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PHYSIOLOGICAL RESPONSES AND RATE OF PERCEIVED EXERTION IN BRAZILIAN JIU-JITSU ATHLETES

Leonardo Vidal Andreato[1,2], Solange Marta Franzói de Moraes[1], João Victor Del Conti Esteves[1], Raphaela Regina de Araújo Pereira[3], Tricy Lopes de Moraes Gomes[1], Thaís Vidal Andreato[1] and Emerson Franchini[2]

[1]Exercise Physiology Laboratory, Human Physiology Department, State University of Maringá, Brazil
[2]Martial Arts and Combat Sports Research Group, Sport Department, School of Physical Education and Sport, University of São Paulo, Brazil
[3]Laboratory of Research and Development of Drug Liberations Systems, Pharmacy Department, State University of Maringá, Brazil

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Abstract:

In this study, the physiological responses and rate of perceived exertion in Brazilian jiu-jitsu fighters submitted to a combat simulation were investigated. Venous blood samples and heart rate were taken from twelve male Brazilian jiu-jitsu athletes (27.1±2.7 yrs, 75.4±8.8 kg, 174.9±4.4 cm, 9.2±2.4% fat), at rest, after a warm-up (ten minutes), immediately after the fight simulation (seven minutes) and after recovery (fourteen minutes). After the combat the rate of perceived exertion was collected. The combat of the Brazilian jiu-jitsu fighters did not change blood concentrations of glucose, triglycerides, total cholesterol, low density lipoprotein and very low density lipoprotein, ureia and ammonia. However, blood levels of high density lipoprotein were significantly higher post-fight (before: 43.0±6.9 mg/dL, after: 45.1±8.0 mg/dL) and stayed at high levels during the recovery period (43.6±8.1 mg/dL) compared to the rest values (40.0±6.6 mg/dL). The fight did not cause changes in the concentrations of the cell damage markers of creatine kinase, aspartate aminotransferase and creatinine. However, blood concentrations of the alanine aminotransferase (before: 16.1±7.1 U/L, after: 18.6±7.1 U/L) and lactate dehydrogenase (before: 491.5±177.6 U/L, after: 542.6±141.4 U/L) enzymes were elevated after the fight. Heart rate (before: 122±25 bpm, after: 165±17 bpm) and lactate (before: 2.5±1.2 mmol/L, after: 11.9±5.8 mmol/L) increased significantly with the completion of combat. Despite this, the athletes rated the fight as being light or somewhat hard (12±2). These results showed that muscle glycogen is not the only substrate used in Brazilian jiu-jitsu fights, since there are indications of activation of the glycolytic, lipolytic and proteolytic pathways. Furthermore, the athletes rated the combats as being light or somewhat hard although muscle damage markers were generated.

Key words: *energy demands, combat sport, recovery, metabolic profile*

Introduction

Knowledge of the physiological demands in sports is important to improve procedures for both training prescription and organization (Bouhlel, et al., 2006; Degoutte, Jouanel, & Filaire, 2003). Brazilian jiu-jitsu is a sport that has gained much popularity throughout the world. However, there have been only a few studies on the physiological aspects of this sport (Andreato, et al., 2012; Moreira, et al., 2012; Vidal-Andreato, et al., 2011; Franchini, Bezerra, Oliveira, Souza, & Oliveira, 2005a; Franchini, Takito, & Pereira, 2003). Because of the duration and temporality of the fights and the moderate blood lactate concentrations (LAC) (10.2±1.5 mmol/L) observed in fighters post-fight (Del Vecchio, Bianchi, Hirata, & Chacon-Mikahili, 2007), Brazilian jiu-jitsu can be considered a predominantly aerobic sport, as the black belt combats last ten minutes, with a moderate activation of the glycolytic system.

However, this fact is debatable because there have not been adequate studies conducted on all of the energy systems involved in the physiology of those engaged in this sport. Thus, the physiological variables for study should be those that are relevant to the sport (Franchini, Matsushigue, Vecchio, & Artioli, 2011), and indirect markers of stress should be measured, such as LAC, heart rate (HR) and rate of perceived exertion (RPE).

