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ORIGINAL SCIENTIFIC PAPER

Post-Exercise Hypotension in Brazilian Jiu-Jitsu

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Abstract

Hypertension is a leading preventable cause of morbidity and mortality worldwide. Exercise is a widely recommended treatment strategy that has been shown to cause both acute and chronic reductions in blood pressure. This study aimed to explore the potential therapeutic effects of Brazilian jiu-jitsu training by assessing blood pressure responses during and after technical sparring. Seven Brazilian jiu-jitsu practitioners (age: 24.0±3.5 years; height: 1.75±0.02 m; body mass: 76.0±4.2 kg; BMI: 24.5±0.9) were included in the study. The participants performed three five-minute technical sparring rounds. Auscultatory measurements of blood pressure were obtained at rest, one minute post-sparring, and every ten minutes for a total of 60 minutes of recovery time. Between rounds, acute increases in both systolic blood pressure ($p<0.0001$) and diastolic blood pressure ($p<0.0001$) were observed. In the subsequent recovery period, both systolic blood pressure and diastolic blood pressure increased at the ten-minute mark compared to baseline values, but then started to gradually decline, with systolic blood pressure dropping 10.0±4.1 ($p<0.0001$) and diastolic blood pressure 5.0±4.1 mmHg ($p=0.001$) after one hour of recovery. These findings indicate that technical Brazilian jiu-jitsu sparring induces significant post-exercise decreases in blood pressure and thus may have value as a non-pharmacological treatment strategy for the prevention and management of hypertension.

Keywords: *martial arts, combat sports, Brazilian jiu-jitsu, hypertension, blood pressure*

Introduction

Chronically high blood pressure (BP), or hypertension (HTN), is a leading preventable cause of morbidity and mortality worldwide. Most cases are primary, with no identifiable underlying cause, making treatment challenging. Approximately 20–24% of the world population have high BP, with over 500 million new cases since 1975 (Zhou et al., 2017). Since early-stage HTN rarely causes symptoms, many hypertensives go undiagnosed, which contributes to the burden of the disease. The level of arterial pressure at which HTN is diagnosed differs between guidelines; some consider a systolic BP (SBP) of 130 mmHg as high normal (Williams et al., 2018) while others classify it as stage 1 HTN (Whelton et al., 2017). However, a negative impact on cardiovascular and renal function can be observed at an SBP as low as 110 mmHg (Forouzanfar et al., 2017).

The management of HTN may include both antihypertensive drugs and non-pharmacological interventions, such as changes in diet and activity levels. Indeed, physical exercise is a widely recommended prevention and treatment strategy in HTN (Pescatello et al., 2004). The antihypertensive effects of physical activity appear to in part be mediated by an acute BP reduction of ~5–7 mmHg in hypertensives following exercise, known as post-exercise hypotension (PEH) (Pescatello, MacDonald, Lamberti, & Johnson, 2015). Blood pressure responses have previously been investigated in both aerobic exercise and resistance training (Domingos & Polito, 2018; Hecksteden, Grutters, & Meyer, 2013; Keese, Farinatti,

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Pescatello, & Monteiro, 2011; Ruiz et al., 2011), with either modality seemingly inducing PEH, particularly in unmedicated individuals who use exercise as a preventive strategy (Carpio-Rivera, Moncada-Jimenez, Salazar-Rojas, & Solera-Herrera, 2016).

