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original article

Hematological and biochemical markers after a Brazilian Jiu-Jitsu tournament in world-class athletes

Marcadores hematológicos e bioquímicos após um torneio de Jiu-Jitsu Brasileiro em atletas de elite

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Abstract – *The objectives of this study were to assess the effect of participation in a Brazilian Jiu-Jitsu (BJJ) competition on biochemical and hematological markers, and to determine whether the skill level of the athletes influenced these responses. Thirty BJJ fighters were divided into two groups: an elite group (EL) including 20 subjects classified as 1st to 3rd place in the previous World Championship, and a non-elite group (NEL) including 10 BJJ athletes not participating in competitions. A BJJ tournament was simulated using the same rules as those of the World Championship. Each athlete performed five fights of up to 10 minutes each, with 5-minute resting intervals between fights. The fighting order was random and fights confronted athletes of the same group. Pre- and post-competition blood samples were collected to assess biochemical and hematological markers. Participation in the competition induced significant increases in the following variables in athletes of the two groups: glucose, uric acid, urea, creatinine, total protein, albumin, creatine kinase, leukocytes, neutrophils, rods, and monocytes. There was a significant increase in platelet count only in the NEL group. Total protein and mean platelet volume were higher in athletes of the EL group, whereas eosinophil and monocyte numbers were higher in the NEL group. A significant time x group interaction was only observed for serum creatinine, with higher mean values in the EL group pre- and post-competition.*

Key words: *Athletes; Biological markers; Hematology.*

Resumo – Os objetivos deste estudo foram avaliar o efeito de um esforço de competição de Jiu-Jitsu Brasileiro (JJB) sobre marcadores bioquímicos e hematológicos, e investigar se esse efeito diferia em função do nível de prestação. Foram estudados 30 lutadores, divididos em: grupo de Elite ou EL (n= 20), composto por atletas com colocações entre 1º e 3º lugar no Campeonato Mundial de JJB Brasileiro; e grupo Não Elite ou NEL (n= 10), composto por praticantes não competidores. Simulou-se um campeonato de JJB com as mesmas regras do Campeonato do Mundo. Cada atleta realizou cinco lutas de até 10 minutos cada e com um intervalo de cinco minutos entre as mesmas. A ordem e a composição das lutas foram realizadas através de sorteio e entre atletas do mesmo grupo. Antes e após a competição, foram feitas recolhas de sangue para obtenção dos marcadores bioquímicos e hematológicos. A competição de JJB induziu aumentos significativos nos atletas de ambos os grupos nas seguintes variáveis: glicose, ácido úrico, ureia, creatinina, proteínas totais, albumina, creatinaquinase, leucócitos, neutrófilos, bastões e monócitos. No plaquetócrito, houve aumento significativo apenas no grupo NEL. As proteínas totais e o volume plaquetário médio apresentaram valores mais elevados nos atletas EL; enquanto os eosinófilos e monócitos foram mais elevados nos atletas NEL. Apenas na creatinina sérica se verificou um efeito significativo na interação momento x grupo, verificando-se valores mais elevados no grupo EL, tanto no pré como no pós-competição.

Palavras-chave: Atletas; Hematologia; Marcadores biológicos.

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INTRODUCTION

In Brazilian Jiu-Jitsu (BJJ), training mainly consists of direct physical contact with an opponent and involves movements of pushing, immobilizing, pulling, overthrow, pressing, turning, and throttle, among others[1,2]. These movements are similar to those used in Judo. BJJ fights are generally characterized as acyclic since the athletes make use of different sequences of movements and expressions of physical skills[1]. The maximum time of each bout is 10 minutes.

Some physiological markers, although measured in an invasive manner, are the most accurate parameters to investigate the acute and chronic effects of exercise[3]. In this respect, hematological and biochemical markers have been addressed in the literature. The chronic adaptation of red blood cell-related measures to exercise has been studied[4-6], and the acute response of white blood cell-related measures as markers of immune function has also been addressed[7,8]. In addition, some metabolites that are released into the bloodstream in response to stress induced by exercise, such as creatinine[9] and proteins[10], are also evaluated.

However, few studies have investigated the physiological responses in fight sports, including mixed martial arts[11], taekwondo[12,13] and, to a lesser extent, BJJ[14,15]. To the best of our knowledge, only one study evaluated biochemical changes induced by a BJJ competition; however, only salivary cortisol and immunoglobulin were analyzed[15]. Therefore, the objectives of the present study were to assess the effect of participation in a competitive BJJ competition on biochemical and hematological markers, and to determine whether the skill level of the athletes influenced these responses.

