

Relationship between mood state and cardiac autonomic modulation in jiu-jitsu fighters in the pre- and post-competitive period: A pilot study

Relação entre estado de humor e modulação autonômica cardíaca em lutadores de jiu-jitsu nos períodos pré- e pós-competitivo: um estudo piloto

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ABSTRACT

Aim: To characterize the changes in body composition, mood state and cardiac autonomic modulation in Brazilian Jiu-Jitsu (BJJ) of athletes in the pre- and post-competitive periods. **Methods:** Eight male athletes were evaluated in 3 moments: 14 days and 1 day before the fight, and 2 days after the competition. Evaluations of body composition, mood state, and cardiac autonomic modulation were performed. The repeated measures Anova test, Pearson and Spearman correlation were used for data analysis ($p < 0.05$). **Results:** We observed reductions in anger (6.80 ± 1.69 vs. 4.20 ± 1.67 vs. 3.40 ± 1.07) and tension (6.60 ± 0.81 vs. 5.40 ± 0.75 vs. 2.60 ± 0.88) after competition. Vigor was reduced one day before the competition and remained the same two days after the competition (12.80 ± 1.60 vs. 10.00 ± 1.95 vs. 10.40 ± 1.03). In addition, there was an increase in sympathetic modulation (LF-PI: 2942 ± 655.3 vs. 5479 ± 2035 vs. 5334 ± 2418 abs). There was a positive correlation between the state of vigor and sympathetic modulation ($r = 0.55$), a negative correlation between the states of depression and sympathetic modulation ($r = -0.68$) and confusion and sympathetic modulation ($r = -0.67$). **Conclusion:** These findings raised concerns about the preparation of these athletes for competitions since changes in the state of vigor might reduce performance and increase cardiovascular risk.

Keywords: mood state; cardiac autonomic modulation; combat sports.

RESUMO

Objetivo: Caracterizar as alterações na composição corporal, estado de humor e modulação autonômica cardíaca em lutadores de Jiu-Jitsu (BJJ) nos períodos pré- e pós-competitivo. **Métodos:** Foram avaliados 8 lutadores em 3 momentos: 14 dias e 1 dia antes da luta, e 2 dias após a luta. Avaliou-se a composição corporal, estado de humor e modulação autonômica cardíaca. Os dados foram analisados por Anova de medidas repetidas e correlações de Pearson e Spearman ($p < 0,05$). **Resultados:** Estados de humor: foi observada redução na raiva ($6,80 \pm 1,69$ vs. $4,20 \pm 1,67$ vs. $3,40 \pm 1,08$), e tensão ($6,60 \pm 0,81$ vs. $5,40 \pm 0,75$ vs. $2,60 \pm 0,88$) após a competição. O vigor foi reduzido um dia antes da competição e se manteve reduzido dois dias após a competição ($12,80 \pm 1,60$ vs. $10,00 \pm 1,95$ vs. $10,40 \pm 1,03$). Adicionalmente, houve um aumento na modulação simpática cardíaca (BF-IP: $2942 \pm 655,3$ vs. 5479 ± 2035 vs. 5334 ± 2418 abs) um dia antes da competição e se manteve aumentado no período pós-competitivo, fato que sugere maior risco cardiovascular a longo prazo. Foi observada correlação positiva entre o estado de vigor e a modulação simpática ($r = 0,55$), e correlações negativas entre o estado de depressão e modulação simpática ($r = -0,68$), e confusão e modulação simpática ($r = -0,67$). **Conclusão:** Estes achados demonstram a necessidade de serem revistos os aspectos da preparação competitiva destes atletas antes das competições, pois mudanças no estado de vigor podem reduzir o desempenho e aumentar o risco cardiovascular.

Palavras-chave: estado de humor; modulação autonômica cardíaca; esportes de combate.

