovascular physiological phenomena, Blood pressure, Martial arts.

#### RESUMO

**Introdução:** O jiu-jitsu é um esporte que envolve diferentes técnicas para levar o oponente à submissão, os combates são caracterizados por esforços intermitentes com alterações em importantes variáveis cardiovasculares. **Objetivo:** avaliar os efeitos agudos de um combate simulado de jiu-jitsu sobre a pressão arterial (PA) e o duplo produto (DP) de lutadores da categoria master. **Métodos:** Foi aferida a frequência cardíaca (FC), PA e DP de seis experientes lutadores, antes e após o protocolo. O combate foi composto por quatro sessões de seis minutos com intervalos de três minutos para recuperação e aferição das variáveis. As medidas foram feitas a cada 15 minutos, subsequentemente ao encerramento do combate. **Resultados:** Observou-se aumento da PA sistólica (PAS) e média (PAM) após a última sessão. Após 30 minutos, verificou-se diminuição da PAM e PAS, até o fim do protocolo. A PA diastólica (PAD) reduziu aos 30 minutos, retornando ao basal a partir de 45 minutos pós-combate. A FC manteve-se elevada até os 30 minutos de recuperação. Apesar do aumento maior que 280% do DP, verificado imediatamente após o combate, 15 minutos de recuperação foram suficientes para que este índice retomasse os valores basais. **Conclusão:** O estudo mostra que um combate de jiu-jitsu, provoca aumento significativo da PAS e PAM, FC e DP com subsequente hipotensão arterial.

**Palavras-chave:** Fenômenos fisiológicos cardiovasculares, Pressão arterial, Artes marciais.

## Introduction

Jiu-jitsu is a combat sport that involves specific techniques of projections, immobilizations, strangulations, and joint keys, which aims to lead the opponent to submission [1]. In this context, it is characterized as a sport that requires intermittent manifestations of agility and muscle power, alternating the activation of anaerobic and aerobic metabolism [2,3], imposing high cardiovascular overload, which can be modulated by the athlete's technique and experience [4].

In a previous study, Moreira et al. [4] demonstrated that, during jiu-jitsu competitions, there is a significant increase in plasma cortisol concentration, which can contribute to altering the blood pressure (BP) of the fighters [5,6]. However, in inexperienced athletes in the adult category (aged 18-29 years), a reduction in systolic blood pressure (SBP) is observed after the end of simulated jiu-jitsu matches [7,8]. Despite the many studies carried out to broaden the understanding of the physiological effects of a jiu-jitsu match [9-11], none of them clarified the impact of a training session on cardiovascular variables, whose changes may be associated with an increased risk of cardiovascular events, such as acute myocardial infarction and stroke.

Given this knowledge gap and considering that cardiovascular risk increases with age [12-14], the present study, to define safety criteria more appropriate to the practice of jiu-jitsu, intends to understand the adjustments hemodynamics and the magnitude of cardiac overload imposed during a jiu-jitsu training session, in individuals of the master category, over 30 years of age. Within this perspective, the objective of this study was to evaluate the effects of a jiu-jitsu match on the parameters of heart rate (HR), BP, and double product (DP) in practitioners of this sport.

## Methods

### *Participants*

This study is following the resolution 196/96 of the National Health Council. It also followed the recommendations of the World Medical Association and the Declaration of Helsinki. This project was approved by the Research Ethics Committee of the Federal University of Sergipe (CAAE: 48071015.9.0000.5371). On the day before the experimental protocol, the participants signed the Free and Informed Consent Form and were instructed not to consume stimulating drinks.

Six men were evaluated, jiu-jitsu practitioners with more than 10 years of training. All subjects were familiarized with the procedures used. Those who used any medication or ergogenic nutritional resources did not participate in the study. Also not included were practitioners who had orthopedic injuries or metabolic disorders in the past six months. All individuals included in the study were affiliated to the Sergipe Federation of Jiu-jitsu, black belts in the master category, and trained regularly, at least three times a week, with a minimum duration of 60 minutes in each session.