Brazilian jiu-jitsu (BJJ) is a grappling-based combat sport with a growing number of recreational and professional practitioners. The effort pattern of BJJ is characterized by aerobic work at lower intensities interspersed with short bursts of high intensity (Andreato, Follmer, Celidonio, & Honorato, 2016). Despite several investigations of athlete characteristics (Andreato, Lara, Andrade, & Branco, 2017; Øvretveit, 2018b) and effort patterns in BJJ (Andreato et al., 2016; Øvretveit, 2018a), data on the health benefits, included the BP responses, of BJJ practise is scarce. Prado and Lopes (2009) found acute increases in BP following 20 minutes of BJJ sparring. During the subsequent 90-minute recovery time, both SBP and diastolic BP (DBP) fell steadily until the 75-minute mark, when an elevation below pre-exercise values was observed. Borges et al. (2012) observed the acute physiological responses to single five-minute sparring rounds, with BP measures at rest (pre-sparring), one, five, and fifteen minutes post-sparring in a training session. A BP increase was observed one minute post-sparring, following a reduction below pre-sparring levels, indicating BJJ-induced PEH. Similarly, Simão et al. (2007) reported BP reductions following a 60-minute judo session, although these findings did not reach statistical significance.

Brazilian jiu-jitsu training typically includes a warm-up followed by technical drilling and sparring (Øvretveit, 2018a). These training components may exert different effects on BP; while warm-ups and technical training may be associated with the PEH typically observed following aerobic exercise, competitive sparring might increase BP due to factors such as increased tension and anxiety (Piskorska et al., 2016) and emotional stress (Munakata, 2018). Notably, previous research on BP responses in grappling does not distinguish between technical (light) sparring or competitive (hard) sparring. As opposed to technical sparring, competitive sparring may increase injury risk and hence be less suitable for regular practice. Accordingly, studies assessing the health benefits of low-risk technical sparring can be used to inform training strategies and health goals in the general BJJ population. To the best of our knowledge, no study to date has explored BP responses in BJJ training.

Thus, this study aimed to investigate training-induced BP in BJJ practitioners and assess the potential therapeutic effects of the sport. We hypothesized that BP would increase acutely after each round compared to resting values, followed by a significant and gradual decrease during the recovery period.

Methods

Participants

The study sample comprised seven male BJJ practitioners (age: 24.0±3.5 years; height: 1.75±0.02 m; body mass: 76.0±4.2 kg; BMI: 24.5 0.9) from the Federal Brazilian Jiu-jitsu School (Team Minerva) at the Federal University of Rio de Janeiro (UFRJ) holding the rank of blue (n=6) and purple belt (n=1), with 5.0±1.3 years of BJJ training experience. To limit the skill discrepancy between the participants, white, brown, and black belts were ineligible for participation. The study protocol was reviewed and accepted as a graduation project at UFJR. All participants were informed of the risks and benefits associated with the investigation and gave their written informed consent prior to participation.

Experimental design

Data were collected on two non-consecutive days (Figure 1). On the first day, height and body mass were obtained with a balance weighing scale with a stadiometer (Filizola, São Paulo, Brazil) in a sport science laboratory. The participants subsequently underwent a protocol familiarization session at martial arts gymnasium's dojo (UFRJ) followed by a recovery period of 48 to 72 hours before the main data collection. In the 24-hour period leading up to the sparring session, participants were asked to abstain from exercise, caffeine, chocolate, green tea, sugary soda, alcohol as well as thermogenic supplements and other stimulating substances such as amphetamines, theophylline, theobromine, and their derivatives.

