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# Thigh muscles flextion/extension ratio in elite judo players

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**Key words:** imbalance, muscle strength, female and male judo players

## Summary

**Introduction.** The female team won the 3rd and male team won the 5th place during European Team Championship in 2006. The goal of this study was to evaluate strength of thigh muscles, concerning flexion/extension ratio.

**Material and methods.** Our research was conducted among 28 (13 female and 15 male) competitive judo players. We suggest that it is necessary to determine whether there is an imbalance among two groups of muscles, which could interfere with technique delivery and increase the injury risk.

**Results.** Isokinetic strength testing revealed a 4.5 %difference between the left and right leg extensors. The average difference between left and right leg flexors was 9.9 %. The analysis showed statistically significant differences.

**Conclusions.** The authors suggest that the above mentioned differences should be corrected in order to achieve the best possible performance. Balance plate training is proposed for such corrections.

## Introduction

In top-level judo, muscular strength is one of the most important abilities. It is important to determine the maximum muscle strength of the judo practitioners, their muscular stamina – its weaknesses and strong points. We can observe all of these indicators using isokinetic dynamometry. Isokinetic diagnostic devices are used for evaluating the current condition of the locomotor apparatus so that the strength of certain muscle groups is tested at different movement speeds. In testing the extremities, lower angular velocities are most often used for measuring maximum strength and higher angular velocities (with a higher number of repetitions) for determining the stamina. Furthermore, during the test, other important parameters are obtained, such as the overall work, movement amplitude, fatigue index, the agonistic/antagonistic muscle groups ratio, etc. [1]. Based on the test, the analysis results and the research carried out so far, [2, 3], it is possible to determine individual abilities of judo practitioners, which further enables making a productive plan and program of training with the precise choice and graded load. In the specification equation of judo, strength occupies a dominant position among the motor abilities [4, 5]. However, in addition to maximum strength, in order to achieve top level sport results it is of utmost importance to maintain a proper strength balance of different muscle groups that prevent a number of injuries which could turn out to be an impeding factor in achieving those results. On the basis of the achieved results, we can model a training process for every judo practitioner in particular. It is necessary to determine whether there is an imbalance among the muscle groups that might have a negative effect on technique performance quality or that might predispose judo practitioners to injuries. Isokinetic testing helped us determine the balance between the agonistic/antagonistic thigh muscles and their bilateral relationship.

## Material and methods

The sample examinees were 13 women (mean age = 19.2 ± 5.1, mean body height =165.7 ± 14.4 cm, mean body weight = 61.25 ± 15 kg), the Serbian judo representatives that won bronze medals in the European Team Championship 2006, and 15 men (mean age = 23.77 ± 8.93, mean body height = 176.46 ± 19.54, mean body weight = 81.02 ± 42.98 kg). The examinees had practiced judo for 14.7 ± 6.2 years. They were tested using „Easy-tech" isokinetic dynamometer. The very testing was carried out at the Provincial Sport Institute according to the standard protocol. The movement amplitude for the tested extremity was 90 degrees. The person who gave instructions to the examinees before the testing was the same person who conducted the measurement. The seat of the dynamometer

was adjusted for every examinee individually, so that the knee joint would be in the axis of measuring head node of the device. The examinees were immobilized in their seats with straps so that movements of only one muscle group (abductor outer thigh and adductor inner thigh muscles) would be possible. The measurement was preceded by a warm-up of the examinees on the apparatus at the tested speed of 60º/s, which was followed by a 2-minute rest period before maximum contractions were performed. 4 maximal contractions were performed in sequence. During the test, the device recorded the following values: peak torque, peak torque as the body weight percentage, maximum work and the overall work as the body weight percentage. The relation between the maximum muscle strength of the front and rear muscles was determined as a derived variable. The software package of the dynamometer collected the data that were later statistically processed. The same procedure was carried out for both legs [6, 7].

In this research the following battery of tests was used:

1. Extensor muscle strength of the right thigh musculature – EMSR
2. Extensor muscle strength of the left thigh musculature – EMSL
3. Flexor muscle strength of the right rear thigh – FMSR
4. Flexor muscle strength of the left rear thigh – FMSL

# Results and Discussion

Isokinetic diagnostics produced the results (Table 1) based on which it was possible to determine the presence of imbalance between antagonistic thigh muscle groups, related to the bilateral difference (Fig. 1).

Other authors have also indicated the imbalance in muscle strength of the sportspeople, but they also state that it is allowed within the limits up to 10 % [8, 9]. In case of two female judo practitioners, a critical imbalance was determined between the muscle strength of the flexor thigh muscle, and in seven female contestants the imbalance required correction.

The variable pairs analyzed using the t-test show differences in thigh muscle strength between the left and the right leg in women.

In case of extensor muscles, there is a high correlation between the left and the right side, along with a significant difference, the left side being predominant (Table 2).

