

## Research Article

### Comparison of Performance Indicators and Heart Rate Responses to the Special Judo Fitness Test in Young Male Judokas and Freestyle Wrestlers

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#### Abstract

**Introduction:** The aim of this study was to compare performance indicators between judokas and freestyle wrestlers using the Special Judo Fitness Test (SJFT). This test was selected due to its ability to assess muscular endurance and performance in combat sports.

**Methods:** This study was conducted on 36 male athletes (25 wrestlers and 11 judokas), aged between 18 and 35 years, who were active in sports clubs in Amol, Mazandaran province. The measured variables included height, weight, age, BMI, body fat percentage, number of throws in 15 seconds, first 30 seconds, and second 30 seconds, immediate heart rate, heart rate after 1 minute, and the SJFT index. An independent t-test was used to compare the mean values between the two groups. Data normality was assessed using the Shapiro-Wilk test


**Results:** the results showed significant differences between judokas and wrestlers in some of the measured indicators ( $P < 0.05$ ). Wrestlers performed better in performance indicators such as the number of throws in 15 seconds, the first 30 seconds, and the second 30 seconds. In contrast, judokas showed superiority in the SJFT index. No significant differences were found in BMI, body fat percentage, or heart rate (immediate and 1 minute post-test)

**Conclusion:** The observed differences may be attributed to the distinct nature of training and physiological demands of each sport. These findings can help coaches develop more tailored training programs for each group.

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## 1. Introduction

Martial arts, as disciplines directly involving physical confrontation and control of the body and opponent, have attracted human interest since ancient times. These sports, including judo and wrestling, in addition to having similar physical characteristics, require the development of technical, strategic, and mental skills. In judo, techniques must be executed accurately and within an appropriate timeframe to effectively apply strength, speed, and explosive power. These short and explosive actions are primarily fueled by anaerobic metabolism, whereas sustaining intermittent efforts throughout the match and the recovery process between periods largely depend on aerobic metabolism. These two energy systems function simultaneously during a judo match to achieve optimal performance. Research has shown that the oxidative system contributes  $77.8 \pm 5.8\%$ , the ATP-PCr system  $16.0 \pm 4.6\%$ , and the glycolytic pathways  $6.2 \pm 2.4\%$  in energy production during judo matches.

Given that judokas perform a high number of different movements in each match, the physiological demands are significantly high, which has been clearly demonstrated through physiological measurements. However, due to the rules and regulations of judo, measuring physiological data during matches is limited. Therefore, specific judo techniques have been analyzed to better assess the energy demands of the activity (2).

Furthermore, as judo is a sport in which training should be directed toward improving various physical abilities (such as strength, endurance, and power) so that athletes can perform technical and tactical movements with higher quality, physical fitness plays a crucial role in both training and competition processes.

In this context, sport-specific tests to evaluate physical fitness in judokas are important, as they can help improve training programs and lead to better competition performance. One such test is the Special Judo Fitness Test (SJFT).

Franchini et al. have recommended that before performing the SJFT, participants complete a 25-minute active warm-up consisting of: 8 minutes of running (4 minutes at 80–100% of lactate threshold, 2.5 minutes at 110%, and 1.5 minutes at 125%), 6 minutes of stretching (particularly for quadriceps and hamstrings), 2 minutes of judo throwing techniques (three sets of 10 repetitions of the technique used in the test, with 30 seconds rest between sets), 3 minutes of stretching, 3 minutes of bodyweight strength exercises (push-ups: three sets of 20 repetitions with 2 minutes rest between sets; burpees: two sets of 15 repetitions with 1 minute rest between sets), and another 3 minutes of stretching (3).

Wrestling is one of the oldest and most respected combat sports in the world and has been officially held in the modern Olympic Games since 1896. It is practiced in two styles: freestyle and Greco-Roman for men, and since 2004, in freestyle for women. Each style has its specific rules and regulations that distinguish it as a unique combat sport. Wrestling is a physically demanding and intense activity requiring high physical and mental fitness. It involves explosive movements and repeated efforts performed intermittently with high intensity. In each bout, wrestlers use technical skills, strength, speed, and endurance to defeat their opponents. These features make wrestling reliant on both aerobic and anaerobic energy systems.

