






## International Journal of Sport Studies for Health

Journal Homepage



# Validity of a Modified Special Judo Fitness Test: A Novel Approach Using Dummies to Improve the Test's Ergometric Properties



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## Article Info

## A B S T R A C T

## Article type:

Original Research

## How to cite this article:

Hernández-Cruz, G., González-Fimbres, R. A., Alonso-Ramos, Z. N., Reynoso-Sánchez, L. F., & Guerrero-Hernández, D. (2026). Validity of a Modified Special Judo Fitness Test: A Novel Approach Using Dummies to Improve the Test's Ergometric Properties. *International Journal of Sport Studies for Health*, 9(1), 1-9.

<https://dx.doi.org/10.61838/kman.intjssh.4403>



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**Objective:** To examine the criterion validity of a modified Special Judo Fitness Test (SJFT) using dummies compared with the original version.

**Methods and Materials:** Forty-seven judo players (22 women and 25 men) participated. The criterion validity between the original and the modified SJFT was examined using the intraclass correlation coefficient (ICC). Linear mixed models employed the two SJFTs as within-subject repeated fixed effects and subject identification as a random effect. Student's t tests for independent samples were used to compare the two SJFTs' parameters between the novice and advanced groups; Hedges' g was used to interpret effect sizes.

**Findings:** A strong consistency was observed between the two versions (ICC [95% CI] = 0.913 [0.843–0.951],  $p < 0.001$ ). Both tests demonstrated specificity, differentiating novice from advanced judokas and men from women. However, systematic mean differences were observed between the original and modified tests, and agreement across parameters was lacking.

**Conclusion:** Preliminary evidence indicates that the modified SJFT may be a useful alternative for assessing judo-specific performance, but it should not be considered interchangeable with the original test. Further studies, particularly those examining test-retest reliability and ecological validity, are needed before recommending its widespread application.

**Keywords:** Combat sport, Dummies, Performance, Evaluation, Judo.

## Article history:

Received 24 July 2025

Revised 25 September 2025

Accepted 05 October 2025

Published online 01 January 2026

## 1. Introduction

Judo is considered an intermittent and acyclic combat sport (1) that demands the use of the oxidative, glycolytic, and ATP-PCr systems for energy production (2), and it is characterized as a high-intensity intermittent activity (3). In the majority of judo matches, the effective combat time can vary from a few seconds to four minutes (4); however, if the match remains tied at the end of regulation, the duration may be extended for up to 8 minutes (4). Thus, high-level competition requires increased physical, psychological, technical, and tactical conditioning (3); consequently, performance evaluation is considered a critical part of the training process.

Although the general performance tests provide valid and reliable assessments of the overall conditioning, they cannot reproduce the real judo movement patterns. Therefore, a specific judo test is needed to assess an athlete's performance (5). While several judo-specific assessments have been developed over the years, the original Special Judo Fitness Test (SJFT), originally published by Sterkowics, is the most popular among researchers and coaches for measuring judo-specific performance (6). The SJFT index (SJFI) has been correlated to the aerobic and anaerobic general tests; therefore, it has been proposed that it can integrate both energy system capacities (7). Furthermore, Hesari (1) has reported a higher correlation between the SJFT and  $\text{VO}_2\text{max}$  ( $r = -.87, p < .01$ ) than between the former and the Wingate test's peak ( $r = -.74, p < .01$ ) and mean powers ( $r = -.62, p < .05$ ), suggesting that the test mainly describes the aerobic power. However, another study has found that the energy supplied during the SJFT is primarily through the alactic pathway, implying the test's validity for judo's high-intensity intermittent performance evaluation (2).

Several research studies have analyzed the use of SJFT in men and women of junior and senior (15 – 19 and > 20 years old, respectively) categories. It has been demonstrated that the SJFT can differentiate between the elite and novice judokas by the total number of throws (TNT), heart rate (HR), and the SJFI (8, 9). Additionally, it can discriminate between the junior and senior categories (10). Moreover, the SJFI classification tables have been created for men (6) and women (11) and recently in judokas under 15 years old (12), on the other hand Courel-Ibañez et al. (14) mentions that in

the SJFT Index there are no differences between the U13 amateur, U16 amateur and U16 advance groups, however in the number of TTs they are different in U16 compared to U13. The Anthropometric characteristics that predict the SJFI have also been identified (12-14). These findings have confirmed that the SJFT is appropriate for the judo-specific performance evaluation and training program development from the novice to advanced level stages (11).

