RELATIONSHIP BETWEEN COMPETITION SIMULATION AND TRAINING ON STRENGTH AND DAMAGE INDICATORS IN JIU-JITSU

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RELAÇÃO ENTRE SIMULAÇÃO DE COMPETIÇÃO E TREINO POR MEIO DE INDICADORES DE FORÇA E LESÕES NO JIU-JITSU

RELACIÓN ENTRE SIMULACIÓN DE COMPETICIÓN Y ENTRENAMIENTO A TRAVÉS DE INDICADORES DE FUERZA Y LESIONES EN EL JIU-JITSU

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ABSTRACT

Background: The relationship between training and competition is very important and aims at a more specific and adequate preparation in Jiu-Jitsu. Problem and objective: To evaluate the relationship between training and competition through indications of injury and muscle strength. Methods: The study sample included nine subjects (22.54 ± 2.77 years of age) who were submitted to the following two conditions: 1) training simulation and 2) competition simulation. Results: There were no significant differences in the countermovement jump (CMJ) test. However, 48 hours after training there was an indication of values higher than the post-competition ones. Creatine kinase (CK) indicated significant differences in muscle damage after competition in relation to the other conditions and moments (p <0.01) with a high effect. Lactate dehydrogenase (LDH) showed differences in the moments before, during, and after both competition and training conditions (p <0.05) with a high effect. The power of the upper limbs (PUL) showed a medium correlation at 24h (> 0.55) and 48h (0.47) after the intervention. There was high correlation (> 0.70) for all conditions in the squat jump (SJ). LDH showed a high correlation (> 0.70) at 48 hours. Conclusion: There was a good correlation between training and competition simulation, which tends to indicate that the training model used in the study properly prepare Jiu-Jitsu athletes for the demands of competition. ***Level of evidence I; High-quality randomized clinical trial with or without a statistically significant difference, but with narrow confidence intervals.***

Keywords: Martial arts; Physical education and training; Muscle fatigue; Muscle strength; Simulation training.

RESUMO

Introdução: A relação entre treino e competição é muito importante e visa a preparação mais específica e adequada no Jiu-Jitsu. Problema e objetivo: Avaliar a relação entre treinamento e competição por meio de indicadores de lesão e força muscular. Métodos: A amostra do estudo incluiu nove indivíduos (22,54 ± 2,77 anos) que foram submetidos às seguintes condições: 1) simulação de treinamento e 2) simulação de competição. Resultados: Não houve diferenças significativas no teste Counter Movement Jump (CMJ). Porém, 48 horas depois do treinamento, houve indicação de valores superiores aos de pós-competição. A creatina quinase (CK) apresentou diferenças significativas de lesão muscular depois da competição com relação às demais condições e momentos (p <0,01), com alto efeito. A LDH apresentou diferenças nos momentos antes, durante e depois das condições de competição e treinamento (p < 0,05), com alto efeito. A potência dos membros superiores (PUL) teve correlação média 24 horas (> 0,55) e 48 horas (0,47) depois da intervenção. Houve alta correlação (> 0,70)com todas as condições no squat jump (SJ). A LDH teve alta correlação (> 0,70) em 48 horas. Conclusões: Houve boa correlação entre o treinamento e a simulação de competição, o que indica que o modelo de treinamento usado no estudo tende a preparar adequadamente os atletas de Jiu-Jitsu para as demandas da competição. ***Nível de evidência I; Estudo clínico randomizado de alta qualidade com ou sem diferença estatisticamente significante, mas com intervalos de confiança estreitos.***

Descritores: *Artes marciais; Educação física e treinamento; Fadiga muscular; Força muscular; Treinamento por simulação.*

RESUMEN

Introducción: La relación entre entrenamiento y competición es muy importante y apunta a una preparación más específica y adecuada en el Jiu-Jitsu. Problema y objetivo: Evaluar la relación entre entrenamiento y competición a través de indicadores de lesión y fuerza muscular. Métodos: La muestra del estudio incluyó a nueve individuos (22,54 ± 2,77 años) que fueron sometidos a las siguientes condiciones: 1) simulación de entrenamiento y 2) simulación de competición. Resultados: No hubo diferencias significativas en la prueba de Counter Movement Jump (CMJ). Sin embargo, hubo indicios, 48 horas después del entrenamiento, de valores superiores a los de post-competición. La creatina quinasa (CK) presentó diferencias significativas de lesión muscular tras la competición en relación con las demás condiciones y momentos (p <0,01), con un efecto elevado. La LDH presentó diferencias en los momentos previos, durante y posteriores a las condiciones de competición y entrenamiento (p <0.05), con un efecto elevado.