In fact, in combat sports, the measurement of physiological responses for gas analysis during the combat itself has been performed only in sports that involve percussive actions such as karate (Beneke, Beyer, Jachner, Erasmus, & Hutler, 2004), kickboxing (Crisafulli, et al., 2009) and taekwondo (Campos, Bertuzzi, Dourado, Santos, & Franchini, 2012).

In contrast, in combat sports such as judo and wrestling, where grappling actions are important, measures for indirect markers have been taken after a fight, or at specific times of combat (Barbas, et al., 2011; Degoutte, et al., 2003; Franchini, Bertuzzi, Takito, & Kiss, 2009; Kraemer, et al., 2001). In an investigation by Degoutte et al. (2003), for instance, the researchers obtained blood samples in judo combats simulations to determine the energy demands during a judo match, and concluded that judo combats resulted in glycolytic pathway activation, but also induced both the protein and lipid metabolism.

Because there are not many studies on Brazilian jiu-jitsu (Andreato, et al., 2012; Vidal-Andreato, et al., 2011), it is common to use other combat sports as a reference, such as wrestling and judo. Nevertheless, despite some technique similarities, there are also just as important differences between Brazilian jiu-jitsu and other grappling combat sports. For example, when time-motion is considered, Brazilian jiu-jitsu (170 seconds of activity – groundwork: 146±119 seconds, standing combat: 25±17 seconds – followed by 13±6 seconds intervals; Del Vecchio et al., 2007) has more longer combat phases than judo (30±33 seconds of activity separated by 11±10 seconds long intervals; Miarka et al., 2012) and wrestling (37±10 seconds of activity separated by 14±6 seconds long intervals; Nilsson, Csergö, Gullstrand, Tveit, & Refsnes, 2002). This fact can promote distinct physiological responses that should be investigated.

Thus, it is necessary to conduct specific studies involving Brazilian jiu-jitsu and it is essential to evaluate the energy demands, the changes in cardiovascular markers, and the rate of perceived exertion, which can be useful to improve training quality. Another relevant aspect to be studied is the cellular stress generated from the use of energy substrates and metabolites and the damage generated by mechanical stress developed especially during eccentric actions performed to control the opponent. Muscle injury can be assessed by measuring serum levels of the muscle injury markers originating from the sarcolemma. Among the biochemical markers used to identify muscle cell damage, creatine kinase (CK) is the most commonly used (Clarkson, Nosaka, & Braun, 1992; Armstrong, 1990), but other biomarkers such as aspartate aminotransferase (AST), alanine aminotransferase (ALT), creatinine, LAC and lactate dehydrogenase (LDH) can also provide relevant data about cell damage (Bessa, et al., 2008).

Thus, the objective of this study was to determine the rate of perceived exertion and physiological responses to and during the recovery from Brazilian jiu-jitsu, by assessing the pathways markers of the breakdown of various energy substrates (glucose, proteins and lipids), its cardiovascular stress and to determine whether a Brazilian jiu-jitsu simulation bout induced significant muscle damage, primarily via mechanical stress.

Methods

Sample

The study included twelve Brazilian jiu-jitsu fighters (age 27.1±2.7 yrs, body weight 75.4±8.8 kg, body height 174.9±4.4 cm, 9.2±2.4% fat), all competitors (three regional-level, nine national- and/or international-level competitors), with the highest attained class ranging from blue belt to black belt and with 5.5±3.1 years of training experience. As a criterion for inclusion in the study, athletes should have practised the sport for at least two years and should have been training for at least two months without interruption, with a minimum frequency of three times per week. In fact, the athletes did Brazilian jiu-jitsu four to six times per week.

All subjects were informed about the study procedures, and all signed consent forms. This study was approved by the local ethics committee. The data were collected at their place of training, during the preparatory period before the competitive fights.

Anthropometry

The athletes had their body mass measured with a Fillizola® scale that had a precision of 0.1 kg, and their body height was determined with a Seca® stadiometer that had a precision of 0.1 cm. The determination of the thickness of skinfolds (chest, midaxillary, triceps, subcapular, abdominal, suprailiac and medial thigh) was performed in triplicate, and the average value was used, according to the standardization method of Lohman, Roche, and Martorell (1988). For this, we used the Harpenden plicometer (John Bull British Indicators®, England) at a constant pressure of 10 g/mm; the plicometer had a precision of 0.2 mm. From the skinfold thickness the body density was determined by using the equation of Jackson and Pollock (1978), and body composition was estimated by using the equation of Siri (1961).