Generally, the energy systems used in wrestling include:

ATP-PCr system (anaerobic alactic): 6.66% (freestyle) and 5.94% (Greco-Roman), Glycolytic system (anaerobic lactic): 62.74% (freestyle) and 67.53% (Greco-Roman), Aerobic system: 30.60% (freestyle) and 26.53% (Greco-Roman)

These data indicate that the glycolytic (anaerobic lactic) system plays a dominant role in energy supply for both wrestling styles. However, the aerobic system is also crucial for energy recovery during rest periods. In wrestling, explosive movements such as throws, technique execution, and opponent control require anaerobic energy, whereas maintaining activity and recovering between rounds depend on aerobic metabolism. This combination of energy systems necessitates a comprehensive training program that develops all three systems. This is particularly important in planning professional wrestlers' training and enhancing their performance.

Additionally, both sports share similar techniques. For example, in judo, the Ippon Seoi Nage is equivalent to the arm throw in freestyle wrestling—both being top techniques for throwing an opponent to the ground. In both sports, the ability to execute such techniques requires a combination of physical strength, endurance, and precision, ultimately leading to success in competition. Unlike wrestling, judo, due to its tactical timing and movement structure, also demands a more stable and efficient aerobic system to manage longer recovery periods and maintain consistent performance throughout the match. This is reflected in differences observed in heart rate immediately after the test and one minute later, with judokas exhibiting higher heart rates,

indicating a greater reliance on the aerobic system for recovery and energy maintenance. In terms of anthropometry, results showed that judokas were taller and heavier than wrestlers, which could be related to the technical styles and rules of each sport. Judo, with its weight categories and demand for high postural stability, accommodates athletes with varied body structures, whereas wrestling, due to the speed and intensity of movements, generally favors athletes with an optimized muscle-to-weight ratio.

Moreover, the SJFT index showed that wrestlers scored lower in this test, indicating skill-based, technical, and physiological differences related to the competitive demands of each sport. This index can serve as a useful metric to evaluate athletes' sport-specific abilities within their respective disciplines.

Examining the functional and physiological differences between wrestling and judo demonstrates that both sports require tailored training programs aligned with the energy and physical demands of their athletes. Wrestling training should focus on enhancing anaerobic capacity, explosive power, and recovery speed, while judo training must balance aerobic system development with improvements in anaerobic capacity. These findings also emphasize the importance of specialized and regular physiological assessments for improving athletic performance and preventing injuries. Coaches and researchers can use these indicators to design more effective training programs that enhance both physical capacity and sport-specific skills. Given the sampling limitations and sample size in this study, future research should include larger and more diverse athlete populations to allow for broader generalizations and more precise analysis.

Additionally, the use of modern technologies for biomechanical and metabolic parameter assessment can contribute to a deeper understanding of the functional similarities and differences between combat sports (1, 2, 4).

## 2. Materials and Methods

### Participants and Sampling

The statistical population of this study included male freestyle wrestlers and judokas aged between 18 and 35 years. Participants were recruited through a public call and selected based on eligibility criteria. A total of 36 athletes participated in the study, including 25 wrestlers and 11 judokas. Inclusion criteria consisted of: engaging in regular wrestling or judo training, absence of musculoskeletal injuries in the past six months, and refraining from the use of medications or performance-enhancing supplements that could affect physiological or performance-related parameters. All participants were fully informed about the procedures involved in the study. The demographic characteristics of the participants are presented in Table 1.

### Instruments and Performance Indicators

To evaluate the athletes' functional and physiological indices, the following instruments and methods were used:

**Height and Weight Measurement:** Height was measured using a stadiometer, and body weight was measured using a digital scale with 0.1 kg precision.