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Introduction

Combat sports athletes usually go through weight loss processes since adolescence [1,2]. When this process happens repeatedly and abruptly, it might lead to a weight gain and loss process resulting of lower basal metabolic rate and unsuccessful weight maintenance [3]. That may harm the athlete's body in many ways, such as electrolytic disturbance; cardiovascular system disorders; and mental and mood disorders in the fighters [4,5]. These damages demonstrate the importance of analyzing body composition of Jiu-Jitsu athletes during competition periods, since the relationship between modifications of the athletes bodies, mood and autonomic cardiovascular modulation is not too clear in the literature [6].

Studies demonstrate the importance of checking the mood state of the athletes in the pre-competitive period, once the high level of stress during this period may change the psychological condition of athletes, unleashing many physical and biomechanical adaptations in the body, which may influence competitive performance [7-10]. Previous studies demonstrated that weight loss in the pre-competitive period harms the mood state and increase cardiac sympathetic modulation in combat sports athletes [5].

The heart rate variability (HRV) is an efficient tool to estimate the risk of a cardiac disease and measure the autonomic cardiovascular modulation, since it is an indicator of the autonomic nervous system (ANS). The ANS is responsible for some vascular activities, such as the control of blood pressure (BP) and heart rate (HR) [11]. The HRV shows the variations in the intervals between consecutive heartbeats, which is related to the influence of ANS in the sinus node, it is also a non-invasive tool that can be used as an indicator in both, common individuals, and specific groups [12].

However, the data are scarce of specific characteristics of jiu-jitsu fighters, as well as their adaptations on competitive periods. This pilot study aimed to identify the changes in body composition of jiu-jitsu fighters, their mood state and autonomic cardiovascular modulation in the pre-competitive and post-competitive periods.

Methods

Experimental study design

The data were collected in the training place and was analyzed at Universidade São Judas Tadeu. The work was developed according to declarations and guidelines on research involving human beings: the Nuremberg Code, Declaration of Helsinki and resolution 466/12 of the National Health Council. The Ethics Committee approved this study in the terms of the protocol number 1.671.569, which was provided by Universidade São Judas Tadeu. The evaluations were carried out in three occasions: 14 days before the competition, 1 day before the competition and 2 days after the competition. These evaluations were performed 3 times to verify the athle-

te's baseline status, their pre-competition and post-competition status of mood state and cardiovascular autonomic modulation.

Inclusion criteria and exclusion criteria

The sample was non-probabilistic, intentional and of convenience with 8 jiu-jitsu athletes. The inclusion criteria were to be practicing the martial art for at least 6 months. The athletes who did not follow the preparation instructions for the bioimpedance test were excluded.

Questionnaire of training characteristics:

All athletes were submitted to a questionnaire to identify the features of the sample, with questions regarding the athlete's experience in the sport, their training frequency, the kind, and the duration of training sessions and history of competitions, drugs and/or anabolic steroids use.

Mood state

The BRUMS test (BRUMS – Brunel Mood Scale) was performed on all test days. This test contains 24 simple mood indicators, such as feelings of anger, nervousness and dissatisfaction. The respondents answered how they felt about such situations (the test days), according to a scale that ranged from zero (nothing) to four (extremely). The completion of this test was performed by the individual himself. The feelings listed on the scale constitute categories, which correspond to the mood states of tension, depression, anger, vigor, fatigue and mental confusion [8].

Body composition

After that, we analyzed the athlete's body composition, their height and weight were measured in all the occasions, and then we calculated their Body Mass Index (BMI). We obtained additional data about body composition through the electrical bioimpedance method using a Bioimpedance analyzer (brand: Biodynamic. Model: BIA450). To carry out that procedure, each athlete was placed in a dorsal decubitus position and had to be fasting for four hours before the procedure. They were also oriented to refrain drinking alcohol, caffeine and exercises for at least one day before the procedure. The bioimpedance test provided the percentages of fat mass, lean body mass, and the amount of body liquid through the passage of an electric current of low intensity (from 500 to 800 μ A) and high frequency (50 kHz) through the body. The current was imperceptible for them [5].