While the SJFT's advantages have been broadly documented in the scientific literature, the use of human Ukes introduces variability that may affect validity and reliability. In this regard, Błach et al. (15) highlighted that “the use of dummies allows for greater standardization and reduces inter-individual variability” when they proposed the Special Fitness Test in Combat Sports (SFTCS), which incorporated the o-goshi technique with dummies, as well as modified distances and times compared to the original SJFT. Their results showed that the SFTCS did not present significant differences in the number of throws or in the Fitness Index compared to the original SJFT.

Therefore, the present study proposes a test modification by substituting human Ukes with dummies. For example, the study by Markovic et al. used dummies to assess the reliability of the two new fight-specific tests, obtaining good results for the measured skills (16). This approach can be a viable alternative for standardization and for minimizing performance-altering factors. Thus, this study aimed to evaluate the criterion validity of a modified SJFT using dummies instead of human Ukes.

## 2. Methods and Materials

### 2.1 Participants

A non-probabilistic convenience sampling method was used. The sample consisted of 47 judo players, 22 women and 25 men (demographic information shown in Table 1) from the local clubs in Monterrey, Mexico. Their participation was voluntary. The participants were classified as either novice (white, yellow, or orange belts;  $n = 26$ ) or advanced (green, blue, brown, or black;  $n = 21$ ). The tests were conducted between 4:00 p.m. and 6:00 p.m., which matched their normal training schedule; there were no specific requirements for diet or fluid intake before taking the test. All players were checked by a team physician to

partake in intense physical exercise without restrictions. Both players and their parents were informed about the benefits and risks of the investigation before signing an informed consent document to participate in the study. The study protocol adhered to the guidelines of the Declaration

of Helsinki. According to Article 17, Paragraph II of the Regulations of the General Health Law in Health Research Matter of Mexico Ethically, the methods used were innocuous, harmless, making it so that the research is categorized as posing minimal risk.

**Table 1.** General characteristics of the advanced and novice judokas.

Characteristics	Advanced		Novice	
	Men (n = 11)	Women (n = 10)	Men (n = 14)	Women (n = 12)
Age (years)	15.82 ± 1.07	15.5 ± 1.26	16.18 ± 1.10	16 ± .81
Weight (kg)	65.78 ± 13.29	62.16 ± 9.01	74.03 ± 17.69	63.66 ± 17.49
Size (cm)	166 ± 3.35	147.3 ± 3.37	169.82 ± 6.93	158.88 ± 4.78
Years of practice	7.18 ± 2.63	6.4 ± 3.37	1.21 ± 0.77	1.03 ± 0.62

Note. The data are presented as mean ± standard deviation; (kg) = kilograms; (cm) = centimeters; Advanced = green, blue, brown, or black belts; Novice = white, yellow, or orange belts.

## 2.2 Procedures

Both original and modified tests were conducted in judo facilities equipped with specific tatamis. The tests were conducted after several familiarization trials during the preparatory training period. Each test was conducted on a separate day, with 48 h of rest between them. Because the tests were considered as single-effort maximal trials, the accumulation of fatigue was not anticipated; thus, the resting periods were considered sufficient for the participants to recover fully. The HR was recorded during the test execution using the Polar Team<sup>2</sup> Pro System (Polar Electro Oy, Kempele, Finland). The HR sensor straps and transmitters were placed around the chest of the participants prior to the test.