**Body Mass Index (BMI):** Calculated by dividing body weight (kg) by the square of height (m<sup>2</sup>).

**Body Fat Percentage (BF%):** Estimated using the Deurenberg formula (5):  
$$BF\% = 1.20 \times BMI + 0.23 \times \text{age} - 10.8 \times \text{sex} - 5.4$$

### Special Judo Fitness Test (SJFT) Protocol:

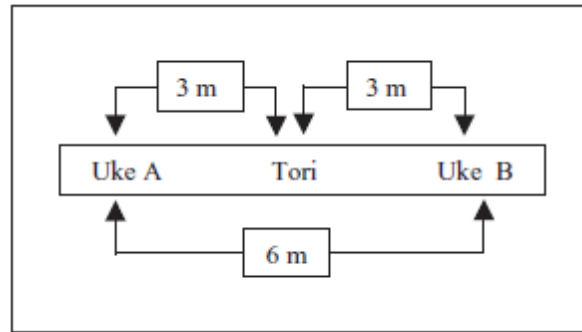
To assess the sport-specific fitness index of judokas and wrestlers, the Special Judo Fitness Test (SJFT) introduced by Sterkowicz and further developed by Franchini et al. was used (6, 7). In this test, judokas were required to perform Ippon Seoi Nage (a commonly used shoulder-throwing technique in judo),

while wrestlers executed "Kol Andaz" (a shoulder-throw technique used in both freestyle and Greco-Roman wrestling that closely resembles the Ippon Seoi Nage in mechanics and purpose).

The SJFT consists of three time intervals of 15, 30, and 30 seconds, with 10 seconds of passive rest between intervals. The performer (Tori) stood in the center, with two partners (Ukes) positioned 3 meters to the left and right of the center. Upon a whistle signal, the athlete executed as many valid and complete throws as possible within the designated time intervals. In each phase, the number of successful throws was recorded. Participants were instructed to perform with maximum effort and speed. Wrestlers followed the same procedure as judokas, except they performed the Kol Andaz technique instead of the Ippon Seoi Nage (Figure 1).

### Heart Rate Measurement:

Resting heart rate, immediate post-exercise heart rate (after the third interval), and heart rate one minute post-exercise were measured using a Brisk P016 pulse oximeter (manufactured in Germany). Measurements were taken simultaneously from the carotid artery and recorded accordingly.



**Figure 1.** Special Judo Fitness Test representation.

The specific fitness index was also calculated using the following equation:

$$\text{Index} = \frac{\text{final HR (bpm)} + \text{HR 1-min after the test (bpm)}}{\text{Number of throws}}$$

**Statistical**

The data obtained from the tests in both groups were analyzed using an independent t-test. For this purpose, SPSS software version 20 was used. Data are presented as mean ± standard deviation (SD), and the level of statistical significance was set at  $P \leq 0.05$ .

**Analysis**

were significantly higher in the wrestling group compared to the judo group. Furthermore, the overall performance index also showed a significant difference between the two groups ( $P = 0.001$ ) (Table 2).

**3. Results**

The present findings indicate that there was no statistically significant difference between freestyle wrestlers and judokas in terms of body fat percentage and body mass index (BMI) (Table 1). The results of the independent t-test showed that, although immediate and one-minute post-test heart rates were higher in judokas compared to wrestlers, these differences were not statistically significant ( $P = 0.162$ ,  $P = 0.179$ , respectively). However, significant differences were observed in performance-related variables. The number of successfully executed techniques during the 15-second interval ( $P = 0.004$ ), the first 30-second interval ( $P = 0.002$ ), and the second 30-second interval ( $P = 0.001$ )

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Table 1. Descriptive Statistics (Mean  $\pm$  SD) of Anthropometric Variables in Wrestlers and Judokas

Variable Mean $\pm$ SD	Wrestle Group (n=25)	Judo Group (n=11)
Age (years)	22.32 $\pm$ 5.51	22.45 $\pm$ 4.76
Height (cm)	171.20 $\pm$ 6.38	179.45 $\pm$ 8.51
Weight (kg)	71.72 $\pm$ 9.89	86.55 $\pm$ 22.30
Body Mass Index	24.39 $\pm$ 2.37	26.56 $\pm$ 4.69
Body Fat Percentage (%)	18.21 $\pm$ 3.29	20.84 $\pm$ 5.82
Heart rate immediately (bpm)	178.80 $\pm$ 7.75	183.27 $\pm$ 10.52
Heart rate after 1 min (bpm)	156.48 $\pm$ 12.24	163.09 $\pm$ 15.60
Total Heart rate (bpm)	335 $\pm$ 18	346 $\pm$ 24