Hemodynamic data

After those procedures, blood pressure was measured using a digital measurer (brand: OMRON model: HEM-705CPIN), three times (with an interval of 2 minutes between each measurement), as directed by the Brazilian Society of Hypertension (2010). The athlete's heart rate was recorded for 25 minutes when they were at rest (to analyze the autonomic cardiovascular modulation subsequently) [5].

Heart rate variability

RR intervals (IP2ms) were recorded using a heart rate monitor (*brand: Polar®*, *model: S810*). The transmitter, which is clipped to a belt, detect the electrocardiographic signal from heartbeat to heartbeat and transmit it through an electromagnetic wave to a *Polar®* receiver clipped to the wrist, where the information is digitalized, displayed and archived [12]. This system can detect the ventricular depolarization, which corresponds to the R wave in the electrocardiogram, with a 500 Hz Electrocardiogram sampling frequency and a 1ms temporal resolution [13].

After the cardiac signal was recorded, the data was transferred to the *Polar Precision Performance Software®* using the Infrared Interface (IrDA). That software enables bidirectional data exchange with a microcomputer for later analysis of cardiac pulse interval variability (RR) in different situation. After these procedures, the data was transferred and saved to Text files, using Kubius software to analyze heart rate variability in both time domain and frequency domain (Rapid Transformation) [5].

Regarding the analysis of the autonomic cardiovascular modulation in the frequency domain, the following parameters were observed: the low-frequency band (LF-PI, sympathetic modulation), high frequency band (HF-PI, parasympathetic modulation) and the ratio between low-frequency band and high-frequency (LF/HF balance) [12].

Statistical analysis

Data were presented as mean \pm standard deviation. Homogeneity of the data was tested using the Shapiro-Wilk test. The difference between the three moments was verified using the repeated measures ANOVA test. Spearman and Pearson correlations were also used. Significance was set to $p < 0.05$.

Results

The participants were 27.6 ± 2.42 years old. The data regarding how long they had practiced the sport, how often they participated in competitions in the last months, how often they trained and the kind of training they had are reported in Table I. The participants did not use weight loss strategies for competitions while tests were carried out, according to them. Nonetheless, three participants reported to have used diuretic medicines in past competitions to lose weight in the pre-competitive period. One participant told us that he had used an anabolic steroid (Deposteron) to maximize his performance 2 years ago.

Regarding the specificity of their training, it was reported that they had, on average, 132 ± 34.99 minutes of technical training, 42 ± 7.34 minutes of physical training in every weekly training session. We did not find any relevant changes in the following parameters: body weight, BMI, lean body mass, fat body mass and total amount of water in the body (Table II).

The values obtained using the Brums scale did not indicate any changes in fatigue (Figure 1A), neither in mental confusion (Figure 1C), nor in depression (Figure 1F) in none of the 3 evaluations conducted in the pre-competitive and post-competitive periods. However, we found some decrease in tension (Figure 1B) (14 days before: 6.60 ± 0.81 ; 1 day before: 5.40 ± 0.75 ; 2 days after: 2.60 ± 0.87), vigor (Figure 1D) (14 days before: 12.80 ± 1.59 ; 1 day before: 10.00 ± 1.94 ; 2 days after: 10.40 ± 1.03) and anger (Figure 1E) (14 days before: 6.80 ± 1.69 ; 1 day before: 4.20 ± 0.66 ; 2 days after: 3.40 ± 1.08) values obtained in the test carried out post fight when compared to baseline.

No statistical difference was found in the values regarding the arterial pressure, neither the systolic or in the diastolic (Table III). Results showed an increase in cardiac sympathetic modulation (LF-PI band) (14 days before: 2942 ± 655.3 ; 1 day before: 5479 ± 2035 ; 2 days after: 5334 ± 2418 ms²) evaluation before the competition and in post-competitive period when compared to baseline evaluations, suggesting an increase in the possibility of high-risk cardiovascular disorder in the athletes (Figure 2A). We did not find any changes in the parasympathetic modulation (HF-PI band) (Figure 2B), neither in the sympatho-vagal modulation (LF/HF) (Figure 2C).

