# Relationship of kimono grip strength tests with isokinetic parameters in jiu-jitsu athletes

## *Relação entre testes de resistência de força com o kimono com parâmetros isocinéticos em atletas de jiu jitsu*

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**Abstract** – The aim of the present study was to correlate two specific kimono grip strength tests (KGST) with elbow flexors and extensors isokinetic parameters in Jiu Jitsu (JJ) athletes. Fifteen male JJ athletes, from blue to black belt, participated in the study. The two KGST were: maximum static lift (MSL), and maximum number of repetitions (MNR), both gripping a kimono wrapped around a bar. Isokinetic tests consisted of three sets of 5 s elbow flexion-extension maximum voluntary isometric contraction (MVIC) in three different elbow angles (45, 90 and 120°), and two sets of five concentric-eccentric elbow flexion-extension maximum dynamic contractions at $60°·s^{-1}$, to determine peak torque (PT). Absolute values of MSL and MNR were $41.4 \pm 16.2$ s and $10 \pm 5$ reps, respectively, and tests presented a nearly perfect correlation among them ($r=0.91$; $p<0.001$). Significant correlations were reported between MNR and PT during MVIC for elbow flexors at 45° and 90°, elbow extensors at 120°, and during concentric and eccentric dynamic contractions for both flexors and extensors. Therefore, KGST were highly correlated with isokinetic parameters, and were nearly perfect correlated among them, supporting that one of the tests could be chosen to evaluate strength in JJ athletes. The MNR test presented apparently higher levels of relation than MSL, and provided significant information about muscle strength endurance in JJ athletes.

**Key words**: Martial arts; Muscle strength dynamometer; Sports.

**Resumo** – *O objetivo do presente estudo foi correlacionar dois testes de força (Kimono Grip Strength Tests - KGST) com parâmetros isocinéticos de flexores e extensores do cotovelo em atletas de Jiu Jitsu (JJ). Quinze praticantes do sexo masculino, faixa azul à preta, participaram do estudo. Os dois KGST foram: máximo tempo de sustentação (MTS), e o máximo número de repetições (MNR), ambos com a pegada no kimono enrolado em uma barra fixa. O protocolo isocinético consistiu em três séries de 5 s de contração voluntária isométrica máxima (CVIM) para flexores e extensores do cotovelo, em três ângulos articulares (45, 90 e 120°), e duas séries de cinco contrações dinâmicas no modo concêntrico-excêntrico a $60°·s^{-1}$, para determinação do pico de torque (PT). Os valores absolutos do MTS e MNR foram $41,4 \pm 16,2$ s e $10 \pm 5$ repetições, respectivamente, e apresentaram uma correlação quase perfeita ($r=0,91$; $p<0,001$). Correlações significativas foram encontradas entre MNR e PT durante a CVIM de flexores a 45° e 90°, extensores a 120° e em contrações concêntricas e excêntricas para flexores e extensores. Portanto, os KGST foram altamente correlacionados com parâmetros isocinéticos, e com correlação quase perfeita entre si, concluindo que apenas um dos testes pode ser utilizado para avaliar força em atletas de JJ. O teste MNR parece apresentar maiores correlações quando comparado ao MTS e fornecer informações significativas sobre força muscular em atletas de JJ.*

**Palavras-chave**: *Artes marciais; Dinamômetro de força muscular; Esportes.*

# INTRODUCTION

Jiu Jitsu (JJ) is a combat sport that requires many physical abilities in order to be successful in competition. Upper-body dynamic and static strength endurance are fundamental to execute important technical actions such as grip dispute[1,2] which allows to control the opponent during both attack and defense[3,4]. Therefore, high levels of muscular strength are required for JJ athletes[5], since this capacity is considered a determinant to sport success[1,2,6].

Therefore, the evaluation of upper body muscular strength seems to be a good strategy to predict an athlete's performance. In this sense, isokinetic evaluation, that provides reliable and reproducible data[7], has been used as a method to assess upper extremities strength (i.e. peak torque - PT) in combat sports such as judo[8,9], boxing[8,10], and taekwondo[10]. However, the most common assessment used to measure strength in JJ athletes is hand-grip strength (HSG)[1,3,11]. As it has been shown elsewhere[6,12], HSG does not represent strength demands during a combat. In addition, protocols used can affect values registered[13].

As an alternative method to evaluate judo athletes' upper body strength, a specific test was proposed - Kimono Grip Strength Tests (KGST)[12,14] . KGST are composed of two tests: maximal static lift (MSL) and maximal number of repetitions (MNR). Both tests have been used to verify the physical components that determine the ability to maintain the grip (i.e., isometric and dynamic strength endurance)[14]. Recently, KGTS have been successfully used to discriminate JJ athletes of different competitive levels[6,15,16]. Additionally, these tests present high reliability[15].