Measurements were performed by a single evaluator who had experience in conducting measurements. The technical error in the measurement of the skinfold thickness was less than one millimeter, and the coefficient of variation was below 3% for all the measurements used in this study.

Experimental design

The data collection was divided into four stages: at rest (ten minutes seated calmly), after ten minutes of warm-up, immediately after the combat and after recovery. Athletes were instructed to perform their usual warm-up routine, and this included stretching, running, push-ups, jumping and specific movements of Brazilian jiu-jitsu.

The duration of the combat simulation was fixed at seven minutes, which is a time of combat that is considered to be of an intermediate level. The simulation did not involve interruptions in the event of submission, which would normally result in the end of a combat. Additionally, there were no referee interruptions during the simulations. This was adopted for all practitioners who were subjected to the same exercise time. The athletes were divided by body mass, so that the athletes fought others with similar weight category. The fighting was conducted among athletes of the same performance level to minimize the technical differences in fighting. For the time of recovery 14 minutes was used because in competitive Brazilian jiu-jitsu combat sets the minimum time between fights is twice the maximum time of the combat.

Heart rate and perceived exertion

Heart rate was measured with a device from Polar®. At the end of the fight, a questionnaire with a scale of perceived exertion from six to twenty points was administered (Borg, 1982).

Blood samples and biochemical analysis

Blood samples (5 mL) were collected from the antecubital veins of the subjects at rest, then after ten minutes of warm-up, immediately after the combat and after recovery, and 25 µL of these samples were immediately dispensed in Eppendorf tubes containing 50 µL of sodium fluoride and 1% for lactate for the lactimeter (Yellow Springs YSI® 1500, OHIO, USA). The blood glucose level was measured with a portable glucometer (Optium Xceed® tapes) and MediSense® Optium analysis. The remaining blood was centrifuged at 3000 rpm for ten minutes and divided into serum and plasma.

The serum was stored in Eppendorf tubes and frozen at -12°C until the biochemical analysis. The levels of CK, AST, ALT and LDH were measured by the kinetic method. The determination of plasma concentrations of triglycerides, total cholesterol, low density lipoprotein (LDL), very low density lipoprotein (VLDL), high density lipoprotein (HDL), creatinine, ammonia and urea was conducted using the colorimetric method. Analyses were performed using a commercial kit (Analyzes Gold®) and a spectrophotometer (Bioplus® UV-2000).

Statistical analysis

The data were statistically analysed using Excel®, GraphPad®, and SPSS® softwares and are presented as means and standard deviations (SD). A comparison across the different time points was performed by conducting a one-way analysis of variance for repeated measures followed by Tukey's tests, using a 5% significance level.

Results

Table 1 shows the physiological responses of the athletes submitted to a Brazilian jiu-jitsu fight.

Table 1. Physiological responses in athletes to a seven minutes Brazilian jiu-jitsu fight (N=12). Data are presented as mean±standard deviation

Variables	At rest	After warm-up	Post-fight	After recovery
Heart rate (bpm)	80 ± 13	122 ± 25***	165 ± 17***††	107 ± 19**#
Glucose (mg/dL)	110.3 ± 18.4	107.1 ± 19.6	117.6 ± 19.1	120.7 ± 27.1
Triglycerides (mg/dL)	116.9 ± 43.3	113.6 ± 53.8	125.8 ± 60.2	108.4 ± 52.6
Total cholesterol (mg/dL)	195.0 ± 48.4	168.8 ± 24.9	198.3 ± 44.9	179.3 ± 30.8
HDL-cholesterol (mg/dL)	40.0 ± 6.6	43.0 ± 6.9	45.1 ± 8.0***	43.6 ± 8.1*
LDL-cholesterol (mg/dL)	131.6 ± 49.2	103.2 ± 26.9	128.1 ± 44.8	117.1 ± 26.1
VLDL-cholesterol (mg/dL)	23.4 ± 8.7	22.7 ± 10.8	25.2 ± 12.0	21.7 ± 10.5
Urea (mg/dL)	57.9 ± 9.4	51.5 ± 9.7*	53.6 ± 6.6	55.6 ± 9.2
Ammonia (mg/dL)	51.2 ± 9.4	44.9 ± 9.5**	46.8 ± 6.3	51.4 ± 7.6
Lactate (mmol/L)	1.3 ± 0.6	2.5 ± 1.2	11.9 ± 5.8***††	6.1 ± 3.1***†#
CK (U/L)	432.3 ± 447.4	522.0 ± 520.5	512.1 ± 504.0	480.5 ± 445.2
Creatinine (mg/dL)	1.1 ± 0.3	1.2 ± 0.3	1.5 ± 0.7	1.2 ± 0.3
AST (U/L)	27.1 ± 5.9	29.8 ± 7.1	32.4 ± 9.4	32.3 ± 9.9
ALT (U/L)	12.0 ± 7.3	16.1 ± 7.1	18.6 ± 7.1**	16.1 ± 5.6
LDH (U/L)	392.5 ± 182.0	491.5 ± 177.6	542.6 ± 141.4*	517.6 ± 222.2
Rate of perceived exertion			12 ± 2	