No significant correlation was observed between all parameters of mood states and sympatho-vagal modulation (LF/HF). States of tension ($r = 0.11$ $p = 0.71$), anger ($r = -0.44$ $p = 0.14$), fatigue ($r = 0.53$ $p = 0.19$), vigor ($r = -0.21$ $p = 0.47$), depression ($r = 0.42$ $p = 0.15$), confusion ($r = 0.07$, $p = 0.82$) and sympatho-vagal modulation. Moreover, correlation analyzes were performed between mood states and cardiac sympathetic modulation (LF-PI band). No significant correlation was observed between mood states tension ($r = -0.40$ $p = 0.17$), anger ($r = 0.29$ $p = 0.33$), and fatigue ($r = -0.02$ $p = 0.93$) and sympathetic modulation. However, a positive correlation was observed between vigor and sympathetic modulation ($r = 0.55$ $p < 0.05$) (Figure 3A), negative correlations between depression and sympathetic modulation ($r = -0.68$ $p < 0.05$) (Figure 3B) and between confusion and sympathetic modulation ($r = -0.67$ $p < 0.05$) (Figure 3C).

Table I - Characteristics of the athletes who participated in this study

Parâmetros	Características
How long they have practiced (years)	7 ± 2
How often they train (in days)	5.8 ± 0.3
How long they train (in hours/per day)	2.8 ± 0.4
How many competitions they had been in	8.2 ± 3.0

The data are presented with mean \pm standard deviation

Table II - Distribution and body composition of the athletes

Parameters	14 days before	1 day before	2 days after	F	P
Weight (kg)	76.24 ± 4.16	76.72 ± 4.59	76.80 ± 4.77	0.1695	0.847
BMI	24.8 ± 1.20	25.12 ± 1.15	24.84 ± 1.13	0.5191	0.6138
Fat mass (kg)	7.14 ± 1.88	7.94 ± 1.78	7.12 ± 1.74	0.5398	0.6027
Fat mass (%)	7.70 ± 1.97	9.32 ± 2.35	7.72 ± 1.60	0.6952	0.5351
Lean mass (kg)	62.88 ± 7.15	62.36 ± 6.46	63.46 ± 6.63	0.2763	0.7655
Lean mass (%)	92.30 ± 1.97	90.68 ± 2.35	92.28 ± 1.60	0.5398	0.6027
Water in the body (total)	54.23 ± 5.97	50.90 ± 4.34	52.43 ± 3.91	0.6423	0.5588

kg = kilograms. The data are presented with mean ± standard deviation

Table III - Parameters related to the arterial pressure

Parameters	14 days before	1 day before	2 days after	F	P
SBP	123.8 ± 7.77	122.8 ± 8.78	130.6 ± 11.24	0.2555	0.781
DBP	81.2 ± 7.66	65.6 ± 4.16	68 ± 4.27	1.792	0.228

SBP = Systolic blood pressure; DBP = diastolic blood pressure. The data are presented with mean ± standard deviation

