

Effect of official judo matches on handgrip strength and perceptual responses

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This study aimed to verify the effect of judo matches on handgrip strength and perceptual responses during an official tournament in medalists and nonmedalists. Thirty-four male judo athletes participated in an official judo tournament. Before the first match and immediately after each match, maximum isometric handgrip strength and rate of perceived exertion overall and in specific areas were assessed. Analysis of variance for repeated measures was used to compare variables before the first match and after each match, and *t*-test was used to compare medalists and nonmedalists with the level of significance set at 5%. Also, effect size (ES) analysis was used. The results showed decrease in handgrip strength in both hands from the third match ($P < 0.05$). The rate of perceived exertion (RPE) increased from the first match and remained high

over the subsequent matches ($P < 0.001$). A very large effect for nonmedalist group (ES = 3.44) and large effect for medalist group (ES = 1.94) was found in the third match compared to prematch. Forearm and fingers were the body regions most cited by athletes in both groups. We concluded that an official judo competition induced significant drop in handgrip strength from the third match and increased the RPE from first match. Medalists seem to have better recovery after the third match compared to nonmedalists.

Keywords: Combat sports, Maximal isometric force, Fatigue, Rate of perceived exertion, Ecological validity


INTRODUCTION

Judo is a combat sport in which athletes are engaged in several high-intensity efforts of intermittent nature (Franchini et al., 2014), requiring a combination of neuromuscular and metabolic systems. The upper limbs are constantly performing pulling and pushing movements to maintain handgrip on the *judogi* and to prepare for attack (Franchini et al., 2013). For this reason, the handgrip strength is considered determinant for judo performance, allowing the execution of throwing techniques and impairing the opponent's actions (Bonitch-Góngora et al., 2012; Calmet et al., 2010).

During an official tournament, judo athletes perform several matches with short recovery periods (approximately 10 to 15 min) between them (Franchini et al., 2011a). The successive efforts may induce muscle fatigue (strength decrement) determining the ath-

lete's performance over the competition, particularly in the final bouts (Detanico et al., 2015). Previous studies have found up to a 15% decrement in isometric handgrip strength after the second judo matches during a simulated competition (Bonitch-Góngora et al., 2012; Iglesias et al., 2003) and a decrement of up to 5% in the shoulder internal and external rotation peak torque after three simulated judo combats (Detanico et al., 2015).

Besides the evident strength decrement after successive combats, effort perception may also provide valuable information about the performance impairment (Day et al., 2004; Detanico et al., 2015; Enoka and Stuart, 1992). The rate of perceived exertion (RPE) reflects the integration of peripheral and central signals that, interpreted by the sensory cortex, produce the general or local perception of the commitment to perform a certain task (Borg, 1982). RPE has already been used to evaluate the intensity of judo com-

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petitions, showing values close to “very hard” and “very strong” after simulated judo matches (Branco et al., 2013) and official competition (Serrano et al., 2001), respectively. The RPE intensity seems to have a strong relationship with other internal load indicators of exercise intensity, such as blood lactate concentration (Gutierrez-Sanchez et al., 2011; Serrano-Huete et al., 2016) and heart rate during judo matches (Bonitch-Dominguez et al., 2005; Branco et al., 2013).

Several parameters have been used by coaches to monitor fatigue and recovery during training or competition, and RPE is one of the most employed because of its ease of use and applicability in different combat sports (Slimani et al., 2017). In the same way, the evaluation of handgrip strength during training or competition may provide important information for load control and recovery strategies, since it is considered a determining factor of judo performance (Bonitch-Góngora and Almeida, 2014; Bonitch-Góngora et al., 2013; Calmet et al., 2010). However, to the best of our knowledge, handgrip strength has not been evaluated in an official competition. During actual competition the evaluation of these parameters show higher ecological validity, since the loss of strength and RPE control may be affected by other aspects of the environment (e.g., psychological factors, rapid weight loss, etc.), which are not evidenced in simulated matches. Furthermore, no information about the responses of handgrip strength loss and RPE were found in the current literature with regard to competition performance. Previous studies verified higher values of handgrip strength in judo medalist athletes compared to nonmedalists (Gutierrez-Sanchez et al., 2011), but it is not confirmed in other studies (Drid et al., 2015; Franchini et al., 2005). Thus, this study aimed to verify the effect of judo matches on isometric handgrip strength and perceptual responses during an official tournament in medalists and nonmedalists.