### *Procedures*

For the characterization of the sample, body mass was measured using a BC 558 digital portable scale (Tanita®, Tokyo, Japan), with 0.1 kg accuracy and a total capacity of 150 kg. Height was measured using the Bodymeter 208 portable anthropometer (Seca®, Birmingham, United Kingdom), with an accuracy of 1 cm. The body

mass index (BMI) was calculated from the body mass in kilograms divided by the square of height in meters.

Skinfold measurement was performed using a scientific adipometer (Cescor<sup>®</sup>, Porto Alegre, Brazil). The protocol used to determine fat mass, lean mass, and percentage of fat (% F) was Pollock's (seven folds) for men and all measurements were performed in triplicate [15]. Anthropometric and body composition variables were assessed before the beginning of the experimental protocol.

The fighters' BP was measured using an automatic, calibrated, and validated device (Microlife, model BP 3AC1-1<sup>®</sup>, Taipei, Taiwan) [16]. HR, systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP) values were recorded. These variables were measured before the protocol, with the fighter sitting in a chair after 20 minutes of rest, according to pre-established guidance [17], immediately after the simulated combat and every 15 minutes for the next 60 minutes.

Participants were randomly divided into pairs. Each pair of fighters held a match, divided into four six-minute sessions, with three-minute recovery intervals. Before the matches, the fighters performed a brief specific stretch/warm-up for five minutes in a free form. The fight started with the athletes kneeling on the ground and during all the time they were motivated to seek victory, keeping the fight dynamic. The verbal stimulus happened whenever the fighters remained more than 20 seconds stopped in the same position. In the event of submissions, the participants were instructed to resume the fight on their knees, and at intervals, the participants hydrated at will with filtered water.

### *Statistical analysis*

Values were expressed as mean  $\pm$  standard error of mean (SEM). To assess the normality of the sample, the Shapiro-Wilk test was used. The analysis of variance tests (two-way ANOVA) followed by the Tukey post-test was used to assess the significance of the differences between the means. Values were considered statistically significant when  $p < 0.05$ .

## **Results**

Table I shows the anthropometric and cardiovascular characteristics of the athletes during the rest.

It can be seen in figure 1A, that the simulated combat promoted an increase of 81% in the SBP ( $p < 0.05$ ) and a significant reduction concerning the initial values (about 18%), after 30 minutes ( $p < 0.01$ ) of recovery, being maintained until the end of the protocol. The same pressure behavior was observed with MAP. Unlike SBP and MAP, there was no increase in DBP due to the protocol, however, there was a decrease of about 17% at 30 minutes after the last session ( $p < 0.05$ ) with subsequent recovery of pre-exercise levels at 45 minutes of recovery.

Figure 1B shows that there was a significant increase in HR immediately after the fight ( $p < 0.001$ ) and remained so until the 30 minutes of the recovery period ( $p < 0.01$ ), returning to rest values after 45 minutes of recovery. In figure 1C, an increase of about 284% ( $p < 0.001$ ) of the DP with baseline values was observed immediately after the fight, which quickly returned to the pre-exercise value, after 30 minutes of recovery, remaining until the end of the protocol.

Table I - Sample characterization (n = 6).

Variables	Results
<b>Anthropometric parameters</b>	
Age (years)	33 ± 1.0
Body Mass (kg)	70 ± 2.4
Height (cm)	173 ± 3.8
BMI (kg/m <sup>2</sup> )	23 ± 0.6
% of fat	6 ± 0.7
Fat mass (kg)	4 ± 0.4
Lean mass (kg)	65 ± 2.7
<b>Cardiovascular parameters</b>	
SBP (mmHg)	125 ± 6
DBP (mmHg)	75 ± 3
MAP (mmHg)	92 ± 4
HR (bpm)	70 ± 4
DP (mmHg x bpm)	8758 ± 1286

Results are expressed as the mean ± the standard error of the mean. Abbreviations: BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; MAP = mean arterial pressure; HR = heart rate; DP = double product; mmHg = millimeters of mercury; bpm = beats per minute.