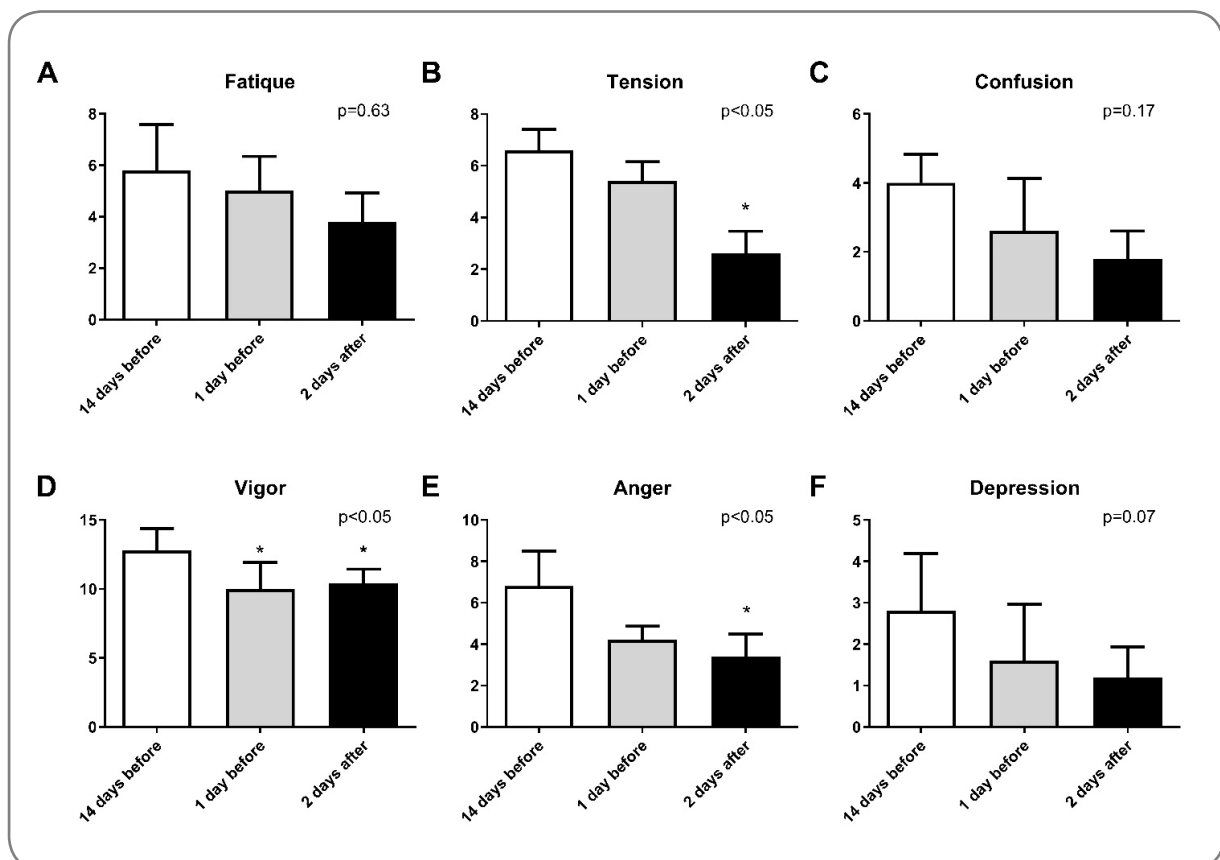


Figure 1 - The affect conditions according to the Brums Mood Scale 14 days before the fight, one day before the fight and two days after the fight. (A) Fatigue, (B) Tension, (C) Confusion, (D) Vigor, (E) Anger, (F) Depression. * $p < 0.05$ vs. 14 days before the fight. Repeated measures ANOVA test