MATERIALS AND METHODS

Participants

Thirty-four male judo athletes participated in the study, comprising 12 purple belts, 10 brown belts, and 12 black belts. Athletes of eight weight categories were divided into two groups: medalists ($n = 16$) and nonmedalists ($n = 18$) with the following characteristics: medalists -23.0 ± 6.7 years old, 75.1 ± 9.8 kg of body mass, 177.8 ± 5.0 cm of height and 13.6 ± 15.5 years of practice time; nonmedalists -23.0 ± 6.7 years old, 72.5 ± 15.0 kg of body mass, 175.9 ± 10.2 cm of height and 14.8 ± 6.4 years of practice time. Athletes were evaluated during an official judo tournament

at state level, with the consent of the organization. All participants and coaches were informed about the aim of the study and signed the informed consent form. The study was approved by the Research Ethics Committee of the local university (protocol number: 2.032.340 Aug 05).

Procedures

Each athlete performed a different number of matches, according to the tournament and the eliminations (minimum one and maximum four). Six athletes performed one match, two athletes performed two matches, 17 athletes three matches and nine athletes four matches. Body mass and height were measured before the competition, before the first match and immediately after each match the handgrip strength and RPE were measured, following the procedures described by Detanico et al. (2017). Also, the perception of effort in specific areas of the body was measured after the last match (Detanico et al., 2017).

Isometric handgrip strength

The isometric handgrip strength was measured by a dynamometer (Carci 225, SH 5001 model, Saehan Corp., Masan, Korea). Athletes were evaluated before the first match and immediately after each match (Detanico et al., 2017) and were instructed to perform the test with maximal effort for 5 sec in both hands. The evaluation was performed with the judokas in standing position, shoulder in 90° of flexion and the elbow completely extended (Bonitch-Góngora et al., 2012). The intraclass correlation coefficient of the handgrip strength dynamometer was calculated previously (Lindstrom-Hazel et al., 2009), showing a range from 0.96 to 0.98 for both hands.

RPE assessment

The application of the scale was performed before the first match and immediately after each fight, in which the athlete answered the following question: “How intensity was your match?” The answer to the question is provided from an analogic scale, from 6 to 20, in which the maximum value (20) was considered the highest physical effort performed and the minimum value (6) the absolute rest condition. Furthermore, after the last match, the athletes reported the RPE in specific areas of body (muscles or muscular groups) according to Nilsson et al. (2002). In the final of competition, athletes were asked to indicate, on an anatomical diagram of anterior and posterior body maps, the areas with most effort perception during the matches (Detanico et al., 2017). They were asked about the magnitude of perceived the exertion (6–20

arbitrary units [a.u.]) and the muscles or muscle groups in which they felt involved. This scale has already been used in other studies with combat sports (Andreato et al., 2015; Chino et al., 2015; Detanico et al., 2017).

Statistical analysis

The Shapiro–Wilk and Mauchly tests were used to verify the normality and the sphericity of data, respectively. Analysis of variance (repeated measures) and Bonferroni correction were used to compare handgrip strength and RPE over the judo matches. The *t*-test was used to compare the variables between medalist and nonmedalist groups (independent samples) and to compare the RPE between specific areas of the body in medalist and nonmedalist groups (dependent samples). The SPSS ver. 17.0 (SPSS Inc., Chicago, IL, USA) was used for analyses with a level of significance set to 5%. The G*Power 3.1.7 software (University of Kiel, Kiel, Germany) was used to calculate the effect size (ES). The Hopkins (2002) criterion of classification was used: 0.0–0.2, trivial; 0.21–0.6, small; 0.61–1.2, moderate; 1.21–2.0, large; 2.1–4.0, very large.

RESULTS

Fig. 1 shows the mean and standard deviation of handgrip strength in prematch and postmatches 1, 2, 3, and 4. The number of athletes evaluated after each match decreased over the tournament (postmatch 1, 34 athletes; postmatch 2, 28; postmatch 3, 25; postmatch 4, 9). Analysis of variance showed significant effect in handgrip strength over the tournament for right hand ($F=4.90$, $P=$

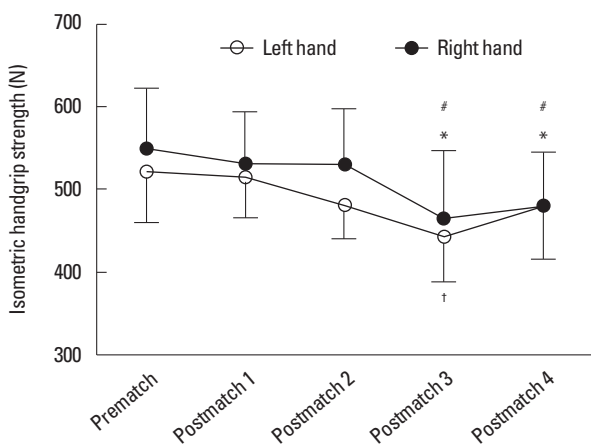


Fig. 1. Handgrip strength of right and left hands during official competition. *Significantly different from prematches. #Significantly different from postmatch 2. †Significantly different from postmatch 1 and 2.