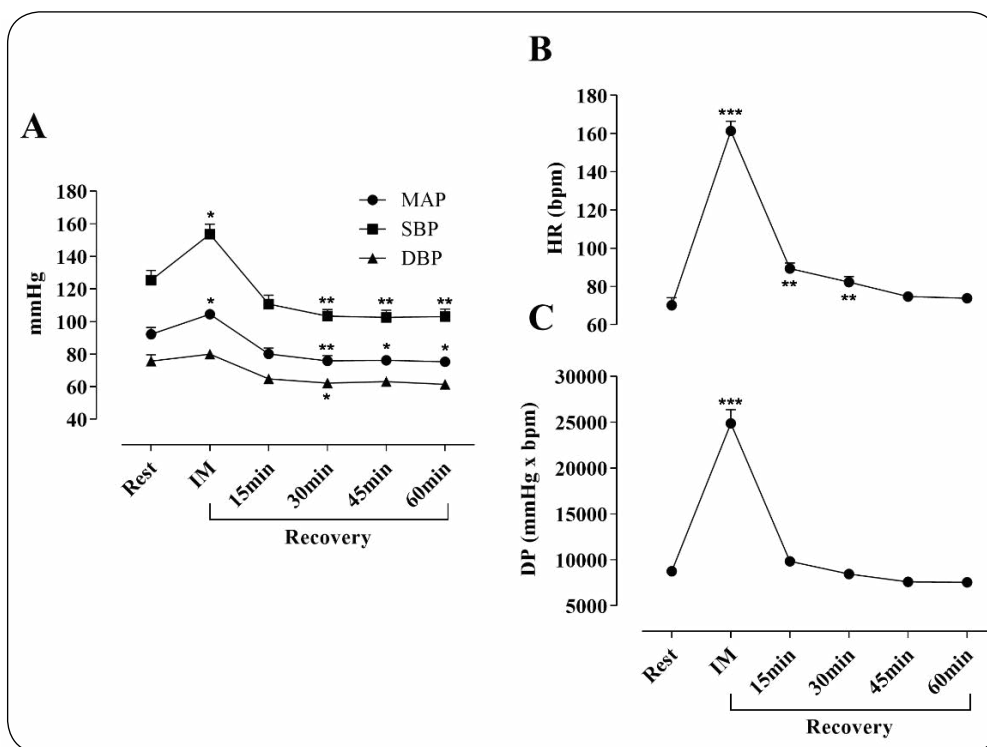


Figure 1 - The behavior of cardiovascular variables at rest, immediately after a sequence of simulated combats (IM) and recovery period. Panel A: mean arterial pressure (MAP), systolic (SBP) and diastolic (DBP). Panel B: heart rate (HR). Panel C: double product (DP). The statistical differences between the means were determined by one-way ANOVA followed by the Tukey post-test. Note: \* (p < 0.05), \*\* (p < 0.01) and \*\*\* (p < 0.001 vs Rest).

## Discussion

The results of this research indicate that a simulated fight of jiu-jitsu, composed of four sessions with six minutes of duration and three of recovery, can promote post-exercise hypotension in practitioners of the master category. In this context, despite the existence of similar protocols in the literature [1], to reproduce the practice usually used in training in jiu-jitsu academies in the country, some modifications were implemented, such as the expansion of the recovery interval between combats for three minutes.

To maintain compliance with the rules of the Brazilian Jiu-Jitsu Confederation, each fight lasted six minutes, the expected duration of fights in the master category, with graduates in the purple belt or higher. Furthermore, as the lack of combativeness is a violation of the rule, to keep the fight dynamic, when the fighters remained 20 seconds without movement, the athletes were frequently alerted and motivated, through verbal stimuli [18].

In the present study, experienced jiu-jitsu practitioners in the master category (aged  $33 \pm 2$  years) were evaluated and despite the shorter fighting time in the simulated matches, the HR, however, remained elevated until 30 minutes after the end of the protocol. Such results suggest that the practice of jiu-jitsu promotes great cardiovascular demand since HR only returns to its baseline values 45 minutes after the end of the fight. Understanding the HR adjustments that occur during and after the practice of jiu-jitsu in individuals over 30 years old can be important information for the cardiovascular safety of master category athletes, especially those at high risk for cardiovascular disease [12,14].

In this regard, it is known that HR is an important variable used to indicate cardiac effort at rest and/or during physical exercise [19]. In this sense, Andreato et al. [20] showed that HR remains increased during all simulated jiu-jitsu matches observed during their study. These authors suggest that jiu-jitsu requires moderate cardiovascular effort in adult practitioners (aged  $28 \pm 4$  years) who performed four fights of 10 minutes each.