To the best of our knowledge, only one study involving judo athletes demonstrated moderate correlations between KGST and other strength test[12]. Nevertheless, MNR and MSL have not been correlated with a reliable nor reproducible test to assess upper body strength, such as the isokinetic dynamometry[7]. Furthermore, KGST are more accessible than dynamometers[12], and the correlation between a practical tool and a recognized strength test could provide the consolidation of these field tests to assess JJ practitioners' fitness status. Thus, the aim of the present study was to correlate KGST with elbow flexors and extensors isokinetic parameters in JJ athletes.

# METHODOLOGICAL PROCEDURES

## Subjects

Fifteen male JJ athletes, from blue to black belt, participated in the present study. Athletes were $26.5 \pm 4.5$ years of age, with training frequency of $5 \pm 1$ times per week for 14.9 uninterrupted months. They were intentionally selected based on the following requirements: (1) subjects between 18 to 40 years of age, and (2) practicing JJ for at least one year, with minimum training frequency of three times per week for two uninterrupted months. Subjects with injuries that could compromise the testing protocol or who were taking any synthetic anabolic substances were excluded from the

study. Participants were recommended to avoid upper body efforts, alcohol, and coffee for approximately 24h before data collection. All volunteers signed an informed consent form in agreement with the State University of Santa Catarina (UDESC) Human Research Ethics Committee (protocol 38774514.4.0000.0118).

## Body composition and handgrip test

Body mass was measured with a scale (SOEHNLE, Murrhardt, Germany) with 0.1 kg resolution and a stadiometer (SANNY, São Paulo, Brazil) with 0.1 cm resolution was used to verify height. Body fat was indirectly determined by skinfold thickness (subscapular, triceps, chest, midaxillary, abdominal, suprailiac, and thigh) using a caliper (CESCORF, Porto Alegre, Brazil) with constant pressure of 10 g/mm$^2$ and 1 mm resolution. Body density was evaluated according to Pollock protocol[17] and body fat by Siri equation[18]. HGS was measured by a dynamometer (SAEHAN™ Corporation, Masan, South Korea) adjusted according to the size of subject's hand[1]. Three non-sequential attempts were made for each hand, and the highest value determined as HGS[1].

## Isokinetic test

After a warm-up and familiarization procedure, isokinetic protocols were performed using an isokinetic dynamometer (Biodex System 4 Pro, Biodex Medical Systems, Shirley, New York, USA) and a Scott Bench. Individuals remained seated next to the dynamometer lever arm, with the shoulder at an angle of 40° of flexion. The apparent elbow joint rotation axis was aligned with the dynamometer rotation axis. The subject's forearm was in a neutral position during all procedures[19]. Tests consisted of 3 sets of 5 s elbow flexion-extension maximum voluntary isometric contraction (MVIC), with 10 s between them[20], in three different elbow angles (45, 90 and 120°), in a random order, and two sets of five concentric-eccentric elbow flexion-extension maximum dynamic contractions at 60°·s$^{-1}$ to determine PT. In order to avoid fatigue, there was 2 min rest interval between attempts[10].

## Kimono Grip Strength Tests (KGST)

On a different day, after general and specific warm up procedures previously described[6,14,16], athletes performed the two KGST (MSL and MNR) both gripping a kimono wrapped around a bar. First, athletes performed the MSL, defined as the time that the subject was able to sustain his own weight at maximal elbow flexion[6,14]. After a 15 min rest period, participants completed the MNR, which consisted of performing a maximum number of repetitions from elbow fully extended to elbow fully flexed, using the same grip as applied during MSL[6,14].

## Statistical analysis

All statistical analysis was performed in SPSS 17.0. Data normality was checked and confirmed via Shapiro Wilk test. Values are presented as mean

and standard deviation (SD). Correlations between KGST and isokinetic parameters were obtained by Pearson product moment, and Hopkins scale[21] was used to classify correlations. The significance level was set at 0.05.

## RESULTS

Descriptive data for body composition and HGS are presented in table 1. Absolute values of MSL and MNR were $41.4 \pm 16.2$ s and $10 \pm 5$ reps, respectively, and tests presented a nearly perfect correlation among them ($r=0.91$; $p<0.001$).

**Table 1.** Mean and standard deviation (SD) for anthropometric and maximal isometric handgrip strength values of jiu jitsu athletes (n=15).

|  | Mean ± SD |
|---|---|
| Body mass (kg) | 82.18 ± 11.92 |
| Height (cm) | 175.83 ± 7.20 |
| Body fat (%) | 14.59 ± 5.58 |
| $HGS_{RIGTH}$ (kgf) | 48.06 ± 5.70 |
| $HGS_{LEFT}$ (kgf) | 45.53 ± 7.86 |

$HGS_{RIGTH}$ = Handgrip strength right side; $HGS_{LEFT}$ = Handgrip strength left side.

