# Correlation between the performance in the Special Judo Fitness Test and the Wingate Anaerobic Test

**Authors' Contribution:**
**A** Study Design
**B** Data Collection
**C** Statistical Analysis
**D** Manuscript Preparation
**E** Funds Collection

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## Abstract

**Background & Study Aim:** To characterise the energy demands of judo, researchers have verified the relevant contribution of anaerobic energy supply to athletes during fights. To evaluate anaerobic capacity, the Wingate Anaerobic Test (WAnT) was developed, which is based on the use of the lower and upper limbs. Sterkowicz created the Special Judo Fitness Test (SJFT), which consists of a repeated execution of the "ippon-seoi-nage". A comparison between the results of these tests allows a verification of the validity of the utilisation of WAnT as a predictor of specific performances in judo. The aim of this study was to correlate the results between WAnT and SJFT for the lower and upper limbs.

**Material & Methods:** Nineteen professional Brazilian judo athletes (mean age 19.16 ± 2.06 yrs, mean body mass 88.24 ± 26.50 kg and mean height 1.76 ± 0.10 m) participated in the study. The athletes underwent both the SJFT and the WAnT for upper and lower limbs.

**Results:** A significant correlation between the SJFT and WAnT results was not observed for the upper and lower limbs. There was a statistically significant correlation between the number of throws in the third set of SJFT (30"B) and the average power in WAnT for the upper limbs; however, the correlation was weak.

**Conclusions:** Because of the lack of a significant correlation between the indicators of the SJFT, the WAnT most likely does not have enough specificity to make an adequate evaluation of the anaerobic capacity of judokas.

**Key words:** Martial Arts • Upper Extremity • Lower Extremity • Sports Performance • Exercise.

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## Introduction

Judo is a sport that requires a high level of physical, technical, tactical, mental and physiological preparation [1-4]. The actions in the sport are characterised by short durations and high intensity and require constant physical effort from its participants [5, 6]. To characterise the energy demands of judo, researchers have verified the relevant contribution of anaerobic energy required by athletes during the fight [6, 2, 7, 8]. Franchini et al [2] have verified that a judo fight may trigger high elevations of serum lactate concentrations, indicating a high anaerobic expenditure. The adaptations generated by anaerobic judo training, such as an increase in handgrip strength, are essential to the success of this modality [9, 10]. According to Thomas et al [11] and Lech et al [8], power and anaerobic capacity are the main physiological characteristics that are developed by judokas.

**Lower Extremity** – lower limbs: hip, thigh, leg, ankle, foot

**Upper Extremity** – upper limbs: shoulder, arm, elbow, forearm, hand

**Sports Performance** – specific results in sports practice

**Ippon-seoi-nage** – one arm back-carry throw

According to Boguszewska et al [12], evaluating the judokas' physical condition is essential to developing an adequate training program. To evaluate the anaerobic capacity, an ergometric cycle test, the Wingate Anaerobic Test (WAnT), was developed in the 1970s [13]. The WAnT can be performed using the lower [14] or upper limbs [15]. Therefore, the WAnT became one of the most convenient tests used to evaluate anaerobic capacity in several modalities [16]. However, this test does not allow the evaluation of the anaerobic capacity during the simultaneous action of the upper and lower limbs.

As judo requires acyclic anaerobic actions from the upper and lower limbs and simultaneously, the WAnT is not a specific test to evaluate the physical condition of judo athletes [17]. Sterkowicz [18] created a specific test, denominated the Special Judo Fitness Test (SJFT), that consists of a repeated execution of the "ippon-seoi-nage", which is a specific gesture from the modality in question. This test has become the most utilised test in the scientific literature to evaluate the fitness capacity of judokas on national teams [2]. However, the simultaneous analysis of the lower and upper limb action by the SJFT cannot identify the real contribution of both limbs.

Some researchers have verified a significant correlation between the upper limb results of both tests [7]. However, no other study has compared the upper limb results from the WAnT to the lower limb results from the SJFT. The comparison between the results of these tests will verify the validity of using the WAnT to predict specific athletic performance in judo. This comparison will also verify the need of an isolated evaluation of the upper and lower limbs in judokas. Thus, the proposal of this study was to correlate the lower and upper limb results between the WAnT and the SJFT.

## Materials and methods

### Subjects

Seventeen professional Brazilian judo athletes (mean age 19,16 ± 2,06 yrs, mean body mass index 88,24 ± 26,50 Kg and mean height 1,76 ± 0,10 m) participated in this study. The study was submitted to the Ethical Committee of the Federal University of Minas Gerais (Belo Horizonte, Brazil).

### Measures and Procedures

In addition to measuring the anthropometric variables, the athletes underwent the SJFT and the Wingate Anaerobic Test (WAnT) for upper and lower limbs. The tests were executed at different meetings. At the first meeting, the volunteers performed the SJFT. At the second meeting, the judokas performed the WAnT for upper limbs and, after a 2-hour interval, the WAnT for lower limbs.

