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ANALYSIS OF THE ACUTE EFFECTS OF THE CONFRONTATION IN THE JUDO, THROUGH THE STUDY OF THE ASSOCIATION BETWEEN METABOLIC AND MECHANICAL PARAMETERS

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ABSTRACT

Introduction: The purpose of this study was to analyze the mechanical and metabolic changes induced by judo fights, studying the possible association between them. **Materials and Methods**: Eight judo fighters of national level participated in this study. Was monitored the heart rate (HR) during each fight. Before and immediately after each fight that were measured: the blood lactate concentration ([LA]); counter-movement jump (CMJ); manual dynamometry (D); supine at 90º (PB90); isometric prone rowing at 90º (RP90), and isometric seating at 160º (S160). **Results**: The HR reached 92.7±3.3% of HR_{max}. The pre and post-fight means were: [LA] 5.39±1.91mmol.L^{-1} and 13.75±3.09mmol.L^{-1} ($p<0.05$); CMJ 39.3±4.1±5.1cm and 40.0cm, D (right), 52.8±10.4N and 50.9±9.7N, D (left), 56.4±10.9N and 53.0±10.4N. The yield fell for RP90 and PB90, reaching statistical significance in PB90. HR% significantly correlated with the loss of power in RP90 post-combat ($r=-0.786$, $p=0.021$). [LA] post-fight significantly correlated with the decrease in income over time to reach the peak (TPFI) in S160 ($r=0.780$, $p=0.022$). **Discussion**: The acute effects of several Judo confrontations produced loss of isometric force largely on the upper than in the lower limb. The absence of relations between the mechanical and metabolic parameters could indicate that the specific fatigue in judo is related to mechanisms of local fatigue.

KEYWORDS

Muscle Strength, Lactic Acid, Heart Rate, Martial Arts.

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Análise dos efeitos agudos do enfrentamento no judô, através do estudo da associação entre parâmetros metabólicos e mecânicos

RESUMO

Introdução: O propósito deste trabalho foi analisar as mudanças metabólicas e mecânicas induzidas por um combate de judô, estudando a possível associação entre eles. **Materiais e Métodos**: Oito judocas de nível nacional participaram deste estudo. Foi monitorizada a freqüência cardíaca (FC) durante cada combate. Antes, e imediatamente depois que cada combate foram medidos: a concentração de lactato sanguíneo ([LA]); salto com contra-movimento (CMJ); dinamometria manual (D); supino 90º (PB90); remo pronado isométrico a 90º (RP90); e agachamento isométrico a 160º (S160). **Resultados**: A FC alcançou 92.7±3.3% da $FC_{máx}$. Os valores médios pré e pós-combate obtidos foram: [LA] 5.39±1.91mmol.L^{-1} e 13.75±3.09mmol.L^{-1} ($p<0.05$); CMJ 39.3±4,1cm e 40.0±5.1cm; D (direita), 52.8±10.4N e 50.9±9.7N; D (esquerda), 56,4±10,9N e 53.0±10.4N. O rendimento diminuiu em RP90 e PB90, alcançando significação estatística em PB90. %FC correlacionou-se significativamente com a perda de força pós-combate em RP90 ($r=-0,786$; $p=0,021$). [LA] pós-combate correlacionou-se significativamente com o declínio do desempenho ao longo do tempo para atingir o pico (TPFI) em S160 ($r=0,780$; $p=0,022$). **Discussão**: Os efeitos agudos de vários enfrentamentos de judô produziram uma perda de força isométrica em maior medida nos membros superiores do que nos membros inferiores. A ausência de relação entre os parâmetros metabólicos e mecânicos poderia indicar que a fadiga específica em judô se relaciona com mecanismos de fadiga locais.

PALAVRAS-CHAVE

Força Muscular, Ácido Láctico, Freqüência Cardíaca, Artes Marciais.