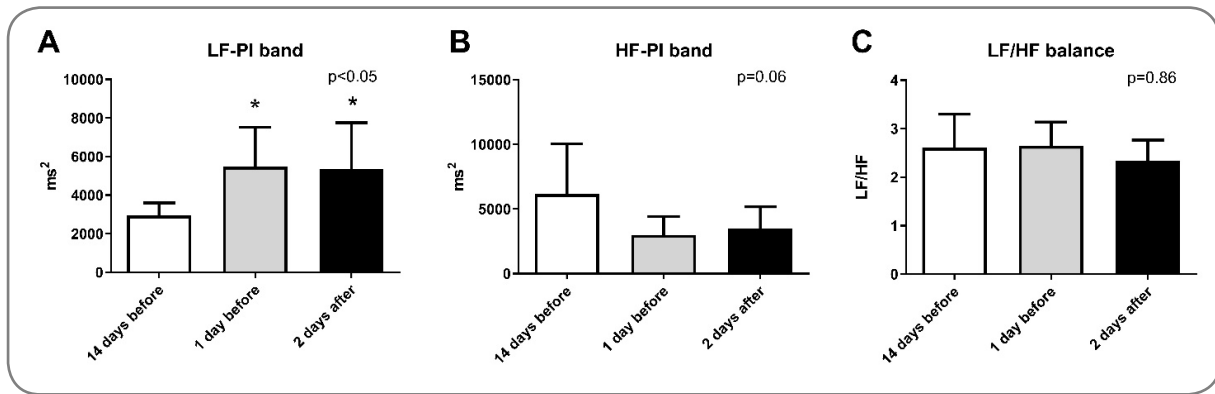


Figure 2 - Cardiac autonomic modulation 14 days before the fight, one day before the fight and two days after the fight. (A) Low-frequency band of the R.R. intervals (B) High-Frequency Ban of the R.R. Intervals. (C) Sympatho-vagal balance. * $p < 0.05$ vs. 14 days before the fight. Repeated measures ANOVA test

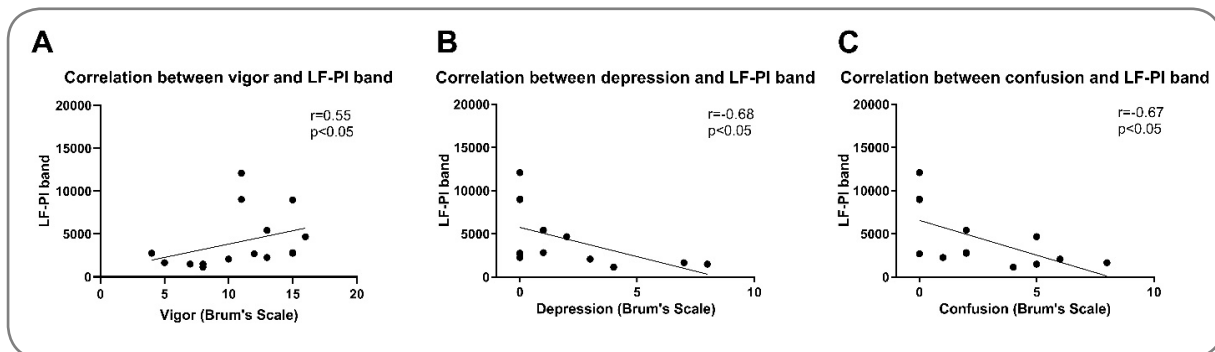


Figure 3 - Correlation between (A) Vigor and low-frequency of pulse interval band, (B) Depression and the low-frequency of pulse interval band and (C) Mental confusion and low-frequency of pulse interval band. Spearman correlation test

Discussion

This study presented previously unpublished results on the changes in the mood state and the cardiac autonomic modulation of jiu-jitsu fighters in the pre-competitive and post-competitive period. Despite the small sample can be a limiting factor of this study, the athletes are experienced, considering the many years they had been practicing and the number of competitions they had participated.

Usually, the mood condition is related to the “optimism” construct, which can influence athlete’s self-confidence during competitions and lead to a better performance and better outcomes [8,14,15]. The fighters have a higher percentile regarding vigor when compared to other states in the three evaluated moments in the pre-competitive period, which was also found regarding other sports [8]. This condition, in which the values related to vigor are higher and the values related to the other feelings (fatigue, mental confusion, depression, anger and tension) are lower is known as “Iceberg Profile” and shows a positive mental condition of the athletes [16].

Nonetheless, the decrease in vigor as the competition day (1 day before the fight vs. 14 days before the fight) approaches is worrisome, since this should be when the athletes are at the peak of the technical, physical, and psychological preparation, compared to all the previous moments. This demonstrates that some aspects of their

training should be reviewed. Regarding the reduction in the feelings of tension and anger in the post-competitive period (2 days after the fight vs. 14 days before the fight), that is exactly what we expected, once the training period and competitive period was over in that moment.

No change was found in feelings of fatigue, depression, and mental confusion. The stability of the percentiles related to the feeling of fatigue is an important predictor of the athlete's performance during the competition, according to a study that analyzed the performance of two-year training of judo fighters for the 1992 Olympic Games [7].