**Original SJFT.** The original SJFT proposed by Sterkowicz (7) consists of three consecutive active series of 15 s (A), 30 s (B), and 30 s (C) divided by 10 s of passive rest. The original test required two judo players of the same weight class and similar height, positioned 6 m from each other (*Ukes*); the tested subject (*Tori*) stood between them. The command “*Hajime*” was given, and the *Tori* was required to run up to one of the *Ukes* and perform an *Ippon-seoi-nage* throw, followed by executing the same type of throw on the second *Uke*. This procedure was repeated for 15 s (Series A), after which the “*Matte*” command was given, followed by a 10 s break. Series B and C followed the first and second 10 s breaks, respectively. During the test, the HR was collected with an HR monitor (Team<sup>2</sup>, Polar Electro Oy, Kempele, Finland). It was registered immediately after the completion of the exercise (HR<sub>exe</sub>) and after a one-minute recovery period (HR<sub>rec</sub>). The TNT was

calculated as the sum of throws from Series A, B, and C. The SJFI was calculated according to the following equation:

$$SJFI = \frac{HR_{exe} + HR_{rec}}{TNT}$$

Where, SJFI = Special Judo Fitness Index, HR<sub>exe</sub> = HR immediately after the exercise, HR<sub>rec</sub> = HR after one minute of recovery, and TNT = Total number of throws.

**Modified SJFT.** The Modified Special Judo Fitness and index were performed and calculated in the same manner as the original, with the difference that the human *Ukes* were replaced with 25 kg dummies (outfitted with Judojis and held in position by two assistants).

To estimate the judo performance, the results of each test were presented either as absolute performance measures (i.e., TNT), measures of cardiovascular response (i.e., HR), or both integrated into an index measure.

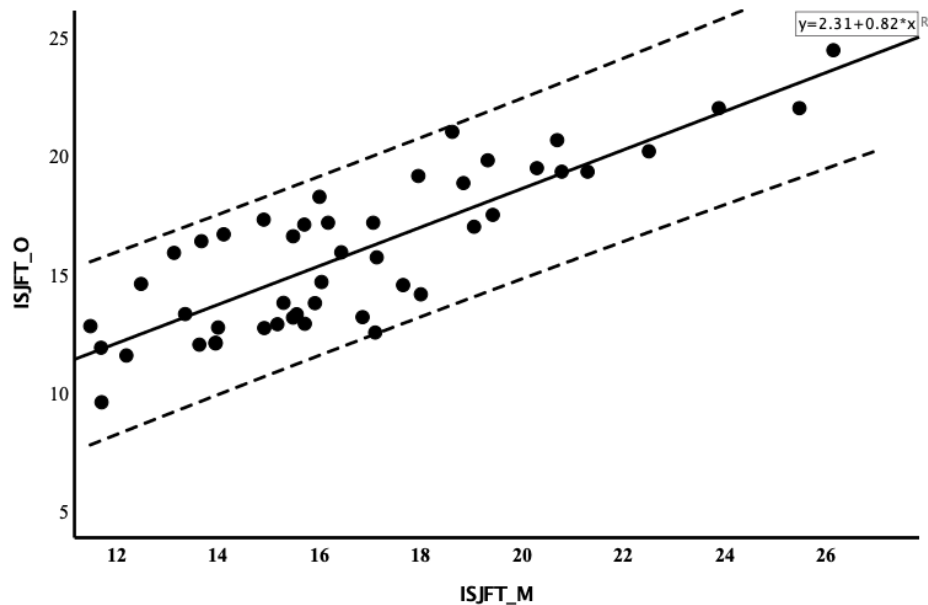
## 2.3 Statistical Analyses

The data were presented as mean ± standard deviation. The parametric tests were employed when the normality and homoscedasticity were confirmed. The criterion validity between the original and modified SJFTs was examined using Pearson’s correlation coefficient, linear regression analysis, and Bland and Altman Plots. Linear mixed models used SJFTs and subject identification as a within-subject repeated fixed and a random effect, respectively, to assess the agreement in the SJFI, TNT, HR<sub>exe</sub>, and HR<sub>rec</sub> parameters. The Student’s *t* test for independent samples was utilized to compare between the novice and advanced and between male and female judo players. Hedges’ effect size (ES) was used to determine the magnitude of the standardized differences between the variables. The ES was interpreted as follows: < 0.20 = trivial, > 0.20 = small, > 0.60

= moderate,  $> 1.20$  = large, and  $> 2.0$  = very large (17). The statistical significance was set at  $p < 0.05$ . Further, the statistical analyses were performed using SPSS version 23 (IBM Corp., Armonk, NY, USA).