Análisis de los efectos agudos del enfrentamiento en judo, a través del estudio de la asociación entre parámetros metabólicos y mecánicos

RESUMEN

Introducción: El propósito de este trabajo fue analizar los cambios metabólicos y mecánicos inducidos por un combate de judo, estudiando la posible asociación entre ellos. **Materiales y Métodos**: Ocho judocas de nivel nacional participaron en este estudio. Se monitorizó la frecuencia cardiaca (FC) durante cada combate. Antes, e inmediatamente después de cada combate se midieron: la concentración de lactato sanguíneo ([LA]); salto con contramovimiento (CMJ); dinamometría manual (D); *press* de banca isométrico a 90º (PB90); remo prono isométrico a 90º (RP90); y sentadilla isométrica a 160º (S160). **Resultados**: La FC alcanzó el 92,7±3,3% de la $FC_{máx}$. Los valores medios pre y postcombate obtenidos, fueron: [LA] 5,39±1,91mmol.L^{-1} y 13,75±3,09mmol.L^{-1} ($p<0,05$); CMJ 39,3±4,1cm y 40,0±5,1cm; D (derecha), 52,8±10,4N y 50,9±9,7N; D (izquierda), 56,4±10,9N y 53,0±10,4N. El rendimiento disminuyó en RP90 y PB90, alcanzando significación estadística en PB90. %FC correlacionó significativamente con la pérdida de fuerza postcombate en RP90 ($r=-0,786$; $p=0,021$). [LA] postcombate correlacionó significativamente con la disminución del rendimiento en el tiempo en alcanzar el pico (TPFI) en S160 ($r=0,780$; $p=0,022$). **Discusión**: Los efectos agudos de varios enfrentamientos de judo produjeron una pérdida de fuerza isométrica en mayor medida en el miembro superior que en el miembro inferior. La ausencia de relaciones entre los parámetros metabólicos y mecánicos podría indicar que la fatiga específica en judo se relaciona con mecanismos de fatiga locales.

PALABRAS CLAVE

Fuerza Muscular, Ácido Láctico, Frecuencia Cardiaca, Artes Marciales.

INTRODUCTION

Nowadays, the analysis of the association between metabolic processes and demonstrations of strength demanded in the fight sports has been transformed in the object of several authors' study[1,2,3,4,5,6].

Therefore, with the purpose of analysing the specific conditional demands in the judo, different authors followed the characterization of the temporary structure of the combat[7,8,9,10,11,12,13,14]. Besides, several studies are based in the obtaining of values referred to physiological (VO_{2max} or heart rate) and biochemical parameters (lactacidemy, CK, testosterone, etc.) to describe the metabolic profile of the judo fighters in laboratory tests[15,16,17,18,19,20], in the course of the execution of specific tasks of the training[21,22,23] or during the development and the finalization of the competitive situation[1,6,24,25,26,27,28,29].

In what concerns the analysis of the strength demands in this sport, the studies can be structured in the following topics:

- Characterizations of the strength in the judo[30,31] and determinations of training and/or planning schedules[28,30,32,33,34];
- Specific dynamic[35,36,37,38] or isometric[18,20,39,40,41,42,43,44,45,46] evaluations.

For other part, although some authors[5,30,34,47] highlight the importance of the isometric strength in the motive

counter-communication of the own combat sports with gripping, were not in the bibliography studies that completely aboarded this strenght demonstration in the judo.

Taking into account that the high level of demand of the specific effort in the fight sports with gripping derives a set of actions with an important implication of strength, and that, reciprocally, the fighter's specific demonstrations of strength have room in disadvantageous metabolic conditions[3], acquires special relevance in this speciality the establishment of interactions and/or associations between neuromuscular and metabolic factors.

with all this in account, the objective of this study was to analyze the association between the values and the modification of the metabolic and mechanical variables derived of the accomplished of the judo's specific effort.

MATERIALS AND METHODS

Sample

The sample was formed by eight masculine judo fighters members of the Senior Galician Selection of Judo. All of them participated voluntarily, after the reading and signature of the corresponding consent. The procedure was accomplished respecting the beginnings of the Declaration of Helsinki (Hong-Kong revision, September 1989). All the sportsmen were specialist (14.37 years of practice), being several of them national and international medal winners, and if they were participating in the Autonomous Senior League. The characteristics of the sample are detailed in the Table 1.