In the present study, practitioners in the master category showed an important reduction in MAP, due to the decrease in SBP and DBP, characterizing the post-exercise hypotensive effect. This is the first study to show a significant reduction in DBP during the post-combat recovery period. This effect is frequently observed in aerobic activities and can be explained, in part, by the reduction of peripheral vascular resistance [21,22].

From the HR and SBP data, it was possible to calculate the SD, considered an indicator of cardiac effort and myocardial oxygen consumption [23]. In this context, two important cardiovascular adjustments related to DP were observed. The first one is related to the permanence of HR significantly elevated up to 30 minutes after the last session of the fight. This effect may be the result of compensatory adjustments necessary to maintain cardiac output, as SBP began to decline shortly after the last combat. The second adjustment occurs after 45 minutes post-combat, when it was found that the SBP remains lower than its resting values, in addition to the complete recovery of HR and DP.

The DP tends to increase according to the type and characteristic of the exercise. Powers and Howley [24] propose that, in maximum exercises, the DP value can reach up to five times the rest values. Our results show an increase of approximately twice the DP immediately after the last combat session. However, 15 minutes after the end of the simulated combat, the DP returns to resting levels, indicating good

cardiovascular aptitude and greater efficiency of the BP control mechanisms of the participants in this research [25].

In a study that evaluated adult fighters aged  $22 \pm 6$  years and with less than one year of practicing jiu-jitsu, there was a significant reduction in MAP due to the reduction in SBP after the practice of 20 minutes of simulated combat [7]. The authors demonstrated that such effects were significant from 60 minutes after combat. Likewise, Borges et al. [8], using a protocol of only 5 minutes of combat, with fighters in the adult category (average of 19 years old), also found a hypotensive effect resulting from the reduction of SBP from the fifth minute of recovery.

The main mechanisms that involve the hypotensive effect observed in this research may be related to the central mechanisms that involve cardiac autonomic balance and/or peripheral mechanisms that are related to vasoactive substances [21].

From a practical point of view, our findings reinforce the idea that cardiovascular stress from jiu-jitsu can be modulated by the athlete's technical level and experience. Within this perspective, it can be observed that, although the results obtained show an increase in hemodynamic variables immediately after the fight, during recovery a hypotensive effect is observed, suggesting that the regular practice of this modality can promote beneficial cardiovascular adjustments, with possible clinical applicability in healthy and hypertensive individuals.

So far, the literature indicates that jiu-jitsu fights moderately activate the glycolytic energetic pathway and result in an expected positive chronotropism [2]. Based on the methodology that was used, the short intervals of three minutes of recovery between fights and the requirement for dynamic movement with verbal incentives can cause high demands on the myocardium, justifying the constant monitoring of heart rate and blood pressure when it is intended to increase the cardiovascular safety of the jiu-jitsu practitioner. Thus, it is important to emphasize the need for further studies that seek to understand the cardiovascular effects provided by this modality, but focusing on aspects such as the interval between combats and the influence of external stimulus.

## Conclusion

The evidence from the present study shows that the simulated combat of jiu-jitsu promotes a significant increase in heart rate, double product, and post-exercise hypotension in black belt fighters over 30 years of age.

### Potential conflict of interest

No conflicts of interest with potential potential for this article have been reported.

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Authors' contributions

### Academic link

There is no link between this study and graduate programs.

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### Authors' contributions

Conception and design of the research: Braga da Silva TLTB, De Melo VU, Macedo FN, Mota MM, Santana MNS. Data collection: Barreto TLM, Braga da Silva TLTB, De Melo VU, Macedo FN, Mota MM, Santana MNS, Santos ALS. Analysis and interpretation of data: Braga da Silva TLTB, Mota MM, Santana MNS, Macedo FN, De Melo VU. Writing of the manuscript: Braga da Silva TLTB, De Melo VU, Macedo FN, Mota MM, Santana MNS. Critical review of the manuscript for intellectual content: Braga da Silva TLTB, Mota MM, Santana MNS, Macedo FN, De Melo VU, De Moraes R.

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