In case of flexor muscles, the correlation is somewhat lower, though statistically significant, whereas the significance level of the difference is p=0.05 with the right side being the dominant one.

The average difference in extensor strength of the right leg compared to that of the left one is 4.5% with the left leg being the dominant one.

The average difference in flexor strength of the right leg compared to that of the left one is 9.9% with the right leg being the dominant one.

Taking this result into account, in further training procedure it is necessary to pay attention to the stated differences and to decrease this imbalance as much as possible in the case of sportswomen. This approach is necessary in order to improve technique performance, reduce the risk of injuries and thus improve the sport results.

The relation between the extensor and flexor muscle strength of the right leg is 44.99%, which represents the muscle strength of the rear thigh.

The relation between the extensor and flexor muscle strength of the left leg is 39.18%.

Isokinetic diagnostics in case of male judo practitioners produced the results (Table 3) based on which it was possible to confirm imbalance between antagonistic muscle groups. When the examinees were analyzed individually, in as many as five examinees the results showed a critical difference in muscle strength of the thigh flexor (over 20%), which also indicates the presence of a trauma and the necessity of medical examination in order to trace the cause of such a vast difference (Fig. 2). In case of one examinee, a critical difference was also detected in the thigh extensor. Only in two examinees it was not necessary

*Tab. 1. Extensor and flexor muscle strength (Nm/kg) of the lower extremities in women and the difference in extensor and flexor strength*

| JUDOKA | Weight (kg) | MSED | MSEL | MSFD | MSFL | SDE(%) | SDF(%) |
|---|---|---|---|---|---|---|---|
| No01 | 48.9 | 170 | 184 | 93 | 85 | 7.61 | 9.41 |
| No02 | 52 | 153 | 150 | 80 | 60 | 2 | 33.33 |
| No03 | 56.1 | 190 | 196 | 76 | 75 | 3.07 | 1.33 |
| No04 | 55 | 164 | 184 | 57 | 61 | 10.87 | 6.56 |
| No05 | 59 | 174 | 189 | 88 | 76 | 7.94 | 15.78 |
| No06 | 60.6 | 196 | 193 | 65 | 78 | 1.55 | 16.67 |
| No07 | 72 | 230 | 242 | 130 | 98 | 4.96 | 32.65 |
| No08 | 74.9 | 227 | 224 | 90 | 81 | 1.33 | 11.11 |
| No09 | 55.2 | 197 | 210 | 110 | 88 | 6.2 | 25 |
| No10 | 68 | 222 | 231 | 88 | 84 | 6.1 | 4.76 |
| No11 | 67.5 | 205 | 217 | 85 | 86 | 5.53 | 1.17 |
| No12 | 53.2 | 182 | 192 | 75 | 75 | 5.21 | 0 |
| No13 | 57.3 | 195 | 205 | 88 | 77 | 4.88 | 14.28 |

SDE-Side difference extensors; SDF- Side difference flexors

to eliminate this imbalance, whereas all other examinees had to be subjected to a training treatment whose purpose would be correcting the imbalance between muscle strength of the right and left thigh musculature.

Analyzing the examinees as a group, we can see that in case of men, there are no statistically significant differences in strength between the left and the right extensor and flexor muscles (Table 4). In the male group, the correlation between the variables obtained for the extensor muscles is significantly higher than this obtained for the flexor muscles. However, individual results show that certain individual corrections are required.

The average difference in extensor strength of the right leg compared to that of the left one is 0.15% with the right leg being the dominant one. The average difference in flexor strength of the right leg compared to that of the left one is 0.8% with the left leg being the dominant one.

The relation between the extensor and flexor muscle strength of the right leg is 40.54%, which represents muscle

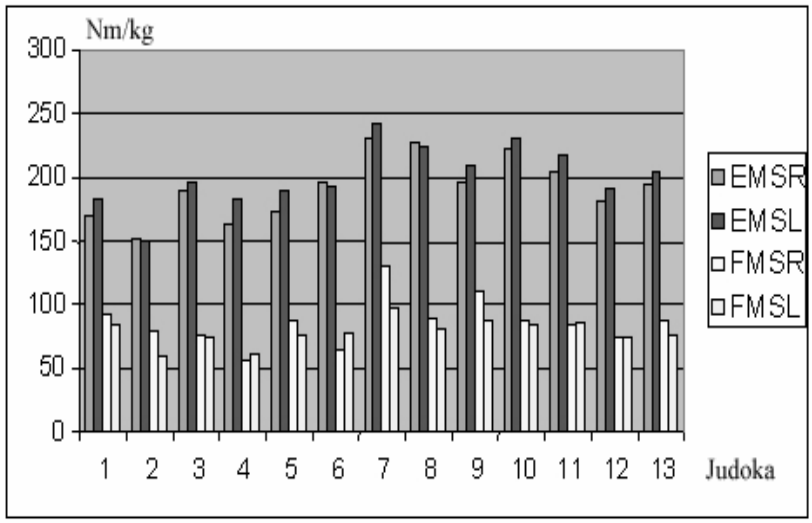


*Fig. 1. Extensor and flexor muscle strength of the lower extremities in women*

*Tab. 2. t-test for women*

| Variable | AS | r | t | p |
|---|---|---|---|---|
| **EMSR**<br>**EMSL** | 192.69<br>201.31 | .953 | -4.198 | .001 |
| **FMSR**<br>**FMSL** | 86.54<br>78.77 | .798 | 2.329 | .038 |