La potencia de las extremidades superiores (PUL) tuvo una correlación media de 24 horas (> 0,55) y 48 horas (0,47) después de la intervención. En el salto, Squat Jump (SJ), hubo una alta correlación en relación a todas las condiciones (> 0,70). La LDH presentó alta correlación (> 0,70) en 48 horas. Conclusiones: Hubo una buena correlación entre el entrenamiento y la simulación de competición, lo que indica que el modelo de entrenamiento utilizado en el estudio tiende a preparar adecuadamente a los atletas de Jiu-Jitsu para las exigencias de la competición. ***Nivel de evidencia I; Ensayo clínico aleatorizado de alta calidad con o sin diferencia estadísticamente significativa, pero con intervalos de confianza estrechos.***

Descriptores: *Artes marciales; Educación y entrenamiento físico; Fatiga muscular; Fuerza muscular; Entrenamiento simulado.*

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INTRODUCTION

In combat sports, the duration, rest interval and number of fights can vary widely and tend to influence performance. In addition to these factors, we have to take into account physiological, technical and tactical aspects inherent to each combat sport.[1,2,3]

In the same direction, the training aims to adapt athletes to the conditions and functional demands of each sport.[4,5] Training tends to generate biochemical and cellular changes that impact muscle structure, generating adaptation to the conditions of competition.[6,7] The means of assessment and control in sports are varied, where markers of muscle damage, indicators of strength and power have been used to assess and control fatigue, adaptation and in general the impact of training.[8]

Therefore, although several studies have investigated training and competition, notably in Jiu-Jitsu, through physiological variables, strength and power, few studies have evaluated the specificity of training and its relations with competition variables. And when they were performed, they indicated conflicting results.[9] In this sense, the objective of our study was to assess muscle damage, strength and power, and its correlation in two different conditions, training and competition simulation.

MATERIALS AND METHODS

The study used a crossover model, where two simulated sessions were separated by one-week intervals. Figure 1 describes the study design. A session consisting of progressive activities was used as the training protocol. Each training session featured 30 minutes of general warm-up with general exercises (callisthenics), 30 minutes of technical training and 30 minutes of combat simulation, totalling 90 minutes. In the warm-up, aerobic exercises were used, with running and speed exercises and counter-resistance with body weight. In technical training, specific Jiu-Jitsu movements, such as guard passes, projections, sweeps, immobilizations and submissions were used. In the combat simulation, there were 6-minute fights, totalling three fights for each individual with a 10-minute interval between fights. The model was adapted from other studies on Jiu-Jitsu.[8,10] The volunteers were familiar with the training regime.

Sample

The study was carried out in four weeks, the first week for familiarization and the final two for the evaluation of conditions and tests. In the first week, there was familiarization with the conditions and tests through two familiarization sessions with a minimum rest interval of 72 h between each session. In the following weeks, the subjects were submitted to two conditions: 1. training simulation and 2. competition simulation. The study evaluated nine male Jiu-Jitsu athletes, (22.54 ± 2.77 years, height of 1.76 ± 0.03 m, body mass of 75.47 ± 6.77 kg and body fat of 14, 67 ± 3.27%), with a minimum experience of 12 months, who had participated in official competitions in the last six months at regional and national level.

As an inclusion criterion, it was adopted not to use stimulants or to not have been involved in a rapid weight loss process before the intervention,[8] these criteria being confirmed through an interview.

The study was carried out in accordance with resolution 466/2012 of the National Commission for Ethics in Research - CONEP, National Health Council, in accordance with the Declaration of Helsinki (1964, reformulated in 1975, 1983, 1989, 1996, 2000, 2008 and 2013) of the World Medical Association. The study was approved by the Research Ethics Committee of the Federal University of Sergipe (protocol 01723312.2.0000.0058), according to the Council on experiences with humans.

