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RESEARCH ARTICLE

JIU-JITSU ATHLETES' CARDIOVASCULAR RESPONSES IN AN ADAPTED BURPEE TEST

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ABSTRACT

Sports combat practitioners number is increasing, and one of the most popular sports is Brazilian Jiu-Jitsu (BJJ), thus it is necessary to use cardiovascular monitoring methods to estimate heart effort. As sport combat a dynamic exercise, adaptation of sport test to resemble one increase its accuracy. The aim study is to determine cardiovascular responses in BJJ athletes through an adapted Burpee test. The sample selection was not probabilistic, for convenience, and comprised 54 fighters BJJ male 18-39 years old. Before, during and after test application were monitored: systolic blood pressure (SBP) and diastolic (DBP), resting heart rate (HR_r), mean (HR_m) and maximum (HR_{max}) by auscultation and frequencymeter for calculation of mean BP (MBP), double product (DP) and effort percentage (% effort). After analysis, we observed a significant increase in SBP and HR pre and post-test ($p<0.05$) and DBP reduction ($p<0.05$). Regarding the DP and % effort, 25770±3707.6 mmHg.bpm and 87.0±6.3, respectively, they yielded values comparable to high-intensity continuous aerobic exercise. We conclude, therefore, that cardiovascular responses found suggest significant changes in the surveyed athletes, these ones being exposed to cardiac overload comparable to a continuous aerobic activity of high intensity, requiring adequate monitoring.

INTRODUCTION

Brazilian Jiu-Jitsu (BJJ) is a combat form that requires intense training to increase physical fitness, using different factors control forms that can determine the success in competition (Jones and Ledford, 2012). This wrestling leads to adaptations in practitioners' body due to training, including cardiovascular system, study object of our work. The importance of understand these changes can be an essential factor for cardiovascular prophylaxis and athletes' sport performance. Factors such as exercise type, intensity, and duration are important for a better understanding of these athletes' adaptations (Kovacs and Baggish, 2015). Thus, acute cardiovascular responses control has fundamental importance in training correct prescription and safety monitoring of proposed activities, which itself is exposed to cardiac overload (Polito and Farinatti, 2003). In addition, it can highlight variations in blood pressure (BP) as one of the major responses and adaptations resulting from physical effort related to cardiovascular system (Pal *et al.*, 2013), besides heart rate (HR).

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And double product (DP) has been used to estimate myocardial performance as non-invasive marker (Farinatti and Assis, 2000).Bringing to our study, it is clear that an increasing number of athletes train and participate of combat competitions, such BJJ, and unfortunately many of these individuals are not accompanied by medical and/or physical trainers. Thus, due to sports combat popularization, the aim of this study is to determine BJJ practitioners' cardiovascular responses of an adapted Burpee test.

MATERIALS AND METHODS

Sample

The sample consisted of 54 BJJ practitioners, selected by non-probability sampling and for convenience. Individuals should: practice BJJ for at least six months, minimum of thrice weekly frequency, being male and aged between 18 and 39 years old. Participants who used any ergogenic resource, possessing musculoskeletal problems that would prevent all or part of test run, used substances that could affect BP and HR (for example: caffeine, alcohol, etc.), and have done physical activity six hours before protocol's implementation were excluded.

Protocol

Test was performed in mat placeholder BJJ gyms. After completing and signing free and informed consent term, participant was Five minutes at rest, while they receive guidance about test execution technique. Executions were collected by appraiser and computed those carried out correctly. The participant may stop at any time and return to perform repetitions, however the clock was not stopped. Every minute the evaluator informs elapsed time and repetitions performed number. All participants agree to be filmed during test, keeping the filming only to conference data collection, and then discarded.

Adapted burpee test

Burpee test is used to check the overall coordination (Marins, 1998). Because this test uses global movements and changes position, approaching BJJ movements, our study chose it as data collection basis, adaptations were made to adjust the proposed objective, as test duration, inclusion of upper limbs movement ("push-up"), a jump and the purpose execution (inducing changes in cardiovascular responses). An important element when choosing a physical effort assessment tool is to reduce execution and measurement error likelihood to increase accuracy one (Ainsworth *et al*, 2015). First, test starts with BP measurement with aneroid sphygmomanometer (Premium®), placed on right arm and a cardiologic stethoscope (Premium®), using conventional auscultation.

To this measurement, it was considered as systolic value The Korotkoff sound first phase and diastolic value the fourth one. The participant has put the frequencymeter (Polar FT4 model®) for resting HR record (HR_r). After, position yourself standing on mat and wait for signal evaluator to start test that was timed (stopwatch Vollo®) for seven minutes. Immediately after test, final and mean PA measurements have been performed and data recorded in frequencymeter (maximum HR - HR_{max} and mean HR - HR_m).