*Tab. 3. Extensor and flexor muscle strength (Nm/kg) of the lower extremities in men and the difference in extensor and flexor strength.*

| JUDOKA | Weight (kg) | MSED | MSEL | MSFD | MSFL | SDE(%) | SDF(%) |
|---|---|---|---|---|---|---|---|
| NO01 | 59.6 | 232 | 238 | 88 | 93 | 2.35 | 5.38 |
| NO02 | 77 | 322 | 294 | 153 | 119 | 9.52 | 28.57 |
| NO03 | 69 | 244 | 256 | 117 | 99 | 4.69 | 18.18 |
| NO04 | 76.5 | 280 | 333 | 94 | 152 | 15.92 | 38.16 |
| NO05 | 70.6 | 313 | 326 | 102 | 149 | 3.99 | 31.55 |
| NO06 | 81.3 | 266 | 224 | 95 | 99 | 18.75 | 4.05 |
| NO07 | 88.2 | 250 | 195 | 95 | 86 | 28.2 | 10.46 |
| N008 | 124 | 358 | 333 | 149 | 179 | 7.5 | 16.76 |
| NO09 | 80.2 | 249 | 259 | 93 | 110 | 3.9 | 15.46 |
| NO10 | 110 | 296 | 323 | 130 | 116 | 8.36 | 12.06 |
| NO11 | 69.8 | 230 | 233 | 88 | 79 | 1.29 | 11.39 |
| NO12 | 70.2 | 182 | 183 | 104 | 102 | .55 | 1.96 |
| NO13 | 75.9 | 262 | 270 | 95 | 76 | 2.97 | 25 |
| NO14 | 68 | 254 | 289 | 94 | 73 | 12.12 | 28.76 |
| NO15 | 95 | 325 | 301 | 141 | 119 | 7.97 | 18.48 |

SDE-Side difference extensors; SDF- Side difference flexors

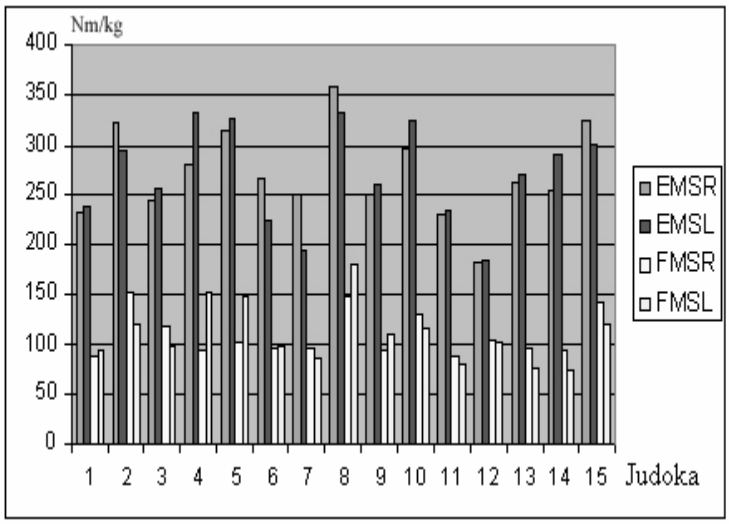


*Fig. 2. Extensor and flexor muscle strength of the lower extremities in men*

*Tab. 4. t-test for men*

| Variable | AS | r | t | p |
|---|---|---|---|---|
| **EMSR**<br>**EMSL** | 270,87<br>270,47 | ,810 | ,053 | ,959 |
| **FMSR**<br>**FMSL** | 109,20<br>110,07 | ,530 | -,126 | ,901 |

strength of the rear thigh. The relation between the extensor and flexor muscle strength of the left leg is 40.84%.

# Conclusions

Based on the research, it is possible to determine a number of specificities regarding judo. Characteristic types of imbalance were detected between the antagonistic muscle groups as a result of the specificity of judo techniques performance. In case of a large number of techniques, a judo contestant bears his/her weight on his „stand-up" leg, while he uses the other leg to throw the opponent to the ground. This specificity is completely understandable, since the Tokui Waza technique, „the favorite" or „best" technique, a technique that brings judo practitioners the highest number of technical points, is always practiced from the same position, subjecting the same side of the body to the pressure. However, in order to reduce the risk, it is necessary to make corrections of the already mentioned imbalances. The optimization of the tested parameters can significantly increase the possibility for achieving the top results.

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