Procedures

Body mass, height, and body fat

For the determination of mass, a digital platform scale (Fillizola 2002, Filizola, São Paulo, SP, Brazil) was used, calibrated from 0 to 150 kg, with a precision of 0.1 kg, and was used to measure the weight in kilograms (kg). Height was determined using a compact ES2040 type tape stadiometer (Sanny, São Paulo, SP, Brazil), fixed to the wall, with a capacity of 2.0 m and

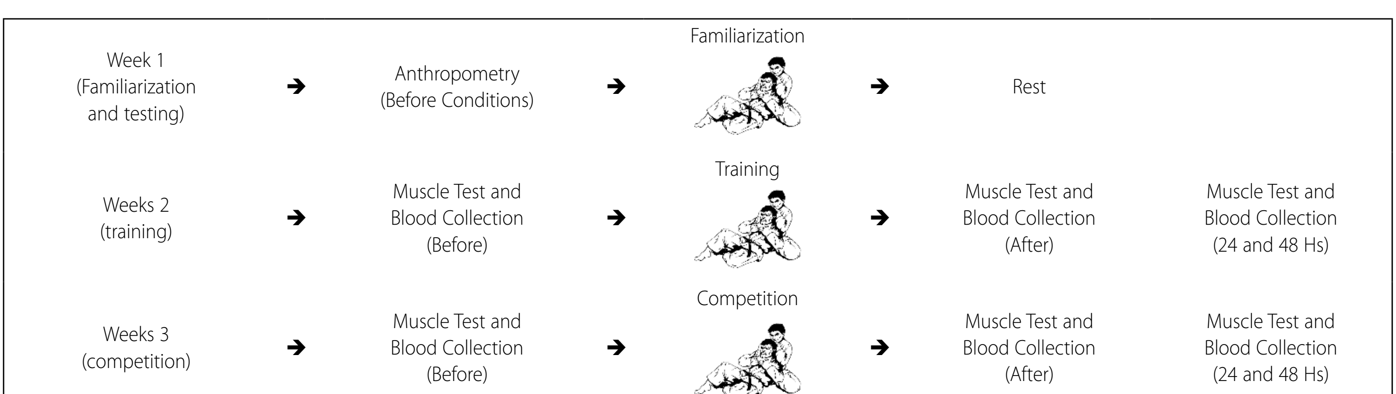

Figure 1. Design of the procedures performed in the study.

an accuracy of 0.1 cm. Body density was determined using an adipometer (Lange Skinfold Caliper; Beta Technology, Santa Cruz, CA, USA) using the equation by Thorland et al.[11] for university fighters. The percentage of body fat (% BF) was estimated using the equation by Brozek et al.[12]

Body density was determined using the Jackson and Pollock[13] equation of three skinfolds.

Power in upper limbs (PUL)

The test was performed using a bar with a grip in the supine position. Three repetitions were performed, and the best result was used. The reliability calculation was performed from the baseline and intraclass coefficient (ICC) of 0.96 and standard error (SE, 95%) of 16.4 W (2.1%). The test and the initial and final positions of the upper limbs, followed the methodology described by Fonseca et al.[8] The tests were performed using an encoder connected to its Muscle lab straps (Model PFMA 3010e Muscle Lab System; Ergotest, Langesund, Norway).

SJ and CMJ

The tests followed the jump protocol where two attempts were made, and the best result was used for analysis.[14] The reliability of baseline repetitions was calculated and ICCs (0.96 and 0.95, respectively) and SEs (95% for both) of 1.23 and 1.39 cm, respectively (1.9% and 2.4%, respectively) were found. For the evaluation of the tests, a 50 × 60 cm conductive surface contact mat was used, connected to a display (Probotics Inc., Oreland, PA, USA).