The correlation between the original and modified SJFTs was strong ( $r = .84$ ,  $p < .001$ ). However, the regression model yields  $R^2 = .705$ , indicating that the modified test explains 70.5% of the variance.

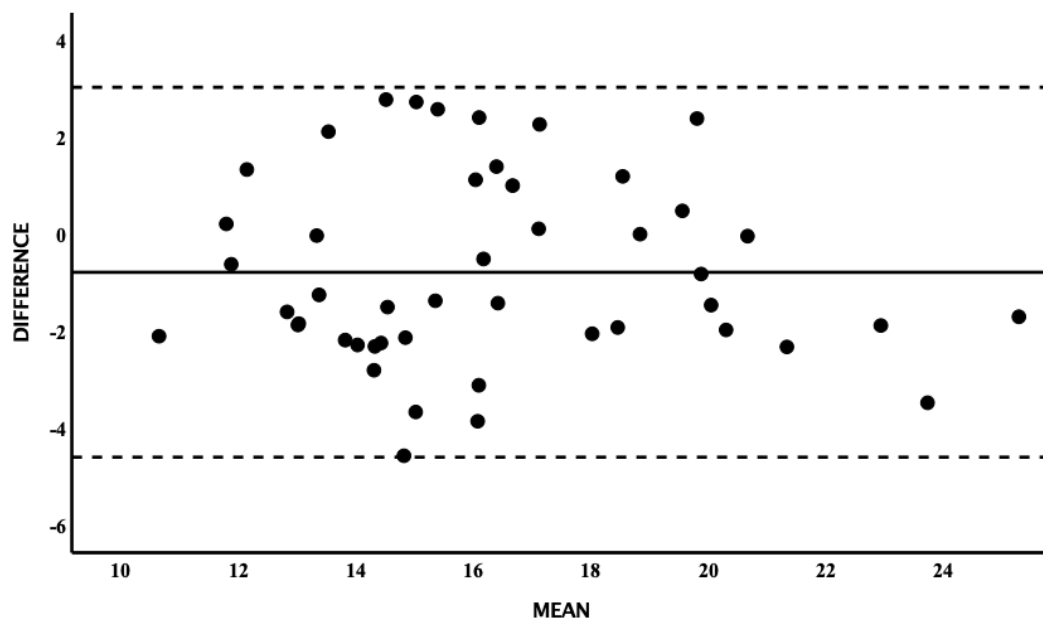
### 3. Results



**Figure 1.** Scatter plots showing associations between the original and modified SJFTs. SJFT\_O indicates the original Special Judo Fitness Test Index scores, SJFT\_M indicates the modified Special Judo Fitness Test Index Scores.

Bland–Altman’s analysis revealed a systematic mean difference of 0.78 between the tests, suggesting that the modified version generally produced slightly higher values

compared to the original, with most differences remaining within the limits of agreement.



**Figure 2.** Bland and Altman plots for assessing agreement between the original and modified SJFTs

Regarding the mean differences, the results for SJFI, TNT, HR<sub>exe</sub>, HR<sub>rec</sub>, and HR variation from immediately after the exercise to one minute of recovery ( $\Delta$ HR) between the two SJFTs are presented in Table 2. Although several of

these differences reached statistical significance, the associated effect sizes were small, suggesting that the practical magnitude of the discrepancies between the tests was limited.