Table 2 presents the data for normalized PT of elbow flexors and extensors during isometric and dynamic contractions.

**Table 2.** Mean and standard deviation (SD) for relative peak torque (PT) during isometric (45, 90, and 120º) and dynamic contractions of the jiu-jitsu athletes (n=15).

|  | FLEXORS | EXTENSORS |
|---|---|---|
| $PT_{45°}$ (N·m·kg$^{-1}$) | 0.77 ± 0.12 | 0.63 ± 0.10 |
| $PT_{90°}$ (N·m·kg$^{-1}$) | 0.91 ± 0.16 | 0.71 ± 0.13 |
| $PT_{120°}$ (N·m·kg$^{-1}$) | 0.77 ± 0.13 | 0.71 ± 0.13 |
| $PT_{CON}$ (N·m·kg$^{-1}$) | 0.68 ± 0.17 | 0.79 ± 0.19 |
| $PT_{ECC}$ (N·m·kg$^{-1}$) | 0.87 ± 0.20 | 1.10 ± 0.25 |

$PT_{CON}$ = peak torque concentric; $PT_{ECC}$ = peak torque eccentric.

All correlation analyses were made with data normalized by body mass. Table 3 shows correlations between KGST and elbow flexors isometric and dynamic isokinetic parameters. Correlations between KGST and elbow extensors are shown in table 4.

**Table 3.** Correlations between normalized data of Kimono Grip Strength Tests and isokinetic parameters for elbow flexors (n=15).

|  | MNR | | MSL | |
|---|---|---|---|---|
|  | r | p | r | p |
| $PT_{45°}$ | 0.78 | 0.001 | 0.71 | 0.003 |
| $PT_{90°}$ | 0.75 | 0.001 | 0.60 | 0.017 |
| $PT_{120°}$ | 0.65 | 0.008 | 0.54 | 0.034 |
| $PT_{CON}$ | 0.71 | 0.003 | 0.66 | 0.007 |
| $PT_{ECC}$ | 0.82 | 0.000 | 0.81 | 0.000 |

MNR = maximal number of repetitions; MSL= maximal static lift; PT = peak torque; $PT_{CON}$ = peak torque concentric; $PT_{ECC}$ = peak torque eccentric.

**Table 4.** Correlations between normalized data of Kimono Grip Strength Tests and isokinetic parameters for elbow extensors (n=15).

| | MNR | | MSL | |
|---|---|---|---|---|
| | r | p | r | p |
| $PT_{45°}$ | 0.46 | 0.082 | 0.39 | 0.141 |
| $PT_{90°}$ | 0.59 | 0.018 | 0.40 | 0.132 |
| $PT_{120°}$ | 0.82 | 0.000 | 0.71 | 0.003 |
| $PT_{CON}$ | 0.82 | 0.000 | 0.69 | 0.004 |
| $PT_{ECC}$ | 0.75 | 0.001 | 0.75 | 0.001 |

MNR = maximal number of repetitions; MSL = maximal static lift; PT = peak torque; $PT_{CON}$ = peak torque concentric; $PT_{ECC}$ = peak torque eccentric.

## DISCUSSION

The aim of this study was to correlate KGST (MNR and MSL) with elbow flexors and extensors isokinetic parameters. Our main finding was that there were significant correlations between MNR and MSL with most of the isometric angles analyzed, and with concentric and eccentric dynamic contractions. Although field tests are important to evaluate, discriminate, and develop training programs, these correlations have never been studied before, and the significance reached between the field tests and the isokinetic variables provide indication of the validity of these tests.

To characterize subjects from present study, we evaluate body composition and HGS. In JJ athletes, low body fat and high levels of lean mass have been reported[5,22,23]. In the present study, higher body fat percentage (14.59%) was observed in comparison to Del Vecchio et al.[5] (9.83%) and Andreato et al. [22] (10.3%). However, this difference may be due to athletes' higher competitive level in other investigations as well as a consequence of distinct training program period during evaluations. Regarding HGS, this test has been extensively used to evaluation of JJ athletes[1,3,11]. However, comparison between studies may not be reliable, since distinct protocols can influence results of this parameter[13]. In this way, when compared with studies that used the same protocol, we found lower[3] and similar[11] values.