#### *Special Judo Fitness Test Protocol*

To perform the SJFT [18], two athletes with similar heights and body mass indices as the evaluated athlete were used as collaborators. They were placed 6 meters from one another, and the evaluated athlete was placed distance of 3 meters from the collaborators. The test was divided into three sets consisting of 15, 30 and 30 seconds, with 10-second intervals between the sets. During each set, the evaluated athlete alternately threw the collaborator athletes as many times as possible using the ippon-seoi-nage technique [19], also "Special Judo Fitness Test" in Archives of Budo.

At the end of the test and 1 minute after the end of the test, the athlete's heart rate was measured. All throws executed by the evaluated athlete were added, and an index (I) was calculated using the following equation:

$$I = FC + FC1 / NT$$

where FC and FC1 represent the heart rate immediately after the test and 1 minute after the test, respectively, in beats per minute, and NT corresponds to the total number of throws executed during the test. The heart rate was measured with the Polar heart rate monitor (Polar Electro Oy, Finland).

#### *WAnT protocol for upper limb*

Before beginning the WAnT for upper limbs, the athletes performed a specific warm up protocol. The Hidrofit Maxx cycle ergometer was utilised and adapted to handwork (Figure 1A). During the warm up session, the judokas spun the hand grips of the cycle ergometer for 2 minutes at 60 rpm. The rhythm was controlled by the MultiSprint Full 3.5.7 software (Hidrofit LTDA, Brazil). The warm up load was fixed in 1,00% of the athlete's body mass [20]. After the warm up, a 2-minute recovery interval was performed. After this interval, the athletes executed the WAnT for upper limbs with load fixed in 5,00% of the athlete's body mass for 30 seconds. The athletes were instructed to spin the cycle ergometer at the highest possible speed and a verbal encouragement was given during the 30-second test. The test data were obtained by a computer connected to the cycle ergometer with the MCE 5.1. Software (JBA Zb. Staniak, Poland). After the end of the test, the load was removed, and the volunteers continued to spin the cycle ergometer for 60 seconds more in a moderate rhythm.

***WAnT Protocol for lower limb***

The same methodological procedures utilised to execute the WAnT for lower limbs were used for the WAnT for upper limbs. As with the WAnT for upper limbs, all the judokas executed a 2-minute warm up, and the test was executed in 30 seconds with the highest possible frequency of pedalling. In this test, the cycle ergometer was adjusted for lower limbs by replacing the gantlet for pedals (Figure 1B). In the warm up, the load utilised was 1,5% of the athlete's body mass, and 7,5% of the athlete's body mass was utilised for the test.

***Statistical Analysis***

Were performed a data descriptive analysis and the results are presented in mean and standard deviation. To verify the normality of the data the Kolmogorov-Smirnov Test was realized. The correlation between the results of WAnT for upper and lower limbs and the SFJT was done by the Pearson Correlation Coefficient. The level of significance was 0.05. The data were analysed to SigmaPlot software (version 12, Systat Software Inc., San Jose, USA).

## Results

All the analysed data showed normal distribution according to Kolmogorov-Smirnov test. The Table 1 presents the mean values, and it respective standards deviations from the values obtained from WAnT for upper and lower limbs and SJFT.

A significant correlation between the results of SJFT and the results of WAnT for upper and lower limbs were not found (Table 2). The unique correlation existent statistically significant was between the number of throws of the third set of SJFT (30"B) and the average power in WAnT for upper limbs, however, it was a weak correlation ($r = 0.495$, $p = 0.043$). The peak power in WAnT for upper limbs showed strong correlation and statistically significant with peak power in WAnT for lower limbs ($r = 0.894$, $p<0.01$). Besides that, a strong correlation and statistically significant was observed between the average power in WAnT for upper limbs and the average power in WAnT for lower limbs ($r = 0.844$, $p<0.01$). One other strong and significant correlation was found between the peak power decline in WAnT for upper limbs and peak power decline in WAnT for lower limbs ($r = 0.770$, $p<0.01$).

## Discussion

The objective of this study was to correlate the results from the WAnT for upper and lower limbs with the results from the SJFT. The findings demonstrated that the SJFT results had no significant correlation with the WAnT results for both upper and lower limbs. However, a significant correlation was found in the comparison between the WAnT results for upper and lower limbs

According to Boguszewska et al [12], evaluating the physical condition of judokas is essential for designing an adequate training program. However, the evaluation of the physical fitness in judo athletics, using field tests, has low validity and accuracy compared to evaluations from laboratory tests [21]. Thus, considering the specificity of judo, it becomes necessary to evaluate performance using specific methods and characteristic for this modality. The SJFT training method [18] is one of the most utilised tests in judo research; a considerable number of national teams use the test to evaluate the physical capacity relevant to judo [2]. Franchini et al [7] affirm that SJFT is valid in relation to the physiological demands imposed by the judo fight.