* p<.05 compared to at rest, ** p<.01 compared to at rest, *** p<.001 compared to at rest, † p<.05 compared to after warm-up, †† p<.001 compared to after warm-up; # p<.001 compared to post-fight. HDL= high density lipoprotein; LDL = low density lipoprotein; VLDL = very low density lipoprotein; CK = creatine kinase; AST = aspartate amino-transferase; ALT = alanine amino-transferase; LDH = lactate dehydro-genase.

One combat of Brazilian jiu-jitsu was not able to change the serum levels of glucose, triglycerides, total cholesterol, LDL and VLDL. The warm-up decreased the urea ($p<.05$) and ammonia levels ($p<.01$). When comparing the different times, the post-fight HDL was high when compared with at rest ($p<.001$), and even after the recovery time the HDL concentrations remained elevated ($p<.05$). As for the markers of cell damage, the fight did not cause changes in levels of CK, AST nor creatinine. However, the serum levels of ALT ($p<.01$) and LDH ($p<.05$) were elevated after the fight.

When compared to resting values, HR was elevated post-warm-up ($p<.001$), post-combat ($p<.001$) and during recovery ($p<.01$). However, the HR values in the post-combat period were higher than after the warm-up ($p<.001$) and during the recovery ($p<.001$). Similarly, the LAC was elevated in the post-combat ($p<.001$) and recovery ($p<.001$) periods, and it remained increased in the post-combat ($p<.001$) period when compared to after the warm-up period. Moreover, LAC removal was slow over the post-combat period, and the recovery time was not enough to bring the LAC level back to the initial levels ($p<.001$). Despite this, the athletes perceived the fight as being only light or somewhat hard.

Discussion and conclusions

The effort performed during the simulation of Brazilian jiu-jitsu fighting was sustained mainly by muscle glycogen breakdown, as blood lactate increased, but blood glucose and other marks of protein breakdown did not change. Additionally, the cardiovascular stress, as measured by the heart rate was low; however, there were signs of muscle damage after the fight. The athletes rated the fight as being light or somewhat hard.

It is accepted in literature that elite athletes can perform the same activity as non-elite athletes with physiological and perceptual responses that are slightly lower due to mechanical advantages and better technical skills (Guglielmo, Greco, & Denadai, 2009; Arruza, Saez, & Valencia, 1996). Thus, for a better reliability of results and best practical applications, it is important to allow for the use of complete motor gestures and to measure the physiological demands of the activity under similar conditions as in the competition, as used in this study.

An indicator of exercise intensity is HR which is easy to monitor and inexpensive to measure. Moreover, HR has a high correlation with training level, and athletes with better aerobic physical conditions have higher resting bradycardia (Bonaduce, et al., 1998) and smaller rises in HR at any level of effort when compared to individuals at lower competitive levels (Arruza, et al., 1996). However, this measure has been little studied in Brazilian jiu-jitsu fighters. Our results show a low cardiovascular stress for enduring the fight.