Table 1 - Characterization of the sample

	mean	sd	category
age (years)	24	5.1	18 - 31
weight (kg)	87.7	24.1	65 - 132
stature (cm)	172.6	10.0	155 - 186
HR_{max} (ppm)	190.0	7.0	180 - 197

sd: standard deviation

Table 2 - Metabolic variables

	mean	sd	category
HR_{mc} (bpm)	175.9	5.7	169 - 184
HR_{max} (bpm)	190.0	7.0	180 - 197
$\%HR_{max}$	92.7	3.3	88 - 98
[LA] pre-combat ($mmol.L^{-1}$)	5.4	1.9	3 - 8
[LA] post-combat ($mmol.L^{-1}$)	13.8	3.1	10 - 19
post – pre [LA] difference	8.4*	3.0	6 - 11

sd: standard deviation; HR_{mc}: mean heart rate in combat; HR_{max}: maximum heart rate in adapted course navette[50];$\%HR_{max}$:% of HR_{max} regarding the maxim; [LA]: lactacidemia

*$p \leq 0.05$; *$p \leq 0.001$*

Table 3 - Height of the vertical jump with against-movement (CMJ).

		mean	sd	category
CMJ (cm)	pre	39.31	4.08	33 - 46
	post	39.96	5.06	31 - 46
Post vs Pre (%)		101.67	8.37	86 - 109

sd: standard deviation; pre (before the combat); post (after the combat); post vs. pre (% of the post-combat value regarding the pre-combat)

Material and procedure

The confrontation took place in agreement with the statute, being modified, according to the official norm, the punctuation-limit existence, with objective that all the contestants developed the total time of combat.

They grouped the subjects in pairs of the same competition category. With each component of the pair it was made the following sequence of evaluations:

1st. Height and weight measurement

For that was used a Tefal scale, accurately of 100g, as well as a caliper with measure category from 80cm to 200cm and precision of 1mm.

2nd. Familiarization with the measurement instruments of the isometric strength and warming protocol

The familiarization level has direct influence in the reliability and validity of the isometric test[48] data, for that was considered its accomplishing in the present study. Besides, due to the different measures of the sportsmen's body segments, this part of the session was used to register

Figure 1 - Olympic Bar with a load of 210kg and stabilized with two disks in each end. The load cell is fixed to the bar with a carabiner

Figure 2 - Placement of the chain in the load cell

Table 4 - Isometric dinamometry of the right and left hands

	Absolute values (kg)			Relative valeus (kg.kg body^{-1})	
	RD (mean ± sd)	LD (mean ± sd)		RRD (mean ± sd)	LRD (mean ± sd)
pre	52.75 ± 10.39	56.40 ± 10.88	pre	0.62 ± 0.12	0.66 ± 0.09
post	50.84 ± 9.71	52.96 ± 10.42	post	0.59 ± 0.09	0.62 ± 0.07
post vs. pre (%)	96.89 ± 8.78	94.53 ± 10.16			

dp: standard deviation; RD: dinamometry of the right hand (kg); LD: dinamometry of the left hand (kg); RRD: dinamometry of the right hand in relation to the body weight (kg.kg^{-1}); LRD: dinamometry of the left hand in relation to the bodyweight (kg.kg^{-1})
p≤0,05

Table 5 - Absolute and relative results in the isometric tests

		PB90 (mean ± sd)	RP90 (mean ± sd)	S160 (mean ± sd)
PFI (N)	Pre	1265.75 ± 254.68	1140.89 ± 170.25	2943.75 ± 488.53
	Post	1187.30 ± 245.05*	1067.73 ± 132.59	2902.88 ± 487.24
MFI (N)	Pre	1093.58 ± 233.05	986.86 ± 179.82	2252.88 ± 411.81
	Post	1004.67 ± 255.64*	862.09 ± 196.94	2271.25 ± 664.12
MFI vs. PFI (%)	Pre	86.30 ± 2.98	86.28 ± 4.47	76.38 ± 3.41
	Post	84.07 ± 6.19	80.10 ± 12.38	77.01 ± 10.78
PFI post vs. PFI pre (%)		93.93 ± 6.20	94.30 ± 9.64	99.37 ± 11.91
MFI post vs. MFI pre (%)		91.60 ± 9.47	87.94 ± 16.99	101.15 ± 22.43

sd: standard deviation; PB90: supine 90º; RP90: isometric prone rowing at 90º; S160: isometric squat at 160º; PIS: maximum peak of the isometric strength; MFI: mean value of the isometric strength;
*p≤0,05; *p≤0,001*