0.005, ES=0.90 – moderate) and left hand ($F=3.70$, $P=0.017$, ES=0.78 – moderate). The *post hoc* analysis indicated that the handgrip strength (right hand) decreased in postmatch 3 and 4 when compared to the prematch and decreased in postmatch 3 and 4 when compared to postmatch 1 and 2. For the left hand, handgrip strength decreased in postmatch 3 compared to prematch and decreased in postmatch 2 when compared to postmatch 3.

Fig. 2 shows the RPE over the matches. A time effect was verified ($F=7.33$, $P=0.001$, ES=1.10 – moderate), in which the values increased after postmatch 1, 2, 3, and 4, when compared to prematch.

Table 1 shows the values of handgrip strength and RPE between medalists and nonmedalists in the prematch compared to postmatches 1, 2, and 3. Considering the prematch vs. postmatch 1, a significant increase was found for the RPE in both groups. According to the effects magnitude, the medalist and nonmedalist teams showed a small effect for right and left hand, and a very large effect for RPE, in both groups. After match 2, only RPE increased compared to the prematch condition. A significant decrease in handgrip strength in the right hand and an increase in RPE were found after postmatch 3 in both groups compared to prematches. According to the effects magnitude, the right hand showed small effect for both groups while left hand showed a moderate effect in the medalist group and a small effect in the nonmedalist athletes. The RPE presented a very large effect for the nonmedalist group and a large effect for the medalist group.

The RPE values obtained after the judo official competition, considering all athletes, medalist and nonmedalist groups are described in Fig. 3. The medalist presented fingers, abdomen and

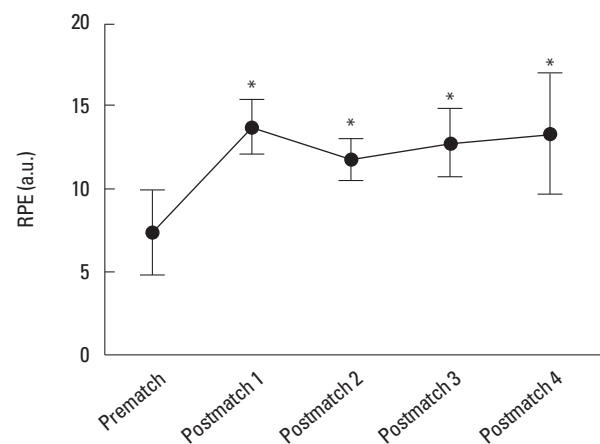


Fig. 2. Rate of perceived exertion (RPE) over the matches. a.u., arbitrary units. *Significantly different from the prematch.

Table 1. Handgrip strength (HS) of right and left hand, and RPE of prematch and postmatches for medalist and nonmedalist groups

Group	Prematches	Postmatch 1	ES	P-value	Postmatch 2	ES	P-value	Postmatch 3	ES	P-value
Medalists										
HS_RH (N)	606.2±117.2	573.8±123.6	0.34	0.16	575.7±128.5	0.37	0.12	517.9±119.6	0.87	0.03
HS_LH (N)	567.0±134.3	549.3±122.6	0.21	0.38	536.4±124.5	0.37	0.14	491.4±92.2	0.80	0.06
RPE (a.u)	6.5±1.7	11.8±2.7	2.24	<0.01	11.25±2.51	2.88	<0.01	13.5±4.0	1.94	<0.01
Nonmedalists										
HS_RH (N)	509.1±112.8	483.6±116.7	0.35	0.07	501.0±104.9	0.41	0.21	433.6±114.7	0.76	0.02
HS_LH (N)	499.3±122.6	485.5±93.1	0.18	0.19	473.3±123.3	0.22	0.36	415.9±102.0	0.60	0.05
RPE (a.u)	6.2±0.8	13.8±2.8	3.01	<0.01	13.5±2.53	3.20	<0.01	14.8±2.8	3.44	<0.01

Values are presented as mean ± standard deviation.

RPE, rate of perceived exertion; ES, effect size; RH, right hand; LH, left hand; a.u., arbitrary units.