**Table 2.** Comparison of the performance variables between the tests.

SJFT variable	Original	Modified	P	ES (g)
SJFI	15.94 $\pm$ 3.38	16.72 $\pm$ 3.48	< .01	0.23 <sup>b</sup>
TNT	22.96 $\pm$ 4.19	21.19 $\pm$ 3.64	< .01	0.45 <sup>b</sup>
HR <sub>exe</sub>	187.98 $\pm$ 12.60	183.87 $\pm$ 14.67	< .01	0.30 <sup>b</sup>
HR <sub>rec</sub>	165.64 $\pm$ 19.03	160.32 $\pm$ 21.60	< .01	0.26 <sup>b</sup>
$\Delta$ HR	-22.34 $\pm$ 9.56	-23.55 $\pm$ 12.84	.34	0.11 <sup>a</sup>

Note. a = trivial, b = small, for effect size;  $\Delta$  HR = Difference between HR<sub>exe</sub> and HR<sub>rec</sub>; HR<sub>exe</sub> = Heart rate immediately after the exercise; HR<sub>rec</sub> = Heart rate after one minute of recovery; SJFT = Special Judo Fitness Test; SJFI = Special Judo Fitness Test Index; TNT = Total number of throws.

Regarding specificity, both methods showed significant differences in the SJFTI and TNT between the novices and advanced athletes ( $p < .01$ ). Both approaches presented non-significant differences, however, small effect sizes in the HR<sub>exe</sub>, HR<sub>rec</sub>, and  $\Delta$  HR between the advanced and novice groups ( $p > .05$ ,  $g = 0.26 - 0.32$ ). The data comparing the

two groups have been presented in Table 3. Similar results were observed when comparing men and women, except for HR<sub>exe</sub>, which showed trivial effect sizes, and  $\Delta$  HR which showed a significant difference and moderate effect size only in the modified SJFT (Table 4).

**Table 3.** Comparison between the advanced and novice groups in each test.

SJFT variables	Original				Modified			
	Advanced	Novice	P	ES (g)	Advanced	Novice	P	ES (g)
SJFI	13.47 $\pm$ 2.04	17.94 $\pm$ 2.89	< .01	1.73 <sup>d</sup>	15.09 $\pm$ 2.40	18.04 $\pm$ 3.69	< .01	0.91 <sup>c</sup>
TNT	26.19 $\pm$ 2.73	20.35 $\pm$ 3.24	< .01	1.90 <sup>b</sup>	22.76 $\pm$ 2.84	19.92 $\pm$ 3.76	< .01	0.83 <sup>c</sup>
HR <sub>exe</sub>	185.95 $\pm$ 10.70	189.62 $\pm$ 13.94	.33	0.29 <sup>b</sup>	182.19 $\pm$ 8.64	185.23 $\pm$ 18.22	.49	0.20 <sup>b</sup>
HR <sub>rec</sub>	162.19 $\pm$ 17.34	168.42 $\pm$ 20.20	.27	0.32 <sup>b</sup>	155.76 $\pm$ 17.91	164.0 $\pm$ 23.87	.20	0.38 <sup>b</sup>
$\Delta$ HR	-23.76 $\pm$ 9.11	-21.19 $\pm$ 9.92	.37	0.26 <sup>b</sup>	-26.43 $\pm$ 11.46	-21.23 $\pm$ 13.63	.17	0.40 <sup>b</sup>

Note. b = small, c = moderate, d = large effect size;  $\Delta$  HR = Difference between HR<sub>exe</sub> and HR<sub>rec</sub>; HR<sub>exe</sub> = Heart rate immediately after the exercise; HR<sub>rec</sub> = Heart rate after one minute of recovery; SJFT = Special judo fitness test; SJFI = Special Judo Fitness Test Index; TNT = Total number of throws.

**Table 4.** Comparison between men and women in each test

SJFT variables	Original				Modified			
	Men	Women	P	ES (g)	Men	Women	P	ES (g)
SJFI	14.84 $\pm$ 2.78	17.19 $\pm$ 3.60	< .05	0.72 <sup>c</sup>	15.25 $\pm$ 2.27	18.40 $\pm$ 3.88	< .01	0.99 <sup>c</sup>
TNT	24.20 $\pm$ 3.74	21.54 $\pm$ 4.30	< .05	0.65 <sup>c</sup>	22.64 $\pm$ 2.93	19.54 $\pm$ 3.72	< .01	0.92 <sup>c</sup>
HR <sub>exe</sub>	187.24 $\pm$ 13.87	188.81 $\pm$ 11.25	.67	0.12 <sup>a</sup>	184.76 $\pm$ 16.62	182.86 $\pm$ 12.40	.66	0.13 <sup>a</sup>
HR <sub>rec</sub>	163.40 $\pm$ 19.75	168.18 $\pm$ 18.30	.39	0.25 <sup>b</sup>	156.40 $\pm$ 23.49	164.77 $\pm$ 18.77	.18	0.38 <sup>b</sup>
$\Delta$ HR	-23.84 $\pm$ 9.59	-20.63 $\pm$ 9.44	.25	0.33 <sup>b</sup>	-28.36 $\pm$ 11.94	-18.09 $\pm$ 11.80	< .01	0.85 <sup>c</sup>