A relevant aspect of those athletes physical training is the amount of time devoted to technical training, rather than to physical training. That fact indicates that, in general, fighters use the biological principle related to the specific characteristics of the sport (principle of specificity), by which their body is provided with specific stimuli that are useful to the practice of the sport. This promotes a better adaptation to the demands of the body during competitions, especially in the muscular system, motor system, and body joints [17]. Another study published shows similar results to those found in our study with fighters of different combat sports [5].

The fighters reported not to use any strategy to lose weight quickly in the pre-competitive period. However, 37.5% of them reported they had done it in the past. It is important to point out that a quick weight loss process harms the body in many ways, such as causing hormonal imbalance, electrolytic disturbance, mood disorders, disorders in the cardiovascular system and a decrease in physical strength [3]. The results regarding the body composition of the athletes have confirmed that there were no changes in the parameters related to that neither in the pre-competitive nor in the post-competitive period.

Jiu-jitsu is considered a good physical conditioning strategy for healthy individuals regarding the cardiovascular system, since its recovery period after exercises promotes blood pressure and heart rate decrease [18]. Indeed, the systolic and diastolic blood pressure values are maintained in the present study, regardless of the stress generated by the pre-competitive preparation process. However, there was an increase of 16 mmHg in diastolic arterial pressure (14 days before of fight vs. 1 day before of fight) and increase of 8 mmHg in systolic arterial pressure (1 day before of fight vs. 2 days after of fight), that are clinically relevant. It might be explained by fluctuations in the autonomous control that regulates hemodynamic parameters [19].

The cardiac autonomic modulation is an important and non-invasive analysis that provides indicators for sympathetic and parasympathetic autonomic modulation. These two complex systems are essential to keep the organic balance [19]. Reflexive responses of the sympathetic and the parasympathetic systems allow adjustments of cardiac output and vascular peripheral resistance, contributing to the stabilization and maintenance of systemic blood pressure during different physiological situations [20]. The high values of cardiac sympathetic pre-combat evaluation (1 day before of fight vs. 2 days after of fight), and the remaining high values in

the post-combat analysis can be considered worrisome. Considering previous studies that demonstrated that a higher of cardiac sympathetic modulation is a strong indicator of increased risk of cardiovascular diseases, since it presents less capacity for adaptation in stressful situations in different populations [20,21].

We found interesting that the values regarding mental confusion and depression remained stable, regardless of whether the test was conducted in the pre-competitive or in the post-competitive period. However, they are negatively related to cardiac sympathetic modulation. The correlation between the feeling of vigor and the cardiac autonomic modulation during a competition is described in a study with Paralympic athletes during a competition. In that study, the authors found a positive correlation between the indicators of cardiac parasympathetic modulation and vigor [8].

Nonetheless, we found a positive correlation between vigor and the cardiac sympathetic modulation. An important fact to point out is that the cardiac autonomic modulation is controlled by both the sympathetic and parasympathetic functions in an integrated way, because of that, we can consider that the capacity of vigor to affect the sympathetic autonomic function is natural. Another important factor is the changes in values of cardiac sympathetic modulation and vigor from the second test (one day before the fight) and from the third test (two days after the fight) which are similar.

Conclusion

The main results of this study demonstrate remarkable changes in the mood state and in the cardiac autonomic modulation in jiu-jitsu fighters in the pre-competitive and post-competitive periods. These findings highlight the need to review some aspects of the training strategies of the athletes before competitions, because the decrease found in vigor may interfere with their performance and induce imbalances on cardiac autonomic modulation.

Potential conflict of interest

No potential conflicts of interest relevant to this article have been reported.

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Author contributions

Conception and design of study: Nascimento-Carvalho B, Sanches IC, Izaias JE; **Acquisition, analysis and/or interpretation of data:** Nascimento-Carvalho B, Sanches IC, Izaias JE, de Jesus NR, Nascimento TLB; **Drafting the manuscript:** Nascimento-Carvalho B, Sanches IC, Izaias JE; **Revising the manuscript critically for important intellectual content:** Nascimento-Carvalho B, Sanches IC, Ruaro MR, Scapini KB.

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