Table 2. Descriptive Statistics (Mean  $\pm$  SD) of Performance Variables in Wrestlers and Judokas

Variable Mean $\pm$ SD	Wrestle Group (n=25)	Judo Group (n=11)
Techniques in 15 sec	6.84 $\pm$ 0.47	6.00 $\pm$ 1.18
Techniques in first 30 sec	11.56 $\pm$ 1.36	9.82 $\pm$ 1.54
Techniques in second 30 sec	10.32 $\pm$ 1.25	8.55 $\pm$ 1.51
Total number of techniques	27	23
Test index	14 $\pm$ 3	12

### 3. Discussion

The aim of this study was to examine and compare two shoulder-throw techniques—Ippon Seoi Nage (a widely used and key technique in judo) and **Kol andaz** (commonly used in freestyle and Greco-Roman wrestling), which are technically and functionally very similar—in terms of index variables, heart rate, and execution capability. Originally, this test was developed as an anaerobic power assessment equivalent to the Wingate test.

The key findings of this study include:

1. A significant difference in the number of repetitions of **Kol andaz** in the designated time frames (15 seconds, 30 seconds, and another 30 seconds) in wrestlers compared to judokas.
2. A significantly higher overall test index in wrestlers than judokas.
3. No statistically significant difference in immediate and one-minute post-test heart rate.

Both judo (a combat sport) and freestyle wrestling are Olympic disciplines and share considerable similarities in various techniques. The validity of this test has been reported as 0.97 for judokas and 0.867 for wrestlers (8, 9).

Our study showed that immediate heart rate (178.80  $\pm$  7.746 vs. 183.27  $\pm$  10.518 bpm) and one-minute post-test heart rate (156.48  $\pm$  12.238 vs. 163.09  $\pm$  15.604 bpm) were considerably lower in wrestlers than in judokas. This is consistent with the findings of Karimi, who used this test with the Ippon Seoi Nage technique for wrestlers and reported immediate heart rate of 177  $\pm$  15 bpm and one-minute post-test heart rate of 152  $\pm$  4 bpm (8).

Francini et al. (1999) tested Brazilian judokas with and without international medals and reported immediate post-test heart rate of 186  $\pm$  6.4 bpm and one-minute post-test heart rate of 136  $\pm$  4.2 bpm. Similar results were reported by Sterkowicz and Francini (6). Another study conducted on experienced but non-elite judokas reported immediate heart rate of 186  $\pm$  11 bpm and one-minute post-test heart rate of 165  $\pm$  13 bpm (10).

Marković et al. (11) evaluated two testing methods for wrestlers using the Suplex throw with dummies of different weights across various weight classes. They applied Francini's equation for judo fitness index, and instead of Francini's protocol, used three 30-second work periods with 20-second rest intervals, reporting immediate and one-minute heart rates of  $188.66 \pm 6.14$  bpm and  $167.14 \pm 12.26$  bpm, respectively.

In another study by Marković et al. (12), two protocols were tested on national team and first/second league wrestlers: three 30-second rounds and three 1-minute rounds (including four 10-second bouts and one 20-second bout in the first minute, and three 10-second bouts and one 30-second bout in the third minute). Immediate heart rates for national team, first league, and second league wrestlers were  $185.67 \pm 14.1$ ,  $183.90 \pm 6.9$ , and  $184.77 \pm 6.9$  bpm, respectively. One-minute post-test heart rates were  $166.40 \pm 16.1$ ,  $166.65 \pm 8.6$ , and  $163.85 \pm 12.2$  bpm.

Francini et al. also evaluated the effects of six weeks of high-intensity interval and aerobic training during the competition season on immediate and one-minute post-test heart rates, reporting no significant difference:  $186 \pm 7$  and  $159 \pm 20$  bpm, respectively.

The physical fitness index calculated in our study showed that judokas had a significantly higher index ( $14 \pm 3$ ) than wrestlers ( $12 \pm 2$ ) (13). According to Francini et al., this index was  $12.53 \pm 1.11$  for elite judokas and  $14.16 \pm 1.52$  for non-elite judokas (10). These findings align with our results, as our judokas were experienced but non-elite, and the wrestlers' index matched that of non-elite judokas in Francini's study.