Similar results were described by Franchini et al. (2003) during a 5-minute simulation of combat (166±16 bpm). Additionally, the authors showed that the HR showed a nonlinear relation with the duration of the fight. Data from the same group of researchers (Franchini, et al., 2005a), with black-belt athletes undergoing ten-minute combats (169±7 bpm) were also similar to those presented in this study. However, Del Vecchio et al. (2007), in a study of Brazilian jiu-jitsu athletes, reported much higher values (182±6 bpm). The highest values of the latter study may be attributed to the fact that such measures were collected during an actual competition of the sport (i.e. 2005 World Cup), as competitions generate more stress than simulation settings (Filaire, Sagnol, Ferrand, Maso, & Lac, 2001). Additionally, the HR may be high due to the influence of the stress of confrontation, especially because some studies have reported increased stress indicators pre-combat (Moreira, et al., 2012; Filaire, et al., 2001; Salvador, Suay, González-Bono, & Serrano, 2003), while the match intensity may not necessarily be high.

Regarding HR recovery, the period of 14 minutes (equivalent to the time of two combats) was not enough for HR to return to the resting values, but it was enough for HR to return to the levels found after warm-up. Another way to measure stress and a tool that can be used to control the training load is to ascertain the rate of perceived exertion (Borg, 1982). This measure uses an accessible scale which is inexpensive and has been commonly used in recent years. It may indirectly provide valuable information about the degree of fatigue and the energy activity demands (Nilsson, et al., 2002).

In our study, the values of the rate of perceived exertion (12±2) indicate that athletes perceived the combat as being between fairly light and somewhat hard. These values were similar to those found in the study by Franchini et al. (2005a) with black-belt athletes undergoing ten-minute combats (13±4) and those reported by Nilsson et al. (2002) who studied wrestlers during the 1998 World Championship (14±3).

It is believed that the perceived exertion was lower than the concomitant increase in HR and LAC because in the combats of Brazilian jiu-jitsu the LAC was probably formed in the small muscle groups. Support for such reasoning can be found in a study of Franchini et al. (2005a) of black belt athletes of Brazilian jiu-jitsu. This study found a higher perception of fatigue by athletes in the muscle regions of the forearm and shoulder, which are small muscles, thus causing little disruption in the general perceived exertion. The same result was observed in wrestlers (Nilsson, et al., 2002). Another factor that can influence the perception of athletes is that during the combats much of the attention is directed to external stimuli (e.g. sensory and auditory) for decision-making, which can decrease the internal load perception and thus reduce the perceived exertion (Bridge, Jones, & Drust, 2009).

In our study, plasma glucose did not change across the different times of measurement. The absence of changes in blood glucose can be explained by the fact that homeostatic metabolic pathways maintain stable levels of plasma glucose and liver and muscle glycogenolysis (Febbraio & Dancey, 1999). However, it has been reported in literature that there is significant glycolytic pathway activation during Brazilian jiu-jitsu matches, based on the values of lactate concentration. The values found in this study were similar to those described by Del Vecchio et al. (2007) two minutes after a Brazilian jiu-jitsu fight (10.2±1.5 mmol/L) and to the values reported by Franchini et al. (2005a) one minute after the fight among black-belt athletes (9.5±2.4 mmol/L). Similar values were found after five minutes of judo combat (~10 mmol/L; Artioli, et al., 2010), in elite (10.2±2.1 mmol/L) and non-elite judo athletes (11.2±3.0 mmol/L; Franchini, Takito, Kiss, & Sterkowicz, 2005b).

However, higher values were found in studies with wrestlers after fights were conducted according to the Olympic rules (20.0±0.7 mmol/L; Kraemer, et al., 2001). High values of LAC (14.8±2.8 mmol/L) were also found among athletes during the 1998 Greco-Roman wrestling World Championship five minutes after the end of fighting (Nilsson, et al., 2002), as well as after wrestling competition simulation (15.8±0.7 to 19.1±0.8 mmol/L) (Barbas, et al., 2011). One reason for this activation of the glycolytic pathway, as evidenced by the moderate LAC, is the time structure of the combats of Brazilian jiu-jitsu that has short periods of interval that are insufficient to fully restore the phosphagen system. The study by Del Vecchio et al. (2007) pointed out that the combats of the sport have an average of 170 seconds from fight initiation (standing fight: 25±17 seconds; groundwork fight: 146±119 seconds) and that the 13±6 seconds of recovery period was insufficient to fully restore the phosphagen system used during the actions performed to score, which are normally high-intensity efforts.