Note. a = trivial, b = small, c = moderate for effect size;  $\Delta$  HR = Difference between HR<sub>exe</sub> and HR<sub>rec</sub>; HR<sub>exe</sub> = Heart rate immediately after the exercise; HR<sub>rec</sub> = Heart rate after one minute of recovery; SJFT = Special Judo Fitness Test; SJFI = Special Judo Fitness Test Index; TNT = Total number of throws.



#### 4. Discussion and Conclusion

This study aimed to evaluate the criterion validity of a modified SJFT compared to the original SJFT, using dummies. Its main findings were: a) a high level of consistency between the two tests; b) both tests showed the same specificity, demonstrating the ability to differentiate between the novice and advanced judokas as well as men and women; and c) the tests did not show agreement in the SJFI, TNT,  $HR_{\text{exe}}$ , and  $HR_{\text{rec}}$ .

Having more practical sports-specific tests provides judo coaches and researchers with the possibility of evaluating athletes constantly, which, in turn, allows them to assess individual and group conditioning improvements, training program efficacy, and project competition performance.

A strong correlation was observed between the original and modified SJFTs ( $r = .84$ ,  $p < .001$ ,  $R^2 = .705$ ), thus strongly suggesting an excellent level of consistency of the modified SJFT. However, a mean difference of 0.78 was found between the tests. Considering that most of the differences fell within the limits of agreement, this mean difference can be regarded as acceptable. The validity of the original SJFT has been investigated extensively. An early interest was the judo-specific test's ability to evaluate the anaerobic and aerobic conditioning. The relationships observed between the original SJFT and the total work index in the Wingate Test ( $r^2 = 0.51$ ), working time, distance covered in the treadmill test ( $r^2 = 0.71$ ), maximum oxygen uptake ( $r^2 = 0.53$ ), and threshold running velocity ( $r^2 = 0.45$ ) confirmed that the original SJFT reflects the judo performance's anaerobic and aerobic components (7). Other studies confirmed that the SJFT demonstrated a better relationship with the aerobic than the anaerobic parameters (1, 18), suggesting that an improved aerobic capacity enhances restitution during the rest periods. Therefore, the original SJFT can be considered as a specific and general conditioning test for judokas. Moreover, Franchini et al. (2) found a larger alactic anaerobic (86.8 kJ) energy supply than lactic (58.9 kJ) and aerobic (57.1 kJ). The high-intensity intermittent efforts executed during the throwing stages of the test mainly require lactic acid as the main energy source. Additionally, the original SJFT not only depends on the energy supply, but also on the exercise technique; this is because an improved SJFI was observed after larger neuromuscular adaptations compared to the cardiorespiratory ones (19). Therefore, we can assume that the modified SJFT is as valid as the original one in assessing

judo-specific conditioning, determined by the aerobic, anaerobic, neuromuscular, and technical parameters.

The main modification of the original SJFT implemented in this study was to substitute the human *Ukes* with dummies. A similar modification was implemented by Marković et al. (16) introduced dummies on a specific wrestling fitness test (SWFT) to standardize the error of measurements. This was because the dummies' unvarying weight and the test's fixed time duration could make it controllable in terms of intensity and volume. They found a high level of reliability, with a Cronbach's alpha level of 0.905, IIC of 0.826, and ICC of 0.821,  $p < 0.01$  for the TNT; a Cronbach's alpha level of 0.914, IIC of 0.842, and ICC of 0.900,  $p < 0.01$  for HR 1 minute; and a Cronbach's alpha level of 0.871, IIC of 0.772, and ICC of 0.674,  $p < 0.01$  for the Index. Nevertheless, the Cronbach's alpha, IIC, and ICC was -0.152, -0.071, and -0.142,  $p = 0.57$ , respectively, for HR 0 minutes. It is believed that the similarity in the mechanics and bioenergetics between wrestling and judo justifies comparisons between their tests, because the SJFT was found to be valid when used with wrestlers (20). Therefore, it is reasonable to consider that the reliability of the modified SWFT can be extrapolated to the modified SJFT, even if this study did not evaluate the test re-test reliability (16).