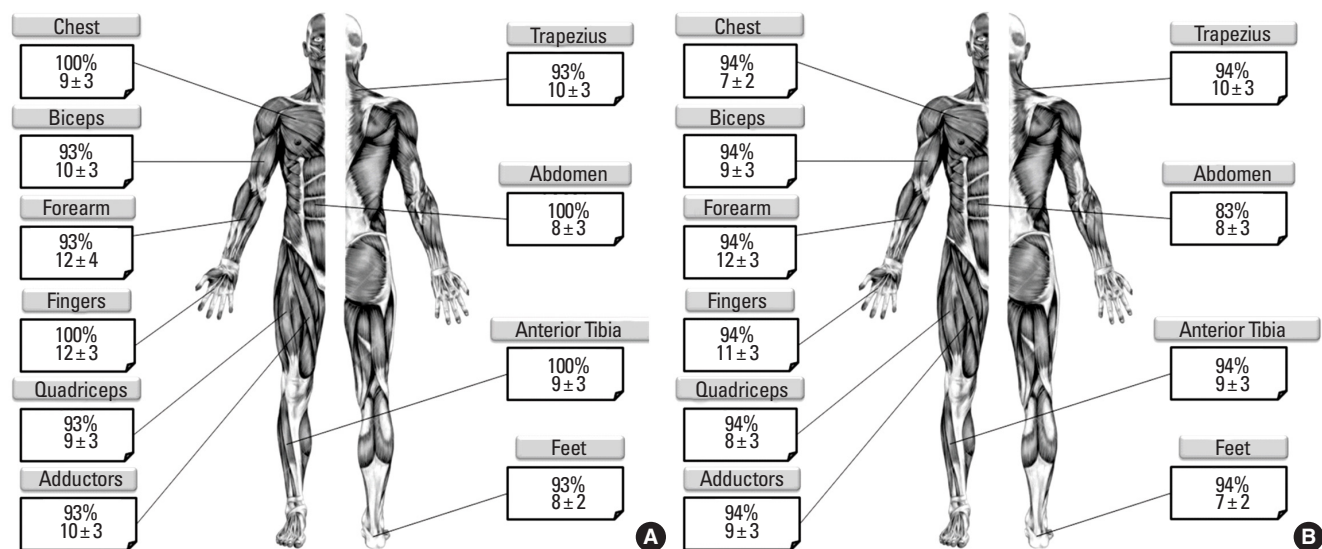


Fig. 3. Relative frequency of specific areas cited by the total athletes and intensity of rate of perceived exertion values (mean ± standard deviation of 6–20 arbitrary units) measured after the official judo competition for medalist (A) and nonmedalist (B) groups.

anterior tibia (100% for all) as the most cited areas and the non-medalist group showed the forearms and fingers (94%) as the most referred. The percentage of each area represents the number of individuals who referred it. The most effort magnitude was also in the fingers and forearm in all athletes—both medalists and non-medalists. Comparing the RPE between the upper body and the lower body, higher values were found in the upper body for the medalists ($P = 0.010$) and nonmedalists group ($P = 0.002$). There was no significant difference between medalists and nonmedalists for the upper body ($P = 0.18$) and lower body ($P = 0.14$).

DISCUSSION

The purpose of this study was to verify the effect of judo matches on isometric handgrip strength and perceptual responses during

an official tournament in medalists and nonmedalists. The first hypothesis was accepted since the handgrip strength decreased and the RPE increased over the combats, as previously related in literature regarding simulated competition. The second hypothesis was rejected because no differences in handgrip strength drop and RPE over the course of the matches were found in either the medalist or nonmedalist athletes. However, ES analysis revealed that the increase in RPE reported after the third match seems to be greater for the nonmedalist group (very large effect) than for the medalists (large effect).

In this study, 12% of handgrip strength decrement in the right hand and 7.8% in the left hand was verified from postmatch 3 compared to the baseline. Previous studies have investigated handgrip strength only during simulated judo combats and reported a decrement of ~15% in maximum isometric handgrip strength at

the end of a tournament in judokas after four matches. Iglesias et al. (2003) observed 5% of decrement in handgrip strength after the first judo official match and 15% after the second. Most parts of judo combat involve handgrip disputes that require elevated levels of isometric and dynamic strength (Franchini et al., 2013), resulting in fatigue over the tournament. The decrease in the capacity to produce maximal force during intense exercise seems to be somewhat inevitable (Enoka and Stuart, 1992), but knowing the magnitude and timing of this loss of strength is very important for training control.