Ethical aspects

Our study is in accordance with Brazilian National Health Council Resolution 466/2012, having been informed to respondents in this research development that it was respected their anonymity and they could withdraw at any time without prejudice.

Statistical analysis

For data analysis, descriptive statistics were used by mean, standard derivation, minimum and maximum values. Inferential statistics were used by one-way ANOVA with Tukey as post hoc, or paired Student T test (when appropriate), besides using Pearson correlation test for surveying pertinent variables for linear regression use. For correlation qualitative analysis, it was considered the work Callegari-Jacques postulated (Callegari-Jacques, 2003).

RESULTS

Individuals surveyed by our study were Young adults who were extremely divergent as Sport practice time, not allowing segregate them into subgroups in attempt to verify hemodynamic parameters surveyed differences. When considering age, two subgroups were formed: age between 18-29 years old and 30-39 years old (significant difference with p<0.05), but none of data collected showed significance when compared pre- and post-test (non exposed data). Thus, 54 subjects were evaluated as a single group, demonstrating relatively similar hemodynamic responses among themselves regarding: mean and maximum HR, DP, mean BP, and initial and final systolic and diastolic BP (SBP and DBP, respectively). The parameter that showed disparity between assessed extremes was HR_r, where there was a difference of 112.5% and high values (Table 1).

Table 1. Mean, standard deviation, minimum and maximum values of individual data (age and practice time) and executions number in adapted Burpee test of Jiu-Jitsu athletes

Assessed Parameters	Mean	Minimum	Maximum
Age (years old)	25.4±5.9	18.0	39.0
Practice Time (years)	3.2±3.9	0.5	20.0
Test Executions (repetitions)	80.0±18.6	43.0	127.0

Regarding pre, during and post-test cardiovascular responses, we identified significant differences between all assessed values, as HR_r, HR_m and HR_{max} ($p<0.0001$), initial and final SBP ($p<0.0001$), with hypertensive response, and initial and final DBP ($p<0.0001$), com with hypotensive response. The effort percentage values (% effort) and DP gave to used test (adapted Burpee) a high intensity aerobic activity characteristic (Tables 2 e 3).

Table 2. Mean, standard deviation, minimum and maximum values of heart rate (HR) before, during, and after Jiu-Jitsu athletes' test

Assessed Parameters	Mean	Minimum	Maximum
HR resting (bpm)	89.0±16.3	64.0	136.0
HR mean (bpm)	168.0±12.9[a]	120.0	195.0
HR maximum (bpm)	193.0±15.7[a;b]	164.0	223.0
% Effort	87.0± 6.3	72.0	97.0

HR – Heart rate; % Effort: effort percentage;
[a]significantly different (p<0.05) from resting HR;
[b]significantly different (p<0.05) from mean HR.

Table 3. Mean, standard deviation, minimum and maximum values from Double Product, Systolic, Diastolic, and Medium Blood Pressure before and after test

Assessed Parameters	Mean	Minimum	Maximum
DP (mmHg.bpm)	25770±3707.6	15600	37800
SBP initial (mmHg)	123.3±12.6	100.0	160.0
SBP final (mmHg)	152.0±17.0[a]	120.0	200.0
DBP initial (mmHg)	73.9±9.8	60.0	100.0
DBP final (mmHg)	58.5±6.8[a]	40.0	70.0
MBP (mmHg)	90.2±9.4	73.3	120.0

DP – Double Product; SBP– Systolic Blood Pressure; DBP – Diastolic Blood Pressure; MBP– Medium Blood Pressure; [a]significantly different (p<0.05) from their respective control (SBP initial or DBP initial).

In an attempt to find out correlation between the assessed parameters to explore relationships between personal, physical, and hemodynamic data for possible values prediction from easier collect variables, we used Pearson correlation, where it was noticed a moderate positive correlation between repetitions number in test and DP ($r=0.46$; $p<0.0001$; Table 4). This enabled a predictive equation construction of cardiac stress that, for each repetition value performed on seven minutes (abscissa or x axis), multiplied by 92.091 and then added to 18394 mmHg.bpm value, it could obtain DP value (ordinate or y axis) with R^2=0.2137. That is, the aim of achieving this regression was verify a functional relationship existence between an independent (repetitions) and dependent (DP) variable.

suffer multifactorial influences, and, among them, emotional part is closely related to changes in autonomic nervous system that directly intervene in heart functioning. Regarding resting and final HR, similar values were found in a work by

Table 4. Pearson correlation values considering collected and calculated personal, physical practice, and hemodynamic data