When analysing the effect of the recovery period, we found that the LAC did not decrease significantly compared to the moments of rest, after warm-up and post-combat. Moreover, the recovery values of this study did not corroborate the findings of Del Vecchio et al. (2007). In that study, the values measured twelve minutes after the fight (11.7±1.2 mmol/L) were similar to the values measured two minutes after the fight (10.2±1.5 mmol/L). However, a similar effect of recovery on the LAC was found among judo athletes who had a similar recovery time (15 minutes) and passively recovered (LAC values ranging from 5.6±2.0 mmol/L to 7.0±2.3 mmol/L) (Franchini, et al., 2003; Franchini, et al., 2005b; Franchini, et al., 2009).

The serum concentrations of triglycerides, total cholesterol, LDL and VLDL cholesterol showed no significant fluctuations across the time points. These results differed from those from Degoutte et al. (2003) who analysed the energy demands during judo fights. In that study, the authors found significant increases in post-fight (three minutes) serum triglycerides and total cholesterol. The low activation of fat metabolism may be due to higher LAC being combined with high concentrations of adrenalin and increased glycolytic flux which are the main factors inhibiting the use of lipids. Generally, in high-intensity exercise, there is only a small portion of energy derived from lipid oxidation (Brouns & Van Der Vusse, 1998). Additionally, this could be related to a decreased blood flow in adipose tissue, which results in a smaller amount of free albumin reaching the site, causing a lower release of fatty acids (Hawley, 2002). Besides these factors, the carbohydrate availability and the physical fitness level are essential aspects determining the use of lipid sources (Ranallo & Rhodes, 1998).

However, in our study, although there were no significant changes in triglycerides, total cholesterol and LDL cholesterol and VLDL showed tendencies to change, HDL significantly increased, which indicated a small contribution of lipid metabolism. This increase in HDL cholesterol was also observed in a study of judo athletes conducted by Degoutte, et al. (2003). Concerning this physiological response, little is known about the acute effects of anaerobic exercise. However, it has been suggested that increases in HDL may be induced by increases in lipoprotein lipase which is active after vigorous exercise (Pronk, 1993), as well as by changes in plasma volume, which may have induced temporary changes in HDL (Degoutte et al., 2003). Moreover, such changes may have been affected by the total duration of exercise (17 minutes) which included the warm-up period.

Additionally, the effect of multiple fights should be investigated, because in analysing the effects of training sessions on female judo players in one week, a study by Umeda et al. (2008) pointed out that both the glucose and cholesterol indices were decreased after the training sessions. Furthermore, intense physical activity can lead to protein degradation, as evidenced by increases in the amounts of circulating urea (Hartmann & Mester, 2000) and ammonia. However, it was found that a Brazilian jiu-jitsu fight was unique in not being able to generate differences in the concentrations of urea and ammonia, which resulted from the oxidation of proteins. Nevertheless, the warm-up was able to generate significant decreases in the levels of urea and ammonia when compared to resting values. Increases in the levels of circulating urea and ammonia are due to proteolysis; therefore, the decrease is likely a result of the low activation of this pathway. Moreover, for our sample the resting values of ammonia were above the reference values (Kratz & Lewandrowski, 1998).

The values of ALT were significantly elevated after the fight, indicating that alanine muscle protein was recruited for the synthesis of ATP (Lijnen, et al., 1988). The study by Degoutte et al. (2003) with judo athletes also observed a contribution of protein metabolism to the energy supply, as evidenced by the increased concentrations of urea post-combat (three minutes) compared to the resting values.

When we analysed the markers of cellular injury such as CK, AST and creatinine, there was no change during the period used in this study. However, ALT and LDH showed significant increases due to the combat. Kraemer et al. (2001) found no differences in CK levels in a single Olympic wrestling combat, and this difference was identified just before the third match. However, fluctuations in the measurements of AST and ALT were more sensitive, as the concentrations of these enzymes were altered significantly after judo fighting for 90, 180 and 300 seconds (Ribeiro, Tierra-Criollo, & Martins, 2006).