Casals et al. reported an index of  $13.22 \pm 1.94$  and 27 repetitions for elite male Spanish judokas (14). In our study, total repetitions were 23 for judokas and 27 for wrestlers. In another study on Brazilian judokas across different age groups, the index values were 13, 13.2, and 12.8, and total repetitions were 26, 26.1, and 26.2 respectively (15).

IŞIK et al. tested female Turkish wrestlers and reported a fitness index of  $12.08 \pm 1.29$  with  $24.06 \pm 2.10$  repetitions (16). Detanico et al. tested Brazilian male judokas aged 18–22, finding an index of  $12.5 \pm 1.3$  and  $27 \pm 2$  repetitions (17).

Herrera-Valenzuela et al. adapted the judo fitness test by replacing the Ippon Seoi Nage with One-arm Shoulder Throw for male wrestlers aged 16–18, reporting an index of  $15.92 \pm 1.81$ ,  $22 \pm 3$  repetitions, immediate heart rate of  $186 \pm 6$  bpm, and one-minute post-test heart rate of  $165 \pm 10$  bpm (18).

Francino et al. developed a wrestling-specific version of the fitness test using the Suplex throw and Francini's equation, reporting an index of  $14.91 \pm 2.61$  and  $24 \pm 3$  repetitions (13). Marković et al. conducted the wrestling-specific fitness test on 61 national and international level Serbian wrestlers (15 national team, 20 first league, 26 second league) aged 17–23. They reported index scores of  $10.88 \pm 1$ ,  $12.43 \pm 1$ , and  $13.38 \pm 1.7$ , and total repetitions of  $32.40 \pm 1.8$ ,  $28.30 \pm 1.7$ , and  $23.04 \pm 3.2$  respectively.

The significant difference in total repetitions and fitness index in the three time periods of the Ippon Seoi Nage (for judokas) and the Kol andaz (for wrestlers) may be attributed to technical differences and greater applicability of the Ippon Seoi Nage among judokas compared to the lesser use of Kol andaz in freestyle wrestling (12). Another reason could be the use of the judo gi, which helps reduce grip slippage due to sweat, whereas wrestlers' bare arms may reduce grip efficacy.

Results for body fat percentage indicated similar body composition between the two groups. Both throws significantly elevated heart rate, potentially reaching near-maximal levels.

## 4. Conclusion

This study is the first to use the Kol andaz—a shoulder-throw technique with high similarity to Ippon Seoi Nage—in a test originally designed for judo, and to compare the performance of the two techniques in the same testing protocol.

Therefore, based on the findings, the Kol andaz can be considered a suitable alternative to Ippon Seoi Nage for evaluating the specific fitness index of wrestlers, especially Greco-Roman wrestlers. Furthermore, this test may also serve as a component of routine wrestling training and be used during the in-season phase of preparation. Notably, the test protocol, timing, and equation from the judo-specific fitness test can be effectively applied to wrestlers as well.

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This study did not have any funds.

## Compliance with ethical standards

**Conflict of interest** None declared.

**Ethical approval** the research was conducted with regard to the ethical principles.

**Informed consent** Informed consent was obtained from all participants.

## Author contributions

Conceptualization: A.GH.N , S.A.KH , N.H ;  
Methodology: S A.GH.N , S.A.KH , N.H .; Software:  
A.GH.N , S.A.KH , N.H ; Validation: A.GH.N , S.A.KH , N.H .;  
Formal analysis: A.GH.N , S.A.KH , N.H ; Investigation:  
A.GH.N , S.A.KH , N.H ; Resources: A.GH.N , S.A.KH , N.H ;  
Data curation: A.GH.N , S.A.KH , N.H ; Writing -  
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& editing A.GH.N , S.A.KH , N.H .; Visualization: A.GH.N  
, S.A.KH , N.H ; Supervision: A.GH.N , S.A.KH , N.H ;  
Project administration: A.GH.N , S.A.KH , N.H ;  
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