METHODOLOGICAL PROCEDURES

Participants

Thirty male black-belted BJJ athletes were divided into two groups. The first group consisted of 20 subjects ranked first to third in the 2010 World Championship (elite group - EL), and the second group consisted of 10 BJJ athletes who did not participate in the World Championship (non-elite group - NEL). The subjects were 18 to 30 years old and had a minimum of 10 years of experience in BJJ. The mean height, body weight and relative fat mass were 1.75 ± 0.60 m, 81.59 ± 5.42 kg and 7.09 ± 5.44%, respectively, in the EL group, and 1.74 ± 0.29 m, 83.27 ± 3.84 kg and 7.82 ± 2.47% in the NEL group. These parameters did not differ significantly ($p > 0.05$) between groups. The subjects were submitted to medical examination to rule out injuries and medical conditions that are contraindications to participation in a competition, and were approved to participate in the experiment. Subjects were asked to refrain from taking any dietary supplement and drugs (e.g., anabolic steroids) for at least one month prior to the experiment.

This study was in accordance with the guidelines of research on humans (Resolution 196/96 of the Brazilian National Health Council). All participants agreed to participate in the study by signing the free informed consent form and the procedures were approved by the Institutional Ethics Committee.

Procedures

Each subject was asked to attend the place of the experiment after a 12-hour fast. All subjects had rested for at least 20 minutes before the first venous blood collection. After blood collection, the athletes received a standard light meal. The tournament was started one hour after the meal. A BJJ tournament was simulated using the same rules as those of the World Championship. Each athlete performed five fights of up to 10 minutes each, with 5-minute resting intervals between fights. The fighting order was random and fights confronted athletes of the same group (EL or NEL). In addition, the athletes fought solely with opponents of the same weight class. Hence, the subjects were allocated to one of the two following body weight classes: 65 to 80 kg and 80 to 93 kg. After the last fight, the athletes rested 30 minutes before the post-competition venous blood collection. The pre- and post-competition blood samples were collected to evaluate biochemical and hematological markers used as dependent variables in the present study.

A certified health professional collected the blood samples from the median cubital vein. No tourniquet was applied in order to minimize possible stress and oxidative damage induced by the ischemia-reperfusion maneuver[16]. The same professional was also responsible for appropriate storage and transport of the blood samples to a certified laboratory where the analyses were carried out. The hematological markers included leukocytes, rods, segments, neutrophils, eosinophils, monocytes, lymphocytes, erythrocytes, hemoglobin, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin concentration, platelets, and platelet count. The biochemical markers measured were creatine kinase (CK), glucose, creatinine, urea, ammonia, total protein, albumin, globulin, and uric acid.

Statistical analysis

The normal distribution of the data was confirmed by the Shapiro-Wilk test and sphericity was evaluated by the Mauchly test. The results are reported as means and standard deviations. Two-factor repeated measures analysis of variance (ANOVA), with post-hoc Bonferroni test, was performed to compare pre- vs. post-competition values and values between the two groups. Partial eta-squared (η_p^2) values were used as a measure of effect size according to the following rule of thumb: small (> 0.01), medium (> 0.06), and large (> 0.14). A level of significance of 5% ($p \leq 0.05$) was adopted. Data were analyzed using the Statistical Package for the Social Sciences for Windows® (SPSS 17.0, Science, USA).

RESULTS

The average time per combat was 8.25 ± 2.42 min and 7.71 ± 3.39 min in the EL and NEL groups, respectively. Tables 1 and 2 show the parameters measured.

A significant group effect was only found for four parameters: total protein ($F = 4.358$; $p = 0.046$; $\eta_p^2 = 0.14$), eosinophils ($F = 6.617$; $p = 0.016$; $\eta_p^2 = 0.19$), monocytes ($F = 4.394$; $p = 0.045$; $\eta_p^2 = 0.14$), and mean platelet

volume ($F = 5.623$; $p = 0.025$; $\eta_p^2 = 0.17$). With respect to the time effect, a significant difference ($p < 0.05$) was observed for eight biochemical markers (glucose: $\eta_p^2 = 0.57$; uric acid: $\eta_p^2 = 0.72$; urea: $\eta_p^2 = 0.25$; creatinine: $\eta_p^2 = 0.63$; total proteins: $\eta_p^2 = 0.50$; albumin: $\eta_p^2 = 0.60$, and CK: $\eta_p^2 = 0.51$) and seven hematological markers (leukocytes: $\eta_p^2 = 0.41$; neutrophils: $\eta_p^2 = 0.38$; rods: $\eta_p^2 = 0.30$; segments: $\eta_p^2 = 0.48$; monocytes: $\eta_p^2 = 0.18$; platelets: $\eta_p^2 = 0.49$, and hematocrit: $\eta_p^2 = 0.14$). A significant group x time interaction was only observed for creatinine ($F = 4.872$; $p = 0.036$; $\eta_p^2 = 0.15$).