By analysing the responses of markers of cellular injury in the training sessions, Umeda et al. (2008) identified significant increases in the values of AST, CK and LDH in female judo athletes. An important variable that directly influences the identification of tissue damage is the trainability, as shown by Miura et al. (2005) who investigated the effects of long-term judo training and concluded that training-induced adjustments generated lower elevations in levels of enzymes such as CK, AST, ALT and LDH in judo athletes submitted to a judo training session.

Finally, more studies should be conducted to expand the knowledge of the physiological demand during a Brazilian jiu-jitsu match, especially with regard to multiple fights and competitive environments.

In summary, the findings of this study indicate that Brazilian jiu-jitsu fights affect glycolytic, lipolytic and proteolytic pathways, suggesting that muscle glycogen is not the only substrate used in the sport. Several factors may have contributed to this, such as trainability, nutrition and metabolic stress. Signs of muscle damage were present after the match. However, the athletes rated the fight as being light or somewhat hard. This may be due to the fact that during the combats much of the athlete's attention is directed to external stimuli (e.g. adversary actions, referee commands and coach instructions) for decision-making, which can decrease the internal load perception and thus reduce the perceived exertion.

Conflict of interest

The authors do not have any conflicts of interest to report.

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Correspondence to:
Leonardo Vidal Andreato
Departamento de Ciências Fisiológicas
Laboratório de Fisiologia do Esforço
Av: Colombo, 5790, bloco H-79, sala 109
CEP 87020-900
Phone: 55 44 3261-3895
Fax: 55 44 3261-3895
E-mail: vidal.leo@hotmail.com

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FIZIOLOŠKI ODGOVORI I SUBJEKTIVNA PROCJENA OPTEREĆENJA BRAZILSKIH JIU JITSU BORACA

U ovom istraživanju istraživali smo fiziološke odgovore i subjektivne procjene opterećenja brazilskih jiu jitsu boraca tijekom simulacije borbe. Na uzorku od 12 muških brazilskih jiu jitsu boraca (27.1±2.7 godina, 75.4±8.8 kg, 174.9±4.4 cm, 9.2±2.4% masti) uzeti su krvni uzorci venske krvi te je mjerena frekvencija srca u mirovanju, nakon zagrijavanja (deset minuta), odmah nakon simulacije borbe (sedam minuta) te nakon oporavka (četrnaest minuta). Nakon borbe zabilježena je vrijednost subjektivne procjene opterećenja. Borba nije uzrokovala promjene u koncentraciji glukoze, triglicerida, ukupnoga kolesterola, lipoproteina niske gustoće, lipoproteina vrlo niske gustoće, uree ni amonijaka u krvi. Ipak, koncentracija lipoproteina visoke gustoće bila je značajno viša nakon borbe (prije: 43.0±6.9 mg/dL, nakon: 45.1±8.0 mg/dL) te je ostala na visokoj razini tijekom perioda oporavka (43.6±8.1 mg/dL) u usporedbi s koncentracijom u mirovanju (40.0±6.6 mg/dL). Borba nije uzrokovala promjene u koncentraciji markera staničnog oštećenja: keratin kinaze, aspartat aminotransferaze ni kreatinina. Ipak, koncentracija enzima alanin aminotransferaze (prije: 16.1±7.1 U/L, nakon: 18.6±7.1 U/L) i laktat dehidrogenaze (prije: 491.5±177.6 U/L, nakon: 542.6±141.4 U/L) u krvi bila je povišena nakon borbe. Srčana frekvencija (prije: 122±25 otk/min, nakon: 165±17 otk/min) i vrijednosti laktata (prije: 2.5±1.2 mmol/L, nakon: 11.9±5.8 mmol/L) bile su značajno više nakon borbe u odnosu na stanje mirovanja. Usprkos tomu, borci su borbu procijenili kao laganu ili donekle tešku (12±2). Rezultati pokazuju da mišićni glikogen nije jedini supstrat koji se koristi tijekom borbe brazilskog jiu jitsa, budući da su zabilježene indikacije aktiviranja glikolitičkih, lipolitičkih i proteolitičkih metaboličkih procesa. Štoviše, borci su ocijenili borbu kao laganu ili donekle tešku iako je zabilježeno stvaranje markera mišićnog oštećenja.

Ključne riječi: *energetski zahtjevi, borilački sport, oporavak, metabolički profil*