Table 6 - Values relative to the body weight of PIS (RPIS) and MIS (RMIS) of the isometric tests

		PB90 (mean ± sd)	RP90 (mean ± sd)	S160 (mean ± sd)
RPIS (N.kg^{-1})	Pre	14.79 ± 2.10	13.41 ± 1.88	34.78 ± 7.13
	Post	13.94 ± 2.38*	12.67 ± 2.35	34.18 ± 6.18
RMIS (N.kg^{-1})	Pre	12.80 ± 2.06	11.55 ± 1.54	26.62 ± 5.93
	Post	11.79 ± 2.49*	10.29 ± 2.88	26.23 ± 5.32

sd: standard deviation; PB90: supine 90º; RP90: isometric prone rowing at 90º; S160: isometric squat at 160º ; PIS: maximum peak of the isometric strength; MFI: mean value of the isometric strength; ;
*p≤0,05; *p≤0,001*

Table 7 - Dependent variables of the strength-time relationship in the exercise of isometric supine pre and post-combat. Time elapsed until reaching the maximum peak of FI (TPFI), category of strength development[51] (SDC) and mechanical impulse (MP)

		mean ± sd	category
TPIS PB90 (s)	Pre	3.83 ± 1.42	2 - 6
	Post	4.77 ± 2.22	2 - 9
SDC PB90 (N.s^{-1})	Pre	100.24 ± 14.36	82 - 132
	Post	75.66 ± 38.29	2 - 115
MP PB90 (N·s)	Pre	4674.63 ± 4257.65	240 - 9713
	Post	6286.50 ± 3821.93	484 - 9587

sd: standard deviation
p≤0,05

Table 8 - Dependent variables of the strength-time relationship in the exercise of pre and post-combat isometric rowing TPIS, SDC and MP

		mean ± sd	category
TPIS RP90 (s)	Pre	3.70 ± 2.88	0.5 - 8
	Post	4.22 ± 1.97	1 - 7
SDC RP90 (N.s^{-1})	Pre	59.98 ± 52.57	(-18) - 126
	Post	66.99 ± 41.70	1 - 119
MP RP90 (N·s)	Pre	7359.00 ± 3181.56	1097 - 9636
	Post	7362.88 ± 2635.99	1912 - 9640

sd: standard deviation; TPIS: peak of maximum of isometric strength; SDC: strength development category[51]; MP: mechanical impulse
p≤0,05

Table 9 - Dependent variables of the strength-time relationship in the exercise of pre and post-combat isometric squat TPIS, SDC and MP

		mean ± sd	category
TPIS S160 (s)	Pre	6.82 ± 2.58	3 - 10
	Post	5.85 ± 1.95	3 - 10
SDC S160 ($N.s^{-1}$)	Pre	259.36 ± 54.93	185 - 340
	Post	198.17 ± 120.96	(-24) - 348
MP S160 (N·s)	Pre	5006.13 ± 2286.96	2126 - 8455
	Post	3939.13 ± 2788.52	364 - 9187

sd: standard deviation; TPIS: peak of maximum of isometric strength; SDC: strength development category[51]*; MP: mechanical impulse p≤0,05*

in a spreadsheet the longitude of the employed current to maintain the angulation proposed for each isometric exercise. This angulation was evaluated by the Jamar manual goniometer. Concluded the familiarization, occurred a specific warm up that lasted 22min.