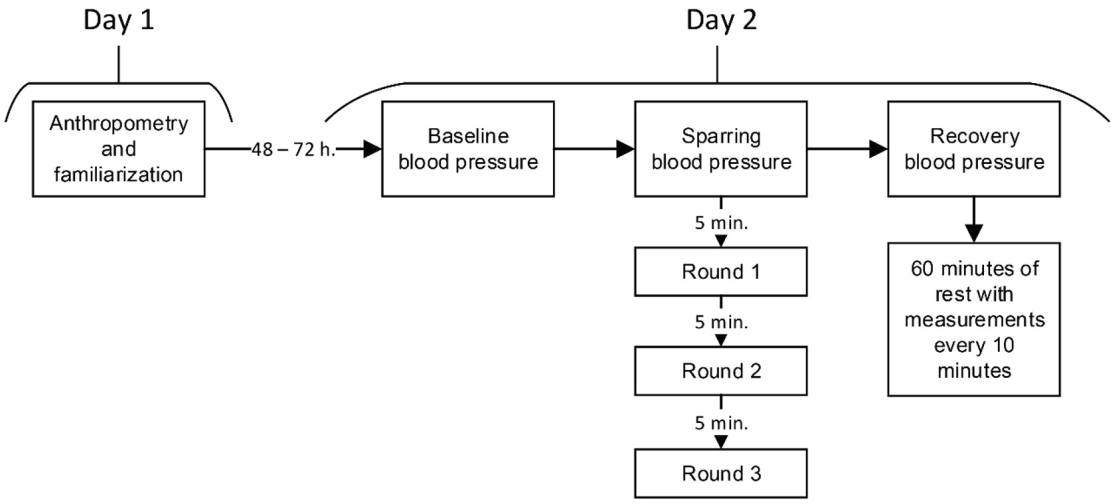

FIGURE 1. Experimental design

All BP measurements were obtained by trained personnel using a stethoscope (Duplex, Rudolf Riester GmbH, Jungingen, Germany) and sphygmomanometer (Premium, Wenzhou Kangju Medical Instrument Co., Ltd, Wenzhou, China). On the sparring day, baseline resting BP was measured in the seated position after ten minutes of rest. Subsequently, all partic-

ipants completed three five-minute technical sparring rounds separated by five-minute breaks. The rounds were characterized by gentle movements without excessive use of muscular force, allowing a greater variety of attack and defence techniques without competitive purpose. When a submission position was achieved, a defence technique was allowed, and the combat continued until the end of time. Following the end of the last sparring round, the participants remained seated in a chair for 60 minutes, avoiding movement and talking. Blood pressure was measured one minute after each round and every ten minutes during the recovery period (Simão et al., 2007). Additionally, participants gave their rating of perceived exertion (RPE) on Borg's category-ratio scale (Borg, 1982) after each round.

Statistical analysis

Statistical analyses were performed using SPSS version 20 (Chicago, IL, USA). Figures were made using GraphPad Prism version 6 (San Diego, CA, USA). The Shapiro-Wilk test was used to test data normality. Differences in BP responses were assessed with repeated measures ANOVA followed by the Holm-Sidak post hoc test. Sphericity was assessed with Mauchly's test, with the Greenhouse Geisser test being used when necessary. To obtain the effect size, $Eta^2_{partial}$ (n^2) was used, calculated as $n^2 = SS_{between} / SS_{between +} SS_{residual}$. A 95% confidence limit was established. Data are presented as mean±standard deviation (SD). An alpha level of $p \leq 0.05$ was considered statistically significant for all comparisons.

Results

All participants successfully completed the designated sparring rounds. No adverse events occurred during any of the measurement procedures. Between sparring rounds, acute increases in both SBP ($F_{1.556, 9.336} = 102.6$; $n^2 = 0.972$; $p<0.0001$) and DBP ($F_{2.683, 16.10} = 30.04$; $n^2 = 0.913$; $p<0.0001$) were observed (Figure 2). This was accompanied by a gradual, albeit non-significant increase in RPE from 5.0±0.8 after round 1, to 6.0±1.4 after round 2, and peaking at 7.0±1.0 after round 3 ($F_{1.370, 8.218} = 3.205$; $n^2 = 0.590$; $p=0.1037$).