According to Franchini et al [6], judo is a sport that demands predominantly anaerobic action and requires contributions from the aerobic system to sustain the judokas' efforts during the fight and to recover during periods

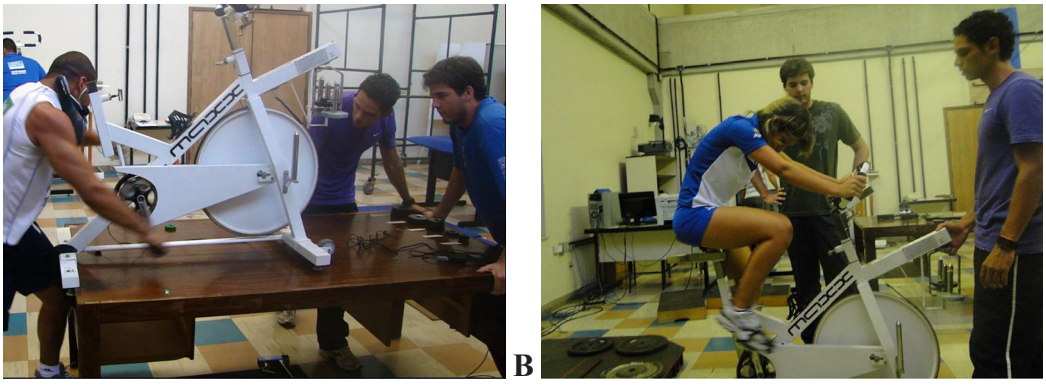

**Figure 1.** Adopted position to perform the WAnT for upper limbs (A) and lower limbs (B).

**Table 1.** Mean and standard deviation of the variables from WAnT and SJFT

| Datas | Mean (n=17) | Standard Deviation |
|---|---|---|
| Average Power – UL* | 5.79 | 0.69 |
| Peak Power – UL | 7.94 | 0.97 |
| Percentag of peak power decline – UL | 28.25 | 3.77 |
| Average Power LL† | 8.39 | 1.07 |
| Peak Power LL | 10.84 | 1.40 |
| Index of peak power decline LL | 23.98 | 4.65 |
| Index of SJFT | 12.28 | 1.38 |
| Number of Throws 15"‡ | 6.29 | 0.69 |
| Number of Throws 30"A§ | 11.29 | 1.05 |
| Number of Throws 30"B II | 10.41 | 1.23 |

*UL: upper limbs, †LL: lower limbs, ‡15": first set of throws in SJFT, §30"A: second set of throws in SJFT, II 30"B: third set of throws in SJFT

of reduced effort. Based on these demands, it is important to have specific tests to evaluate the physical fitness of the judokas to improve the aspects related to training and contribute to a higher level of performance in competitions [20]. The WAnT is one of the most utilised tests for evaluating the anaerobic capacities of athletics in several sport modalities, although it is measured using an ergometric cycle [16]. However, the results found in this study suggest there is no significant correlation between the results from the SJFT and the results from the WAnT in the upper and lower limbs. These results contradict the findings from Franchini et al [2], who found a correlation between the SJFT and WAnT results. Hence, the results obtained from WAnT cannot express the real anaerobic condition of an athlete for a judo fight.

Although the SJFT requires physical simultaneous effort from the upper and lower limbs, this test cannot evaluate the real contribution of each limb. Thus, it is difficult to determine what mechanisms are responsible for positively influencing a judokas performance because many factors can influence performance in this sport [3, 12, 17, 18, 22]. Note that the higher correlation between the anaerobic performances of the upper and lower limbs also occurs in specific situations; therefore, a test that evaluates both limbs simultaneous, such as the SJFT, can be sufficient.

Competitive judo can be described as a high intensity combat sport [23]. Thus, evaluating the fitness level of the athlete is one of the most important variables for the training process [11] because the determined parameters can be instrumental to plan load training. The results from this study indicate that SJFT has no significant correlation with the results from WAnT for both upper and lower limbs. Also, the results suggest that for competitive level athletes there is a strong correlation between all WAnT variables. These findings indicate that a separated evaluation might be unnecessary. However, this high correlation between the performance of the lower and upper limbs was verified by the WAnT; perhaps the performances of the upper and lower limbs were different in another more specific test.

## Conclusion

In the present study, no significant correlation between the results of the WAnT for upper and lower limbs and the SJFT were observed. The strong correlation found between the results of WAnT for upper limbs and the results of WAnT for lower limbs suggests that only one of these tests can be used to analyse variables, such as peak power, average power and peak power decline. Because of the insignificant correlation with the SJFT indicators, WAnT most likely does not have enough specificity to adequately evaluate the anaerobic capacity in judokas.

**Table 2.** Results on the Pearson's correlation coefficients of the variables of WAnT and SJFT

| | Peak Power UL | Average Power UL | Peak Power Decline UL | Peak Power LL | Average Power LL | Peak Power Decline LL |
|---|---|---|---|---|---|---|
| Number of throws 15" | 0.296 | 0.381 | -0.305 | 0.256 | 0.235 | -0.066 |
| Number of throws 30"A | 0.361 | 0.412 | -0.230 | 0.308 | 0.256 | 0.019 |
| Number of throws 30"B | 0.477 | 0.495* | -0.139 | 0.317 | 0.210 | 0.162 |
| Index of Sterkowicz | -0.356 | -0.443 | 0.300 | -0.160 | -0.145 | 0.077 |

*$p < 0.05$

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