Muscle damage

Muscle damage markers, Creatine Kinase (CK), Lactate Dehydrogenase (LDH), Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT), were measured using blood samples, collecting 8.0 mL of blood from the antecubital vein and stored in tubes containing coagulant gel (Vacuette; Greiner Bio-One, Campinas, SP, Brazil). The blood was kept for 30 min at room temperature for coagulation and then centrifuged at 4,000 rpm for 8.0 min to separate the serum. Biochemical measurements were performed on an automatic analyzer (Vitros model 5600; Ortho Clinical Diagnostics, Raritan, NJ, USA), and biochemical tests were performed using the Vitros® 5600 film system (Ortho-Clinical Diagnostics, Johnson & Johnson Company, Linden, NJ, USA). The assessment of the levels of LDH, AST and ALT was determined by the multipoint kinetic technique.[8] The CK level was measured using the multipoint rate technique.[8] The variation coefficients for the same sample were defined for serum LDH at 1.2%, accuracy of 1.909 IU / L, for serum AST at 1.8%, accuracy of 1.781 IU / L, and for serum ALT at 1.9%, accuracy of 1.909 IU / L. As for the serum CK level, it was measured by the multipoint rate technique at 1.5%, with an accuracy of 8,456 IU / L.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM Inc, New York, NY, USA) Measures of central tendency, mean ± standard deviation were used. To verify the normality of the variables, the Shapiro - Wilk test was used, considering the sample size. To verify the possible differences between the conditions, the two-way ANOVA (condition and moment) was used. Bonferroni's post hoc test was used. In ANOVA, to determine the effect size, the "partial square eta" ($\eta 2p$) was used, adopting values of low effect (≤0.05), medium effect (0.05 to 0.25), high effect (0.25 to 050) and very high effect (> 050).[15,16] Pearson's correlation coefficient "r" was used for training and competition.[15,17] Statistical significance was considered at $p < 0.05$.

RESULTS

Figures 2–8 show the results of muscle damage, i.e., the levels of CK, LDH, AST, and ALT, and the results of the SJ and CMJ tests as well as the PUL test at pre and post-test and 24 and 48 h after intervention through training simulation and competition, along with their kinetics.

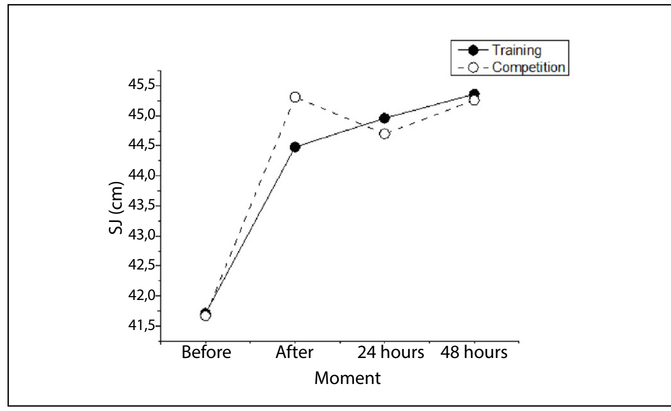

Figure 2. Squat Jump (SJ) in training and competition simulation.

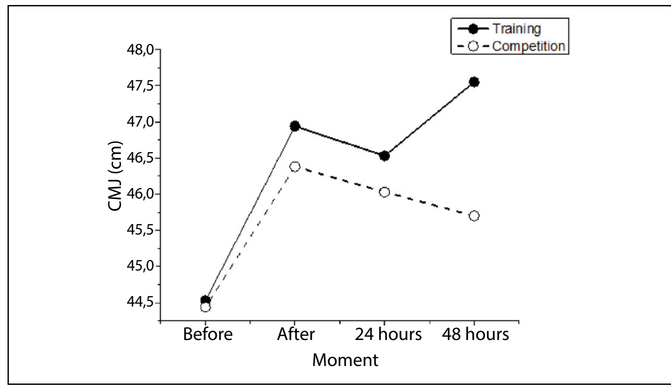

Figure 3. Counter Movement Jump (CMJ) in training and competition simulation.

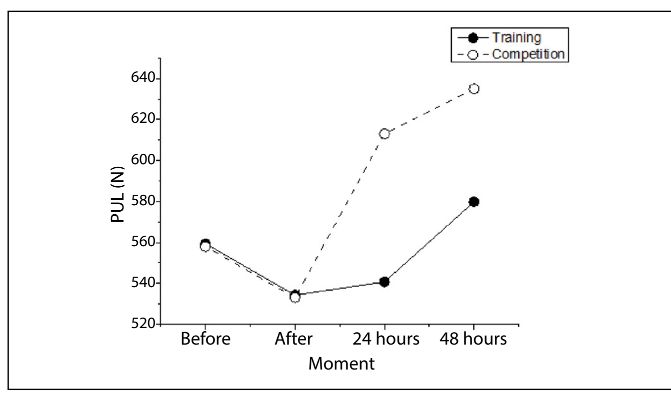

Figure 4. Power in Upper Limbs (PUL) in training and competition simulation.