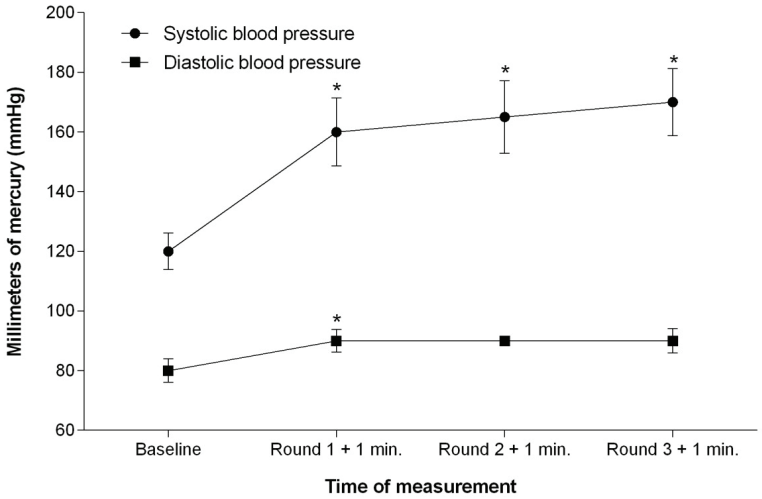

FIGURE 2. Blood pressure responses during sparring. Data presented as mean±SD. *Significant increase compare to baseline (p<0.05)

In the subsequent post-training recovery period, both SBP and DBP increased at the ten-minute mark compared to baseline resting values, but then started to gradually decline (Figure 3), with SBP dropping 10.0±4.1 ($F_{1.813, 10.88} = 39.16$; $n^2 = 0.931$; $p<0.0001$) and DBP 5.0±4.1 mmHg ($F_{1.790, 10.74} = 20.32$; ; $n^2 = 0.879$; $p=0.001$) after one hour of seated recovery.

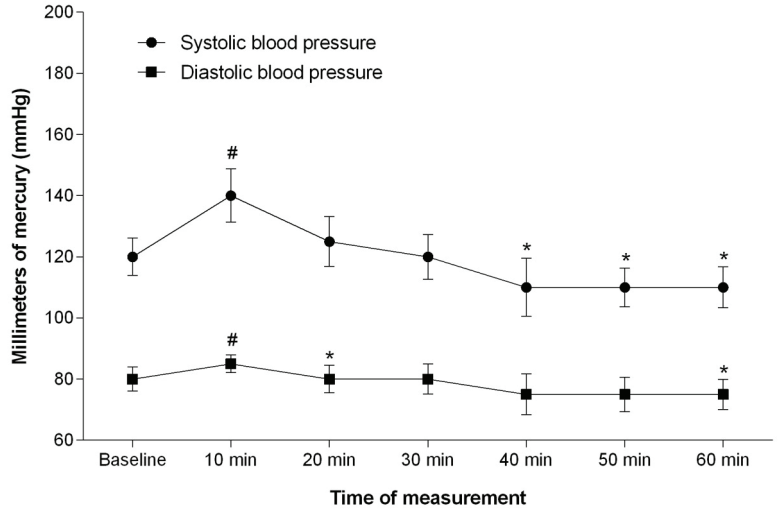

FIGURE 3. Blood pressure responses after sparring. Data presented as mean±SD. #Significant increase compare to baseline (p<0.05); *significant decrease compare to baseline (p<0.05)

Discussion

The increasing global prevalence and burden of HTN, and the well-established efficacy of physical exercise as an antihypertensive treatment strategy, warrants the investigation of various exercise modalities and their effects on BP. Thus, the present study sought to measure BP responses to controlled combat sports training in young, healthy adults. As hypothesized, our main finding was that both SBP and DBP decreased significantly following technical sparring, demonstrating a distinct PEH effect, which is in accordance with previous observations (Borges et al., 2012; Prado & Lopes, 2009; Simão et al., 2007) and indicates the efficacy of BJJ in the prevention and treatment of HTN.

Contrasting the observed increase ten minutes into recovery were the findings of Borges et al. (2012), who reported a reduction in SBP as early as five minutes after sparring. However, this may be due to differences in training volume, as the measurements were obtained after a single round of sparring, whereas we assessed recovery after three consecutive rounds. Furthermore, our findings on acute post-sparring (i.e., after one minute) increases in SBP are in agreement with previous observations (Borges et al., 2012; Prado & Lopes, 2009). The increasing RPE indicates cumulative fatigue as a result of consecutive bouts of sparring. Cumulative RPE in BJJ appears to be related to between-round recovery time, with short breaks leading to a progressive increase in perceived fatigue (Øvretveit, 2018a) while longer breaks result in similar RPE after consecutive bouts (Andreato et al., 2015). Accordingly, breaks during training can be adapted to the general training goals, e.g., extended to support recovery or narrowed to induce perceived fatigue. Although being considered as an appropriate method for training load quantification in combat sports, the subjective nature of the RPE measurement makes it susceptible to several factors such as the competitive level, external stimuli, training modalities, and intensity of the session (Slimani, Davis, Franchini, & Moalla, 2017). Thus, comparisons of studies and individual practitioners should be made with caution.