Table 1. Mean and standard deviation of biochemical markers in the elite and non-elite groups pre- and post-competition.

	Elite		Non-elite	
	Pre	Post	Pre	Post
Glucose (mg/dl)	75.0 ± 4.7	113.0 ± 28.1	75.9 ± 6.3	100.7 ± 16.4
Uric acid (mg/dl)	4.9 ± 0.8	7.3 ± 1.2	5.1 ± 1.2	6.6 ± 1.4
Urea (mg/dl)	32.2 ± 6.5	36.7 ± 6.4	33.5 ± 7.5	37.0 ± 7.2
Creatinine (mg/dl)	0.9 ± 0.1	1.2 ± 0.1	0.8 ± 0.1	1.0 ± 0.2
Total protein (g/dl)	8.1 ± 0.8	8.9 ± 0.5	7.8 ± 0.6	8.2 ± 0.5
Albumin (g/dl)	4.9 ± 0.2	5.5 ± 0.4	4.9 ± 0.2	5.3 ± 0.3
Globulin (g/dl)	3.2 ± 0.7	3.4 ± 0.6	2.9 ± 0.5	3.0 ± 0.7
A/G ratio (%)	1.6 ± 0.6	1.6 ± 0.4	1.7 ± 0.3	1.9 ± 0.5
Creatine kinase (IU/l)	231.8 ± 157.3	352.6 ± 199.7	316.9 ± 261.9	424.1 ± 344.0

A/G: albumin/globulin ratio.

Table 2. Mean and standard deviation of hematological markers in the elite and non-elite groups pre- and post-competition.

	Elite		Non-elite	
	Pre	Post	Pre	Post
RBC (ml)	5.2 ± 0.3	5.4 ± 0.4	5.2 ± 0.3	5.3 ± 0.3
Hemoglobin (g/dl)	14.5 ± 1.0	15.2 ± 1.2	14.6 ± 0.9	14.8 ± 0.9
Hematocrit (%)	46.4 ± 2.9	48.6 ± 4.1	46.8 ± 3.1	47.3 ± 3.0
MCV (μ^3)	89.5 ± 0.5	89.5 ± 0.6	89.6 ± 0.5	89.4 ± 0.5
MCG (%)	31.0 ± 0.2	31.0 ± 0.2	31.0 ± 0.0	31.0 ± 0.0
RDW	13.7 ± 0.9	13.7 ± 0.9	13.9 ± 1.0	13.6 ± 0.5
Leukocytes (ml)	6,355.0 ± 1,272.6	8,730.0 ± 2,251.6	7,430.0 ± 1,662.7	8,930.0 ± 2,265.2
Neutrophils (mm^3)	3,269.3 ± 831.3	4,902.7 ± 2,342.4	4,299.4 ± 1,495.4	5,661.5 ± 2,013.0
Rods (mm^3)	101.5 ± 45.1	234.4 ± 168	185.6 ± 120.5	275.8 ± 187.5
Segments (mm^3)	3,167.2 ± 799.6	5,573.1 ± 2,263.2	4,113.8 ± 1,381.4	5,383.8 ± 1,875.5
Eosinophils (mm^3)	157.7 ± 63.9	158.3 ± 76.2	224.2 ± 107	216.1 ± 47.3
Lymphocytes (mm^3)	2,740.3 ± 565.2	2,533.1 ± 591.7	2,695.1 ± 519.4	2,751.4 ± 1,247.0
Monocytes (mm^3)	191.5 ± 78.9	233.2 ± 85.1	207.6 ± 75.5	300.6 ± 117.2
Platelet count (mm^3)	288.6 ± 56.5	335.7 ± 66.1	262.9 ± 41.5	327.0 ± 65.4
MPV (fl)	9.6 ± 1.5	9.9 ± 1.3	8.8 ± 0.8	8.1 ± 3.0
PDW (%)	17.6 ± 1.1	18.0 ± 1.2	17.1 ± 0.6	15.5 ± 5.5

RBC: red blood cells; MCV: mean corpuscular volume; RDW: red cell distribution width; MCG: mean corpuscular hemoglobin; MPV: mean platelet volume; PDW: platelet distribution width.

DISCUSSION

The objectives of the present study were to evaluate the effect of participation in a BJJ competition on biochemical and hematological markers, and to investigate whether the skill level of the athletes influenced these responses. It was shown that a BJJ competition induces significant changes in most of the biochemical markers studied. Changes were also observed in the hematological markers, especially white blood cell-related variables. Overall, only four measures differed between groups and only one biochemical marker (blood creatinine) was sensitive to the time x group interaction.