Stages of the test of physical evaluation

Elapsed 10min after the finalization of the warm up, the pretest evaluation began. Each one of the tests was accomplished in an alternative way. The developed material, procedure and order, were the following ones:

a. Manual isometric strength

Material: Takei dynamometer, model 1875, was used with category understood between 7kg and 99,5kg and 0,5kg increments. *Procedure*: each subject applied the largest possible strength during 5s. The arm that runs the test was attached to the trunk and the elbow extended. The test took place once, alternatively with the right (DD) and left (OF) hands.

b. Counter-movement jump (CMJ)

Material: A contact platform was used Ergojump® connected to the MuscleLab 4000 device. The handling of the signs using the MuscleLab V7.18 software.

c. Maximum isometric strength in the rowing bank 90º, supine 90º and isometric squat 160º exercises.

Material: for the isometric exercises of superior members, it was used a bench and two regulated in height racks; a static Olympic bar (that exercised the settlement function), which was an unbeatable load for the judo fighters of our study. By a carabiner that went by one of the orifices of a MuscleLab System cargo cell, connected to a MuscleLab 4000 device, fixed this to the static bar (Figure 1). Through the free orifice from the cargo cell and with the help of a hook we pass a chain of 1,5m that was hooked at each end of the bar of strength investment (Figure 2).

For the isometric squat 160º the isometric dynamometer was employed according to the offer of Hornillos[49]. The only difference was found in the union of the inferior end

Figure 3 - Load cell united to the lumbar Takei T.K.K. 5102 dynamometer - for the accomplishing of the isometric squat 160º

Figure 5 - Test of maximum isometric strength in squat (S160º)

Figure 4a - Test of maximum isometric strength in prone rowing (RP90º)

Figure 4b - Test of maximum isometric strength in supine (PB90º)

Table 10 - Significant correlations between %HR_{max} and mechanical parameters

		PIS Post vs PIS Pre PB90 (%)	DPIS Post S160
% HR_{max}	*r* of Pearson	-0.689	0.719*
	Sig. (bilateral)	0.059	0.045
PIS Post vs. PIS Pre PB90 (%)	*r* of Pearson		-0.668
	Sig. (bilateral)		0.070

PIS: Peak of maximum of the isometric strength; PB90: supine 90º; S160: isometric squat at 160º
*p≤0,05; *p≤0,001*

Table 11 - Correlation (Rho of Spearman) between% HR_{max} and change index (%) in rowing

		PIS Post vs PIS Pre RP90 (%)
% HR_{max}	Correlation coefficient	-0,786*
	Sig. (bilateral)	0,021
PIS Post vs. PIS Pre PB90 (%)	Correlation coefficient	0,786*
	Sig. (bilateral)	0,021

PIS: peak of maximum of the isometric strength; PB90: supine 90º; RP90: isometric prone rowing at 90º
*p≤0,05; *p≤0,001*

Table 12 - Correlation between post-combat [LA] and mechanical parameters

		TPIS Post S160 (s)	MP Post S160 (N·s)	MP Post vs. Pre S160 (%)
[LA] Post (mmol.L^{-1})	r of Pearson	0.780*	0.728*	0.934*
	Sig. (bilateral)	0.022	0.040	0.001
TPIS Post S160 (s)	r of Pearson		0.386	0.614
	Sig. (bilateral)		0.345	0.105
MP Post S160 (N·s)	r of Pearson			0.856*
	Sig. (bilateral)			0.007

[LA]: sanguine lactate; TPIS: peak of maximum of isometric strength; MP: mechanical pulse; S160: isometric squat at 160º
*p≤0,05; *p≤0,001*

of the cargo cell and a Takei T.K.K. 5102 lumbar dynamometer (Figure 3). It was obtained the strength-time curve (S-t) that represented the traction force in time unit that the subjects exercised on the extensiometric transducers pick-up (cargo cell) connected to the Musclelab 4000 device. *Procedure*: the subjects generated a voluntary maximum contraction during 10s (Figures 4 and 5). The procedure of the tests was described in a previous study[3].

d. Lactacidemia measurement

Material: The portable Escoteiro lactate analyzer was used, which bears reactivate ribbons and a enzymatic-amperometric biosensor system as measurement element. The measurement category range from 0.5 mmol.L^{-1} up to 25.0 mmol.L^{-1}. Took place different comparative studies, finding correlations above 0.95 in the most frequent levels of lactic acid analysis. The time that needs to display the result is of only 15s. *Procedure*: 3min after the finalization of the mechanical tests, was extracted a sample of 0.5µL (microlitre) of blood with a lancet pinch in the earlobe (Figure 6). The extracted blood was put in the reactive ribbon that was introduced in the analyzer to obtain the measurement of the lactic acid concentration in blood.