R	Age	Repet	PT	HR_r	HR_{max}	%Esf	DP	SBP f	DBP f	SBP i	DBP i
Age	-	0.23	-0.02	-0.08	-0.05	-0.06	0.13	0.26	0.33*	0.34*	0.49*
Repet	-	-	-0.17	-0.07	0.07	0.13	0.46*	0.44*	-0.23	0.24	0.11
PT	-	-	-	0.07	0.05	-0.04	-0.11	-0.14	0.11	-0.15	-0.12
HR_r	-	-	-	-	0.12	0.21	0.15	-0.03	-0.08	0.33*	0.16
HR_{max}	-	-	-	-	-	-0.48*	0.38*	0.12	-0.13	-0.13	-0.17
%Esf	-	-	-	-	-	-	0.24	0.03	0.00	0.26	0.02
DP	-	-	-	-	-	-	-	0.87*	-0.09	0.47*	0.06
SBP f	-	-	-	-	-	-	-	-	-0.01	0.52*	0.16
DBP f	-	-	-	-	-	-	-	-	-	0.19	0.45*
SBP i	-	-	-	-	-	-	-	-	-	-	0.51*
DBP i	-	-	-	-	-	-	-	-	-	-	-

r – Correlation value; Repet – Test repetitions; PT – Practice time; HR_r – Resting heart rate; HR_{max} – Maximum heart rate; %Esf – effort percentage; DP – Double product; SBP f – Final Systolic Blood Pressure; DBP f – Final Diastolic Blood Pressure; SBP i – Initial Systolic Blood Pressure; DBP i – Initial Diastolic Blood Pressure; * $p<0.05$.

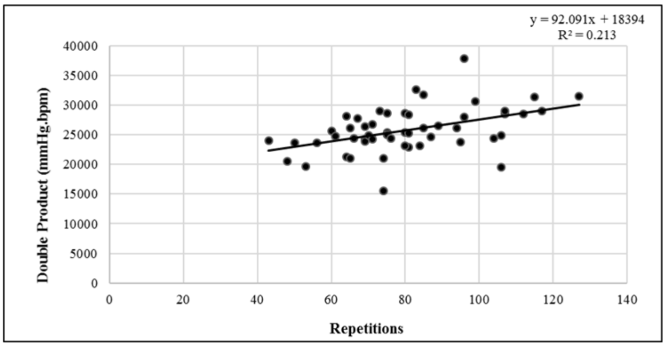

Figure 1. Double Product dispersion diagram (y axis) based on repetitions performed number at adapted Burpee test (x axis) with Linear Trend Line (Linear Regression). y – Ordinate Axis Value; x –Abscissa Axis Value; R^2 – Determination Coefficient

DISCUSSION

In our study, sample characterization data showed a young group with high practice time and relatively good repetition mean (leaning on average value over maximum value). When we verify different groups in our sample by age and practice time, there was no statistically significant difference. Ravagnani *et al.* (2005), in their study of maximal oxygen consumption decline (VO_{2max}) as an age function, they realized that there was a decrease of approximately 10% in VO_{2max} per studied decade. However, Roger *et al.* (1990) assert that active individuals can reduce aerobic capacity loss to 5% when they maintain constant their physical activity levels and body composition.

Farinatti and Assis (2000) in their study obtained much lower HR values and much higher BP (both systolic and diastolic), probably because we selected active to athletes individuals, different from mentioned work group above. Passaglia *et al.* (2013) mention that there seems to be a positive relationship between dose and response to physical training, which differs not active, active, and athletes individuals one to another. Another interesting finding in our study is that participants average resting heart rate was relatively high (89.0±16.3 bpm), which we believe to be related to emotional and/or environmental factors. Ribeiro *et al.* (2000) argue that HR may

Rodrigues *et al.* (2012), where in an incremental test performed on 24 normotensive young people (22.6±3.5 years old), it was identified, respectively, 110.25 and 187.23 bpm, resembling our findings. The effort percentage in our study was 87.0±6.3%, characterized like a high-intensity activity. Farinatti *et al.* (2000), comparing aerobic and resistance exercises on cardiac demand in 18 subjects of 23.0±6.0 years old, identified that resistance exercise, regardless of intensity, promote lower cardiac demand (DP) than aerobic exercise, and the smaller muscle mass requested, lower will be absolute DP, approaching our study DP values with ones obtained by authors above in group that performed up to 5 min cycling at 75-80% HR reserve.