It has always been a constant concern of coaches to have practical and useful indicators of load and intensity control; from this perspective, RPE has been widely used in recent years (Slimani et al., 2017). RPE increased significantly in all matches from the first match and the intensity considered as “somewhat hard.” Some studies have reported comparable findings after an official and a simulated judo competition, Serrano et al. (2001) verified RPE values close to “somewhat hard” after three judo official matches and Serrano-Huete et al. (2016) reported “heavy” RPE over successive simulated matches.

In the present study we tested whether these load control variables of the matches would differ according to the level of performance obtained in the competition. No difference was found between medalist and nonmedalist groups for handgrip strength. Official judo competition induced a decrease in handgrip strength only after the third match for both groups, showing the first and second matches were still not enough for the accumulation of fatigue in forearm muscles. Gutierrez-Sanchez et al. (2011) found higher handgrip strength in female gold medalists compared to bronze medalists and nonmedalists, indicating the finalist athletes seem to present higher muscular endurance in the forearm muscles. However, Drid et al. (2015) found no difference in the handgrip strength between elite and nonelite judo medalists of half-heavyweight category. Franchini et al. (2005) also observed no difference in the handgrip strength between elite and nonelite judo athletes. Thus, it is still unclear whether the handgrip strength can be used to discriminate medalist and nonmedalist athletes. Judo-specific protocols involving dynamic actions seem to show better discriminant power, e.g., in the Special Judo Fitness Test and Judogi Grip Strength Test, especially in the dynamic mode (Franchini et al., 2011b). This supports the idea that the *judogi* grip is also dependent of dynamic actions of the upper limbs, particularly in the arms, forearms, and back muscles.

RPE responses were similar in medalist and nonmedalist groups after the first and third match; however, a very large effect for non-

medalist group and a large effect for medalist group were reported in postmatch 3 when compared to prematch. This may indicate better recovery in the medalist group after the third match, i.e., probably the medalists have a better level of physical fitness or better technical efficiency and effectiveness during the matches (Drid et al., 2015). Lastly, we analyzed whether RPE in the body areas could differ between medalists and nonmedalists. Medalist group reported fingers, abdomen and anterior tibia as the most cited areas, and nonmedalist group cited forearms and fingers. Forearm and finger muscles are involved in handgrip actions, whereas the anterior tibia and abdomen muscles group is required for several throwing techniques, attack, defense, and transitions to the groundwork (Franchini et al., 2011a; Franchini et al., 2013). Similar findings were observed in previous studies that found higher values of RPE in the forearm muscles after simulated jiu-jitsu matches (Andreato et al., 2014; Andreato et al., 2015) and after an Greco-Roman wrestling tournament (Nilsson et al., 2002). No studies assessing the RPE values during judo matches were found for medalist and nonmedalist athletes.

Higher values of RPE in the upper body compared to lower body were found for both medalist and nonmedalist athletes; on the other hand, no differences between the groups were verified. The greater demand of the upper body observed in the current study may be explained because athletes spend a lot of time in gripping the opponent's *judogi* (Miarka et al., 2012). This corroborates the handgrip strength drop, particularly after the third match. According to Franchini et al. (2011b), the upper body of judokas is constantly involved in actions of maximal strength muscular endurance and power, which explain the perception of high effort.

In conclusion, an official judo competition induced significant drop in the handgrip strength in both hands from postmatch 3, and increased the RPE from the first match. Forearms and fingers were the areas most reported by the athletes as greatest effort. Both medalist and nonmedalist groups reported decrease in handgrip strength and increase in RPE over the matches; however, the medalists seemed to show better recovery after the third match.

The findings of this study may provide valuable information for coaches to improve the physical performance of judokas. To maintain optimum levels of neuromuscular performance in a tournament, strength and endurance exercises may be performed, especially using specific exercises involving pulling and pushing actions in gripping the *judogi*. Motor actions that require the forearms, fingers and back muscles should be developed for repeated muscle activation in both medalist and non-medalist athletes. RPE scale (6–20) may be considered an appropriate method to identify

the responses during official judo matches. Also, it may be used to plan the training loads to stay close to the real combat situation and to use as an appropriate method to control the stress-recovery balance (Slimani et al., 2017). The responses of both handgrip strength and RPE seem to be similar in official (as in the present study) and simulated judo matches (Bonitch-Góngora et al., 2012; Branco et al., 2013; Iglesias et al., 2003; Serrano-Huete et al., 2016), showing that these variables may be assessed during simulated matches with similar neuromuscular and perceptual responses than official matches.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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