e. Measurement of the heart rate (HR) during the combat

Material: HR during the confrontation was registered in 5s intervals with a of Polar S625X heart beat monitor. The heart monitor was fastened in the belt of the judo fighters to avoid possible rubbings and impacts. *Procedure*: the observers that accompanied the judo fighters were the person in charge to turn on the beatmeter during the combat and turn it off, keeping the archives to be later analyzed with the Polar Precision Performance software.

Once concluded the combat, and after 1min of recovery, was accomplished a new lactacidemia register. Following, proceeded the repetition of the strength evaluation in the described order.

Finally, elapsed seven days, the measurement of maximum HR (HR_{max}) was made with objective of expressing the values of HR in percentage of the maxim. The judo fighters accomplished an incremental and maxim test: the "course navette" adapted by Thomas *et al.*[50].

The data collection process was schematized in the Figure 7.

Figure 6 - Extraction of the blood sample of the earlobe for the lactate analysis

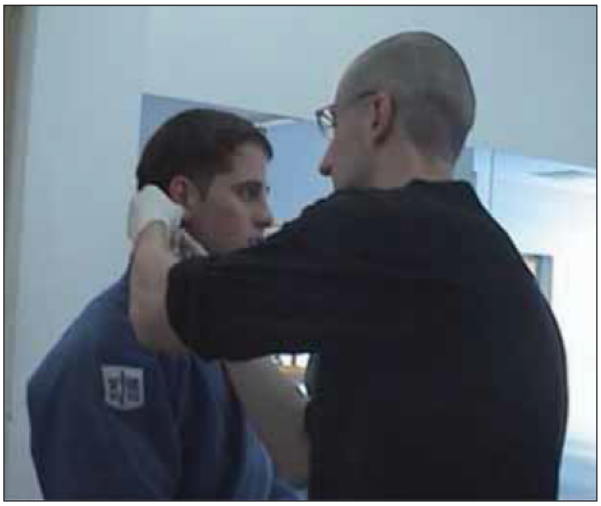


Figure 7 - Schema of the data collection process

Statistical handling

The statistical handling took place by the SPSS 14.0 statistical packet for Windows. In the descriptive study of the results, were contemplated mean, standard deviation and categories (maximum and minimum). The normality of each one of the analyzed variables were accomplished by the test of Shapiro-Wilk. The comparison of means was accomplished using the Student's "t" Test for related samples if the variables presented a normal distribution. Otherwise, the test of the categories of Wilcoxon was employed. The association between equal variables pairs established by the correlation coefficient of Pearson, in the case in that both variables fulfill the normality requirements, or the Rho correlation coefficient of Spearman, in the case that this requirement did not come true. The statistical significance was decided in $p \leq 0.05$.

RESULTS

Metabolic parameters

The results obtained during the evaluation of the metabolic parameters are in the Table 2. The lactacidemy difference between the pre and post-combat values was statistically significant ($p < 0,001$) (Graphic 1).

Mechanical parameters

The values obtained by the judo fighters of our study in the pre-combat and post-combat tests, in relation to the vertical counter-movement jump (CMJ), are exposed in the Table 3.

In the Table 4 are the absolute and relative values of the isometric test of manual dynamometer.

In the Tables 5 and 6 are detailed the absolute and relative mean values of the body weight of the isometric tests. In the Tables 7, 8 and 9 were collected the parameters that are defined for the relationship between the strength and the time: time to reaching the peak of isometric strength (TPIS); strength development category (SDC[51]); and the quantity of strength accomplished by the judo fighters (MP) in the isometric exercises of PB90°, RP90° and S160°.

Assisting the SDC category, we can observe that the minimum is $-18N.s^{-1}$ in pre-combat rowing and $-24N.s^{-1}$ in post-combat squat, what indicates that a decline is produced in the curve, situation that the can be owed to an impairment of the muscular tension by the judo fighters during the execution (Graphic 2).