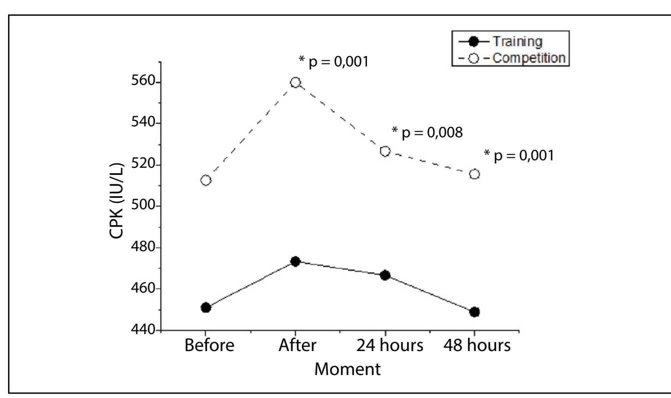

Figure 5. Creatine Kinase (CK) in training and competition simulation.

Figure 2 shows that there were no significant differences concerning the SJ test at different time points in the applied methods. In Figure 3, it can be observed that there were no significant differences in the CMJ test; however, 48 h after the training, higher values than those in the week of the competition were observed. Regarding the PUL

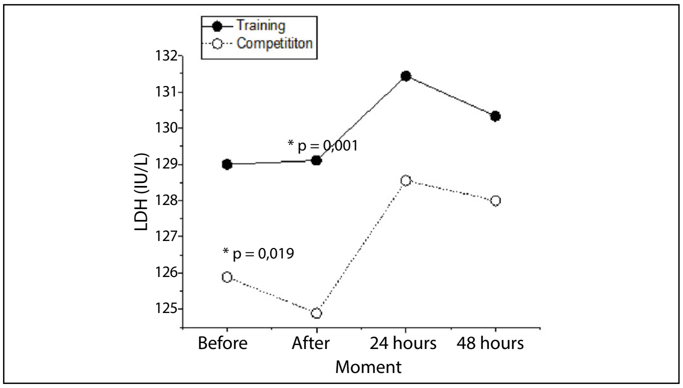

Figure 6. Lactate Dehydrogenase (LDH) in training and competition simulation.

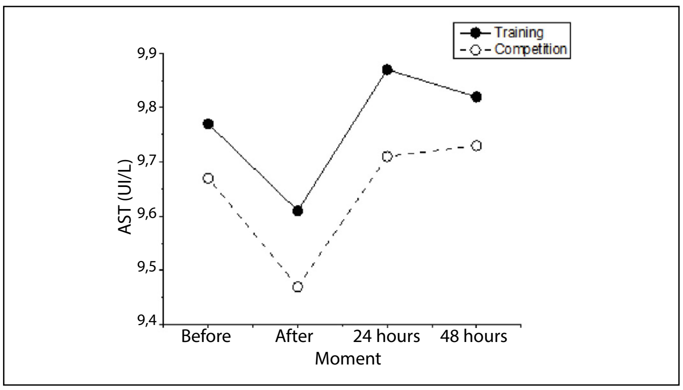

Figure 7. Aspartate Aminotransferase (AST) in training and competition simulation.