Figueiredo *et al.* (2011) when comparing two resistance training protocols with different intervals between sets, found that both HR, SBP, and DP increased similarly to our results, especially when they were compared to lowest interval group, however DBP remained unchanged (regardless of protocol). In this same work, DP value obtained was similar to that one found in our study in protocol with less rest between sets, probably to give a protocol continuity character, meaning a higher cardiac stress is given by intervals shorter recovery. Gonçalves *et al.* (2015) conducted a study with 52 subjects (active Young adults) in two different protocols: endurance and resistance, in both upper and lower limbs.

They identified in all applied protocols an increase in HR, SBP, and VO_{2max}, whereas DBP decreased only in endurance protocol, using lower limbs, resembling our results, featuring our protocol as predominantly aerobic and high intensity (considering at this effort percentage). These same authors assert that any training protocol may influence cardiovascular parameters, however those ones whom use higher muscle quantity and demand more practice time promote more pronounced changes. Kravchychyn *et al.* (2015) claim direct tests are considered “gold standard for determining physiological variables, however costs are high and require specialized labour. Thus, most professionals use other tests as more affordable alternative, being advantageous to create protocols able to estimate cardiac stress just repeating predetermined movements. In our study, although various relationships have shown significance in Pearson test, it was considered just DP's relationship to repetition performed number, finding a moderate to strong correlation, building up a linear regression graph that it might serve as a new test to be developed to estimate cardiac stress from simple and generalized request movements.

It is known acute cardiovascular responses vary depending on exercise type, intensity, and duration (Brum *et al*., 2004). D'Assunção *et al.* (2007) can be noticed this behaviour when considering different work intensities and durations relating to SBP, HR and DP, even if DBP remained unchanged. Aldenucci *et al.* (2010), in a paper about blood pressure behaviour and other physiological variables in exercise response to 75% of 1RM dynamic force, assessed 16 males (26.3±1.1 years old) and found SBP initial values of 107.69±3.02 mmHg and final one of 127.31±3.82 mmHg, while DBP remained practically unchanged (initial: 68.75±2.39 mmHg and final: 70.0±3.41 mmHg). HR varied from 79.0+4.17 bpm to 136.62+2.23 bpm. These values were relatively different from our group, even if similar age, probably because exercise performed type. Cunha *et al.* (2006) argue that factors such exercise type, intensity and duration can interfere on different individuals' cardiovascular responses.

Forjaz *et al.* (1998) identified that pressure drop magnitude and duration caused by continuous exercise are dependent on exercise duration, which they have tested two different durations (cycle ergometer) and realized that mainly DBP responds with more pronounced reduction in longer protocol. Similar results were seen in our study which DBP significantly reduced, considering protocol used time (seven minutes). In normotensive people, Paschoal *et al.* (2004) justify post-exercise DBP drop by peripheral vascular resistance (PVR) reduction, which it could be explained by peripheral vasodilatation maintenance, and it seems to be related to person's exposure time to exercise or abrupt reduction of this one.

Cunha *et al.* (2006), comparing different durations and intensities exercises, realized in both exercises type (continuous intensity to 60% HR reserve and varied intensity) SBP and DBP behaviour were similar to our findings, which it was observed a SBP increase and DBP decrease after exercise, however HR value was closer more to interval exercise one (varied intensity) than continuous one, probably due to higher intensity (142.0±7.63 bpm). According to Lopes *et al.* (2006), in a study conducted after resistance exercise, a diastolic hypotension was detected. This fact is probably due to a large muscle mass mobilization, leading to a greater amount of vasodilatation blood vessels. Venous return may still be influenced by muscular pump interruption at test end.

In this same study (Lopes *et al.,* 2006), comparing three different exercise protocol (treadmill, stationary bike and bodybuilding circuit), it was also identified that DP was not significantly different between groups. However, hypotensive response was more pronounced in bodybuilding circuit group, probably indicating that greater muscular vasodilatation occurred in this group because it involves more muscle mass. At our work Burpee adaptation was made considering a greater muscles group actuation during its execution, resembling the sport in question (BJJ). Also regarding DBP physiological mechanisms reduction, Polito and Farinatti (2006) argue that scientific literature does not yet provide consistent data on it. These authors suggest as a hypothesis sympathetic activity reduction on cardiovascular system (observed mainly in hypertensive individuals). Monteiro and Sobral Filho (2004) and Legramante *et al.* (2002) suggest that another associated mechanism is a PVR reduction, due to endothelial vasodilatation substances action (prostaglandins, nitric oxide) which they are released during effort physical.

Conclusion

Cardiovascular responses data found suggest significant changes, which all studied parameters (HR, SBP and DBP) had an increase when compared initial and final activity data, except for DBP that demonstrated a significant reduction, when they were exposed to a cardiac overload comparable to a high intensity continuous aerobic activity, serving as a screening proposal, and requiring adequate monitoring.

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