Correlations between the metabolic and mechanical parameters

Due to the high number of possible pairs, just highlight those that reached statistical significance, in the Tables 10, 11 and 12.

DISCUSSION

Metabolic and mechanical parameters

The discussion of the modifications induced by the confrontation was already aborded in a previous study

(Carballeira & Iglesias[3]), for that this chapter will accost the association between metabolic variables and mechanics. In spite of, it is worth to highlight that the fatigue provoked by the confrontation allocated the isometric strength of the superior limbs, but, on the other hand, was not observed an impairment of the performance in the inferior limbs.

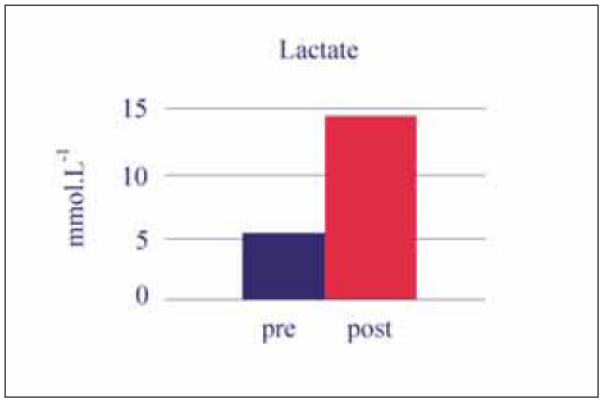
Association between metabolic and mechanical parameters

HR in percentile values of the maxim (%HR_{max}) was only correlated in significant way with a larger percentile loss of performance of the postest PIS regarding the pretest, in the exercise of isometric rowing, besides a larger variability in the strength demonstration (DPIS) during the exercise of postest squat. The significance lack with the remaining of the analyzed mechanical parameters agrees with was marked by Iglesias *et al.*[6], that affirm that aspects of the specific fatigue of the judo fighters linked to local isometric processes are not reflected in its totality by a central parameter, as the heart rate. In spite of the different discovery in the present study, the mentioned authors[6] found association between%HR_{max} and the right manual dynnamometry. It is necessary to take into account that HR is a highly influenciável parameter for motivacionais, thermal, neuromuscular factors, etc.[22,52]. Therefore, its relationship as indicator of the intensity of the exercise loses reliability, especially in intense efforts as judo[6,16,19].

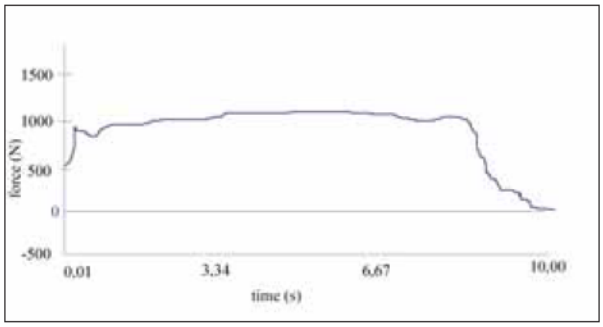
As for the association between lactacidemia and mechanical performance, this was only significant in the squat exercise. In this case, it was found positive and significant correlation between post-combat [LA] and TPIS. Starting from the obtained data it could be deduced that the subjects that had higher values of post-combat [LA] was the judo fighters that elevated their TPIS, reducing the values of TPIS in other cases, since the mean of post-combat TPIS (5.85±1.95s) in squat was smaller than pre-combats (6.82±2.58s) (Graphic 3). On the other hand, exists the explanation because that this association possibility is the focus of the most part of the subjects decrease their TPIS, and those that suffered smaller variation, obtained larger [LA]. This seems to indicate that the [LA] braked the TPIS impairment in some subjects, or that this metabolism allocated the performance in TPIS, starting from certain levels.