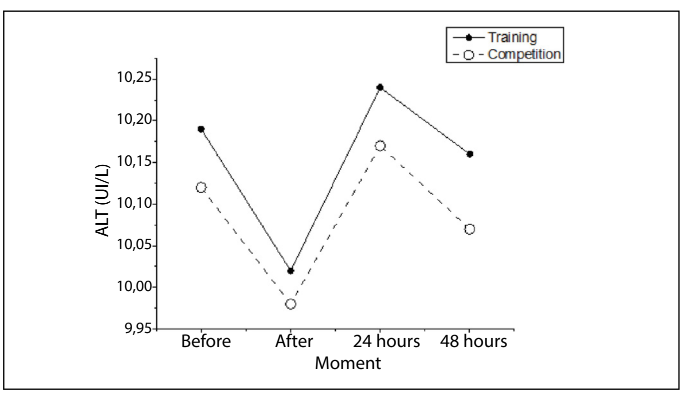

Figure 8. Alanine Aminotransferase (ALT) in training and competition simulation.

test (Figure 4), the results were in contrast to the CMJ test, where the values, although not significantly different at the distinct time points, 48h after the competition were higher than those in the training period (p > 0.980). Regarding CK levels (Figure 5), there were significant differences after competition relating to the other time points and intervention (p = 0.003), with a high effect. Regarding LDH levels (Figure 6), there were significant differences in post-competition and pre-competition concerning pre and post-training (p = 0.017), with a high effect. The other variables did not present significant differences both at the different time points and between the training intervention and competition. The AST and ALT levels showed no significant differences and presented a very similar kinetics, and the values were also similar (Figure 7 and 8).

Table 1 describes the correlation at the different time points between training and combat simulation.

It was observed that the PUL results showed a median correlation 24 h (> 0.55) and 48 h (> 0.47) after the intervention. The SJ test results showed a high correlation, and the other test results showed a very high correlation (> 0.70).

Table 2 describes the correlation at the different time points between training simulation and combat simulation (CK, LDH, AST, and ALT levels).

All variables presented a very high correlation at both time points of the study. Only the variable LDH level, 48 h later, presented a high correlation. ALT did not present a good correlation to make an equation.

Table 1. Correlation between training and competition in Squat Jump (SJ), Counter Movement Jump (CMJ), Power in Upper Limbs (PUL), and muscle damage (mean±standard deviation).

Moment	Train	Combat simulation	*r*
SJ (Cm)	44.41±3.26	45.33±6.11	0.721*
SJ (Cm) 24 hours	44.97±4.77	44.71±6.11	0.752*
SJ (Cm) 48 hours	45.37±5.34	45.27±6.06	0.897*
CMJ (Cm)	46.85±5.13	46.37±6.92	0.817*
CMJ (Cm) 24 hours	46.54±6.06	46.04±5.75	0.912#
CMJ (Cm) 48 hours	47.57±7.88	45.61±5.42	0.817*
PUL (W)	537.12±44.88	535.17±96.38	0.917#
PUL (W) 24 hours	541.80±158.17	611.03±88.41	0.532
PUL (W) 48 hours	579.92±166.43	634.97±90.75	0.469

* High correlation. # Very high correlation.

Table 2. Correlation between training and competition simulation in the muscle damage variables CK, LDH, AST and ALT tests (mean ± standard deviation).

	Train simulation	Combat simulation	r
CK (UI/L)	477.31±22.37	557.01±55.25	0.925#
CK (UI/L) 24 hours	467.67±26.47	527.68±50.02	0.927#
CK (UI/L) 48 hours	447.87±32.17	517.57±75.67	0.977#
LDH (UI/L)	129.12±1.97	123.87±2.17	0.919#
LDH (UI/L) 24 hours	131.57±3.37	128.57±4.25	0.977#
LDH (UI/L) 48 hours	131.34±2.97	127.02±2.62	0.777*
AST (UI/L)	9.65±0.35	9.45±0.32	0.977#
AST (UI/L) 24 hours	9.88±0.45	9.72±0.45	0.935#
AST (UI/L) 48 hours	9.81±0.37	9.97±045	0.977#
ALT (UI/L)	10.02±0.31	9.98±0.32	0.978#
ALT (UI/L) 24 hours	10.24±0.27	10.16±0.38	0.897*
ALT (UI/L) 48 hours	10.16±0.68	10.07±0.69	0.997#

* High correlation. # Very high correlation. Legend: CK: Creatine Kinase, LDH: Lactate Dehydrogenase, AST: Aspartate Aminotransferase, and ALT: Alanine Aminotransferase.

DISCUSSION

The present study aimed to analyze the muscle damage, strength and the correlation that could exist in the Jiu-Jitsu modality at two different time points.