To the best of our knowledge, there was no study regarding muscular torque of elbow flexors and extensors in JJ athletes. Only one study[10] evaluated elbow flexion PT at 90° in different combat sport athletes. Although JJ comprises more isometric elbow actions than other combat sports[14], results from normalized PT[10] were slightly higher for elbow flexors (boxers: 1.05 N·m·kg⁻¹; taekwondo ITF: 1.12 N·m·kg⁻¹, and taekwondo WTF: 1.0 N·m·kg⁻¹) than those observed in the present study (see Table 2). These differences could be due to athletes' experience level[10] (i.e. international vs regional), and/or by subjects' adjustment during the dynamometry test (i.e. forearm position)[19]. However, results for elbow extensors[10] were similar (boxers: 0.73 N·m·kg⁻¹; taekwondo ITF: 0.72 N·m·kg⁻¹, and taekwondo WTF: 0.71 N·m·kg⁻¹) to those reported in JJ athletes (see Table 2).

Regarding KGST, high-level judo athletes performed 35 ± 18 s and 12 ± 5 reps, while regional judo players achieved 39 ± 14 s and 9 ± 4 reps

for MSL and MNR, respectively, with significant differences only in the MNR[14]. However, for JJ athletes both tests resulted in significant differences between athletes with different competitive levels[6,15]. Additionally, several studies evaluated MSL and MNR in JJ athletes, in which results were nearly identical to our results, mainly to MNR results[15,16]. Only one study[15] investigating high-level athletes reported better performance in MSL (56 ± 10 s). These similarities allow us to compare and to imply the extrapolation of our findings. Furthermore, in the present study, correlation between MNR and MSL was nearly perfect (r=0.91; p<0.001), while previous studies found correlation values of 0.75 (p=0.013) in judo[12] and 0.71 (p=0.001) in JJ athletes[15]. Therefore, the assumption that MNR or MSL could be chosen to evaluate strength performance[12] is supported by our results. Moreover, high-level correlation shows that results of any KGST can be used to assess muscular fitness status in JJ athletes, with high reliability[15] (MSL: ICC=0.99, limits of agreement = -6.9 to 2.4-s, with a mean difference of –2.3-s, 95% confidence interval: –3.3 to –1.2-s, and MNR: ICC=0.97,limits of agreement were –2.9 to 2.3-rep, with a mean difference of –0.3-rep, 95% confidence interval: –0.9 to 0.3-rep). To the best of our knowledge, the only study that investigated correlation between KGST and others standardized strength tests was conducted in judo athletes[12]. According to the authors, moderate correlations were observed between KGST and average relative power assessed by Wingate anaerobic test for upper limbs (r = 0.69), relative $HGS_{LEFT}$ (r = 0.73), and relative 1RM in row exercise (r = 0.71)[12].

Results showed a very large correlation between MNR and flexors PT during concentric and eccentric dynamic contractions and for MVIC at 45° and 90º (Table 3), which corresponds to the same joint angle of the initial and middle phases of the MNR test, when subject pulls up concentrically. Although the main movement of the MNR is the elbow flexion, there is a concomitant shoulder extension, recruiting muscular action from shoulder extensors, as well as the long portion of triceps brachii[24]. Therefore, a very large correlation of MNR with elbow extensors PT in dynamic modes and in MVIC at 120° (Table 4) suggests that there could be substantial contribution of triceps brachii during MNR execution.

Despite the isometric pattern of the MSL, it seems that the highest correlation observed was not with MVIC, but with eccentric dynamic contractions, both for elbow flexors (Table 3) and extensors (Table 4). In fact, there was a very large correlation of MVIC of elbow flexors at 45°, disputing the idea that the most specific joint angle (120°) in the dynamometer would present the largest level of correlation. Nevertheless, levels of correlation of all MVIC were apparently lower than those obtained at eccentric mode. Tendency analysis during the execution of MSL (while athletes sustained their own body mass) revealed a clear effort to avoid eccentric contraction of elbow flexors and shoulder extensors, while maintaining isometric position at the maximum flexion elbow angle. Therefore, even with the isometric aspect of the MSL test, it seems that this test represents a better correlation with subjects' eccentric strength, more than the isometric capacity.

Therefore, both MNR and MSL are closely related to strength parameters in elbow flexors and extensors. It has been previously claimed[6] that the MNR test represents a more precise way to estimate strength parameters than handgrip dynamometers in JJ athletes. In the present study, even with the dynamic patterns of the test, MNR presented supposedly a higher index of correlations than MSL for every angle evaluated isometrically or dynamically, both for elbow flexors and extensors. These results suggest that MNR test could assess muscular strength parameters in JJ athletes, with high levels of correlation with isometric, concentric, and eccentric PT, measured by isokinetic dynamometry.

## CONCLUSION

Kimono grip strength tests were highly correlated with parameters from the isokinetic dynamometer evaluation. As the correlation among the two KGST were nearly perfect, one of them could be chosen to evaluate strength in JJ athletes, especially the MNR test, which presented apparently higher levels of correlation with the isokinetic parameters than MSL. This test with specific kimono grip provides significant information about muscle strength endurance in JJ athletes, supporting new studies with this population and helping coaches and practitioners to develop training programs.

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