Besides, the post-combat [LA] positively and significantly correlated with a parameter that links the stamina to the force, as the post-combat (MP) and its index change (postest/pretest). It is difficult to determine to what extent poat-combat [LA] allocated MP, since this parameter, acted by the accumulated area below the force-time curve, showed several profiles that evidenced different manners of strength investment. Therefore, futures studies should

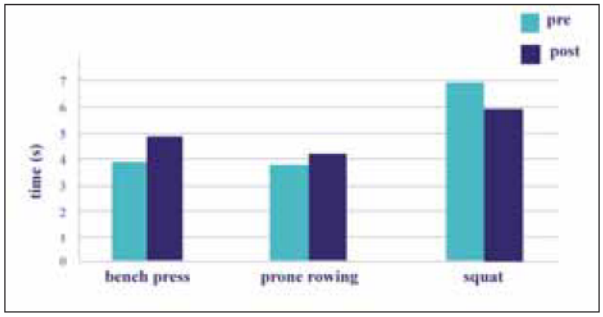
Graphic 1 - Comparative graph of the lactacidemia values before and after the combat



Graphic 2 - F-t Curve of isometric rowing 90º. The subject accomplished an impairment in the tension production, that is reflected in the start of the curve (decline). At the end, he was not capable to maintain the contraction up to 10s



Graphic 3 - Comparative graph of TPIS (s) in the three isometric exercises



contemplate what was already marked by Wilson & Murphy[48] about the relevance of the familiarization when the isometric work is evaluated.

Besides, it is important the adjustment of the articular angles of isometric strength measurement to more favorable articular positions, with the objective to minimize the mistakes in measurement. In this sense, some autors[53] found larger production of the knee extenders in angulations of 105º, front to obtained in 155º. In this study was determined an angulation of 160º, what can be the cause of the obtaining of such variability in the profile when analyzing the curves of isometric strength production in the

squat. Everything that was previously exposed will have to be taken into account in the planning of futures studies.

In the study of the acute effects of the effort in a sporting specialty, when accomplishing the analysis of the associations between different variables is reflected from a more trustworthy way what happened if were taken into account the indexes change between the evaluation moments, than if this analysis was made with the absolute values of such variables. In this study, the [LA] did not associates with indexes change, nor in the superior group or in the inferior group. Regarding this, several authors[21,27,54] assumed that the association between inadequacy of oxygen and accumulation of lactic acidosis is related with the disturbance of the muscular contraction and the further decline of the sporting performance. On the other hand, Brooks[55] indicates that the lactic acid is not the responsible for the increase of muscular acidity. In this line, Robergs *et al*.[56] accomplish a revision which they sustain that there is any biochemical study that demonstrates that the lactate production causes the acidosis, besides they affirm that if the muscle did not produce lactate, the acidosis and the fatigue would appear more quickly, harming the performance in the exercise. In spite of this, the measurement of the lactic acid concentration is a glucolisis occurrence indicator, and, in this sense, even if this metabolite is not the direct responsible for the fatigue, what seems clear is when this situation occurs, the lactic acid is present.

Allied, was not found clear association between indicators of metabolic stress and changes of mechanical performance induced by the confronting, besides the performance in CMJ gets better, even if in a non-significant way, after the accomplishing of a judo combat. This elevation in the jump capacity was not a surprise, since it was reflected in other studies[4,6] with similar measurement situation. That sends us to the coexistence between increase of potency and fatigue, suggested by several authors[57,58,59,60], that propose that, after the accomplishing of maximum muscular contractions, exists a period of time which the fatigue and the potency elevation live together, until that the fatigue vanishes before the potency declines, being produced a temporary improvement in the contractile capacity. This phenomenon was called as post-activation potency (PAP). In this sense, in two doctorate thesis that analyze the development of the muscular strength in successive judo combats, so much for the inferior limbs[1] as in the superior limbs[2], were obtained larger values of muscular potency after combat in relationship with the pre-combat values.

The data contributed in this study show a larger decline of the isometric performance in the superior limbs, compared with the performance of the inferior limbs, that, besides, improves, even failling to reach statistical significance. In this line, Hamada *et al*.[59] found different levels of potency increase between superior and inferior groups, depending on the musculature type involved in the training. Therefore, it seems that, in the judo fighters of this study, the fatigue prevailed in the superior group, while the most punctual request of the inferior group in the confronting seems to allow the potentiation mechanisms to appease the effects of the fatigue.

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