It was verified that concerning the strength measured by the SJ, after training (41.71 cm) and post-competition (45.33 cm), the correlation was still higher after, after 24 and 48 h (*r* > 0.70). Regarding CMJ, the correlation at all time points was higher (r > 0.70), demonstrating that there is an interconnection between training and competition for the various types of strength manifestations. Still, regarding the PUL, there was a correlation after the training (557.12 W) and after the competition simulation (535.17 W).

However, after 24 h, the recovery did not occur with the same kinetics, with different values in the training (540.80 W) and competition (611.03 W) with an intermediate correlation (*r* > 0.55), and after 48 h, the correlation was lower (*r* > 0.47). These results demonstrate that competitive efforts tend to be higher relating to upper limbs, and the requirements in competition tend to be more stressful in this follow-up than those in training.

The actions inherent to the fight, such as guard passages, sweeps and blockages with the legs, tend to cause fatigue, due to the isometric, concentric and eccentric muscle actions performed during the combat actions, where these actions tend to be performed at high intensity and with short rest periods, mainly in the eccentric way, and end up providing increased overload and mechanical muscle stress.[10,18,19] During a simulated judo competition, Detanico et al.[20] found a decrease in the performance of the vertical jump after three combats, and this was explained by the powerful eccentric actions performed by the legs during that combat, which caused a loss of muscle function. On the other hand, another study demonstrated that, through training procedures with recovery in ice water, the PUL showed significant differences 24 h after training, with the values presented being higher than the values of the present study, with recovery in ice water (757. 9 ± 125.1 W) and in the control group (695.9 ± 56.1 W).[8]

Regarding muscle damage, a high correlation was observed in all CK damage indicators (r > 0.9) at all times after training simulation or combat simulation. In the same context, it was found that, in the levels of CK, significant differences were found at the time after all moments of the competition in relation to training (post-training 561.01 to 477.31; 24 h 527.68 to 467.67 and 48 h after 517.57 to 447.87), respectively. The results of the present study corroborate those of other studies that found an increase in post-exercise serum CK concentrations, which was inversely proportional to the muscle's ability to generate strength.[8] Nonetheless, another study that evaluated muscle damage after training also identified CK levels as the most altered.[8] Still, intense exercises, as in combat sports, tend to increase oxidative stress, and this would be due to the stimulation promoted by muscle contractions. In this sense, among others, there would be an acceleration of muscle fatigue and induction of muscle adaptation.[21]

Regarding LDH levels, a high correlation between training and combat was observed ($r > 0.9$ in the post-training and after 24 h, and $r > 0.70$ after 48 h). On the other hand, LDH is present in large quantities in the skeletal muscle, as this enzyme is responsible for the anaerobic conversion of pyruvate to lactate. The association of LDH with muscle damage is closely linked to increased CK concentration,[22] which would explain the results of our study.

Regarding AST and ALT levels, the correlation between training and combat was high ($r > 0.70$ at all-time points after). AST and ALT are important liver enzymes for amino acid catabolism, and although not concentrated in the muscle, increased activity of these enzymes occurs during intense exercise[23] or intermittent exercise,[24] since intense exercise tends to increase protein catabolism. However, no major changes in AST and ALT levels were found in our study. Also, regarding CK and LDH levels, a study using other grappling methods found an increase of 15%–42% in the serum concentration of these enzymes after 2.5 h of training.[25]

In this direction, the physical demands of the training and competition of the fights are still not well elucidated, therefore, currently it is not possible to affirm which variables are better to promote the success in competitions.[26] However, the establishment of more specific evaluations has been researched including simulated competition and correlation with physiological variables with different simulated situations. Some indicators have been shown to be important such as competitive level, intensity, training modalities and volume, aiming at monitoring the fight as well as the short and long term training loads, which tends to positively impact planning and assist programs training and competitions.[3]

CONCLUSION

It can be concluded that there is a great correlation between strength-related and biochemical variables related to damage both in training simulation and in competition simulation. Regarding muscle power, it was noticed that the methods used in the training of the upper limbs should be reviewed since these limbs showed signs of greater wear after the simulated competition than that observed in the training session.

To summarize, a good correlation exists between training simulation and competition simulation, where the model adopted as training can meet the needs imposed in the competition and may undergo changes to better approach the true conditions found in a competition.

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