Studies have shown changes in red blood cells as a chronic adaptation to training in cyclists[5]. These changes have been attributed to factors such as hemodilution, a disproportion between hematopoiesis and intravascular hemolysis, and body iron deficiency/reduction[5,17]. In the present study, no changes in red blood cell-related variables were observed in the EL group. This finding is expected since these variables are typically sensitive to pathological states such as edema or overtraining and as a factor of disease control[18], but are not necessarily an indicator of the acute response to physical exercise. The only change observed post-competition was an increase in hematocrit, possibly as a result of the hemodilution phenomenon. This finding agrees with Nagel et al.[19] who observed a decrease of hematocrit in runners after long distance events. Contrarily, Shinkai et al.[4] and Rodrigues[6] did not detect changes in hematocrit in long-distance runners after a competition. Conflicting results regarding hemoglobin concentration in athletes have been reported in the literature, with the results ranging from unchanged[20] and increased[4] to reduced post-effort levels[19]. Taken together, the present results suggest that a BJJ competition is less likely to severely affect red blood cell counts and related measures. In fact, despite the full-contact nature of the sport, the movements in BJJ are not heavily traumatic as observed in boxing, a fact that may explain the lack of changes in red blood cell parameters.

With respect to white blood cell count, significant changes were observed after the competition. Inflammation is a protective process that involves blood cells and tissue proteins in response to injury, infection, trauma, or immune response[17]. Therefore, the increased leukocyte response observed in the two groups can be viewed as normal. Eosinophils were increased in the EL group and reduced in the NEL group. According to Costa Rosa and Vaisberg[21], a decrease in these cells of 30% to 50% below baseline levels may occur after vigorous exercise. The inflammatory process is directly related to the fight intensity and fighting may therefore increase the total number of eosinophils[22]. This fact would help explain the different results between the two groups of athletes. Based on the observations of Costa Rosa and Vaisberg[21] and El-Sayede et al.[23], it can be suggested that the leukocytosis seen during a fighting exercise such as BJJ is directly related to the release of neutrophils from peripheral tissues into the bloodstream. The present data corroborate these results as the BJJ competition induced

increases in monocytes, rods, and segments. In contrast to the present findings, Lee et al.[13] observed an increased lymphocyte response after taekwondo competitions.

The high magnitude of the leukocyte increase observed in the two groups (> 8000 post-competition) indicates that BJJ is a high-stress sport activity. In this respect, Nehlsen-Cannarella et al.[10] showed that high-intensity exercise is associated with a biphasic change in circulating leukocytes. In line with the results of the present study, Bachur et al.[8] found a two- to three-fold increase in leukocyte counts above normal values in mice submitted to physical exercise. The return to baseline levels takes about 24 hours after completion of physical exercise[7]. Unfortunately, in the present study it was not possible to follow the athletes after return to their daily workout/life routines. Hence, we are unable to confirm these assumptions.

Among the biochemical parameters analyzed, only total protein was sensitive to the group effect. However, most parameters vary with the competitive exertion (glucose, uric acid, urea, creatinine, total protein, albumin, CK). Creatinine was the only measure sensitive to the group x time interaction, which increased significantly post-exercise. This effect was probably related to the high demand for creatine phosphate resynthesis and AMP formation during exercise. An alternative explanation is the occurrence of hypovolemia, which decreases the glomerular filtration rate[24]. The high levels of CK in the two groups may reflect an invasion of the total protein in the bloodstream to be transported to various sites of muscle injury.In fact, a significant increase in total protein was observed in the present study, in agreement with the findings of Crespilho et al.[9]. Overall, the levels of CK, proteins, globulin and uric acid found in this study suggest the presence of mechanical stress due to muscle damage resulting from several successive contractions. An increase in urea and uric acid was observed post-competition, probably as a result of amino acid catabolism[25]. The albumin, urea and glucose results can be explained in part by the 12-hour fast of the athletes. Prolonged fasting can increase endogenous proteolysis to use amino acids as an energy source, causing an increase in urea concentration and changing rates of albumin and glucose[26]. However, the response may also be related to the high-intensity exercise and subsequent catabolic action of cortisol[25]. In the present study, no change in globulin or in the globulin-to-albumin ratio was observed in the EL group. In contrast, in one of the few studies involving BJJ athletes, Moreira et al.[15] showed that a sequence of two fights increases salivary immunoglobulin and cortisol.

CONCLUSIONS

This was the first study analyzing the acute response of a series of biochemical and hematological parameters to a complete BJJ tournament performed by elite and non-elite athletes. The results indicate that a tournament is able to promote significant changes in immune function (demonstrated

by white cell counts) without significant changes in red blood cell-related measures. In addition, several biochemical markers usually related to the high stress induced by exercise, if not by the severe aggression to the muscle tissue itself, were also found to respond to the competitive effort. However, the comparisons between the two groups do not permit us to conclude that different skill levels truly affect the amount of acute physical stress imposed by the sport.

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