The magnitude of PEH after single bouts of exercise may be indicative of the long-term BP response to chronic exercise (Hecksteden et al., 2013). Accordingly, individual PEH may be used as an indicator of the degree of exercise-induced BP-reductions that can be expected over a given training period (Liu, Goodman, Nolan, Lacombe, & Thomas, 2012). Moreover, PEH likely plays an important role in the overall BP reductions caused by exercise training, highlighting the importance of regular physical activity (Pescatello et al., 2015). As demonstrated by the present study, light BJJ sparring elicits significant PEH effects and can, due to its relatively low physiological load, be performed with a high frequency without leading to overtraining and/or injury. However, exercise intensity has also been shown to be an important mediator of BP reductions (Boutcher & Boutcher, 2017) and exercise recommendations for the prevention and treatment of HTN must strike a balance between intensity, frequency, and volume of training. Although no study to date has compared the effects of light and hard sparring on PEH, BJJ practitioners have been shown to reach and maintain a relative heart rate (HR) of 85% during sparring at unrestricted intensities (Øvretveit, 2018a), which suggests that sparring can reach very high intensities, which has implications for exercise tolerance and subsequent adaptations. Thus, it might be appropriate to apply intensity restrictions to sparring sessions based on the goal of the practitioners. Importantly, while high-intensity sparring is often used for athletic conditioning, athletes who seek improvements in aerobic endurance should include alternative high-intensity conditioning approaches in their training plan (Øvretveit, 2019).

Although it is the type and degree of physiological stimulus rather than the specific exercise modality that generally should inform the balance of intensity, frequency and volume, BJJ practitioners must consider the inherent injury risk of the sport when they plan their training. Our findings suggest that low-intensity training is conducive to PEH and consequently can be appropriate for practitioners seeking BP reductions. Conversely, more competition-oriented practitioners may opt for a higher training intensity to more closely emulate the conditions of competition. While the injury rate in BJJ competition is reportedly lower than for other combat sports, such as taekwondo, judo, wrestling and mixed martial arts (Scoggin et al., 2014), injuries during BJJ training are very common (Petrisor et al., 2019). Furthermore, BJJ training intensity is thought to increase the risk of injury (Spano, Risucci, Etienne, & Petersen, 2019). Thus, inappropriate programming of high-intensity BJJ training may negatively affect both short- and long-term training adaptations and ultimately adherence to the sport. As the perceived risks and benefits of BJJ training may vary between practitioners, individual goals should govern the training plan. Considering that BJJ does not require athletic trainers or medical professionals to monitor practice sessions, the education of coaches and practitioners is important to minimize injury risk (Spano et al., 2019).

Exploring the underlying mechanisms of BP responses during and after exercise training is beyond the scope of this study, and the exact causes of the observed PEH remain to be determined. Indeed, the effects of exercise on the complex pathophysiology of HTN may be more appropriately explored in a different context. The study was limited by the small sample size and lack of objective intensity measurements during sparring, such as HR. To further elucidate the role of intensity in BJJ-mediated BP reductions, larger studies comparing different training intensities is needed.

In summary, technical BJJ sparring appears to lead to significant PEH, indicating its potential as a non-pharmacological approach to treat and prevent HTN. Although hard sparring can be appropriate for active competitors in preparation for competition, it might negatively impact BP through increased psychological stress, as well as increase the risk of injury. The relative safety and apparent effect of technical sparring on BP make it a compelling training approach for improvements in cardiovascular health.

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Conflict of Interest

The authors declare the absence of conflict of interest.

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