The modified SJFT showed the same specificity as the original, with the ability to differentiate between the novice and advanced as well as between male and female judokas. It was reported that the original SJFT was able to discriminate between the elite and non-elite Brazilian judokas regarding the TNT and SJFI (9). This study's results confirmed this; the original SJFT was able to differentiate between the novice and advanced judokas. The latter are supposed to have better technical abilities than the former. This was demonstrated by the fact that a higher TNT was executed by the advanced judokas in both tests. The original SJFT showed a larger significant difference in the TNT than the modified SJFT (1.90 vs 0.83 ES). It must be considered that the human *Ukes* participating in the original SJFT are in the *Tori*'s same level and weight category; therefore, when evaluating the advanced *Ukes*, a more fluent execution of the receiving end of the throw is observed, assisting the *Tori*'s throwing technique execution. Nevertheless, the novice *Ukes*' lower technical ability can hinder the *Tori*'s throwing execution, thus incrementing the differences between the advanced and novice TNT. This is evident when observing a larger difference in the TNT in the advanced to novice judokas regarding the original versus the modified SJFT.

Conversely, the dummies used in the modified SJFT were inanimate objects that did not cooperate. This indicates an insufficient influence of the *Uke*'s technical ability to assist or obstruct the *Tori* when different competitive levels are being evaluated, suggesting that the modified SJFT provides a more accurate evaluation of the *Tori*'s technical ability, as compared to the original SJFT.

Regarding the HR parameters, both the original and modified tests showed similar non-significant differences with small effect sizes when comparing the advanced vs. novice and men vs. women, indicating that both have the same specificity. The mutual  $HR_{exe}$  and  $HR_{rec}$  were slightly higher in the novice than in the advanced judokas on both tests. The same trend was observed for sex, with the women exhibiting slightly higher HR values than the men. These HR parameters have been considered as valid indicators of the training status (21). Therefore, the sum of  $HR_{exe}$  and  $HR_{rec}$  was regarded as the cardiovascular component of the SJFI. A study conducted in the Padel athletes by Courel-Ibáñez and Herrera-Gálvez (22) showed that the one-minute  $HR_{rec}$  can differentiate between the competitive and performance levels. However, another study on soccer players by Araujo et al. (23) found no significant differences between sex and level in the one-minute  $HR_{rec}$  after an intermittent endurance effort. Moreover, a systematic review found mixed results in studies comparing the one-minute  $HR_{rec}$  between trained and untrained subjects (24). These discrepancies can be attributed to the confounding factors, such as age, temperature, intensity, and duration of the exercise period preceding the HR recovery. For example, some studies have used maximal tests for exhaustion, while others have employed submaximal trials and intermittent tests. Although the  $HR_{exe}$  in the modified SJFT can be achieved at what is considered a maximal intensity, the SJFT is not exhausted; therefore, technically, the  $HR_{exe}$  is a submaximal value with an intermittent nature. The original and modified SJFT tests were executed with maximum effort, eliciting approximately 90% of the  $HR_{max}$ . Insufficient differences between men and women in the  $HR_{exe}$  are expected, given that the  $HR_{max}$  depends more on age than sex. Therefore, because the participants were in the same age category, a large difference in the  $HR_{exe}$  was unanticipated. The inadequate standardization has caused the application of  $HR_{rec}$  in high-intensity intermittent sports to remain questionable (21); hence, more studies and improved standardization are required to better understand the HR recovery dynamics.

Both the original and modified tests could differentiate the novice from the advanced judokas based on the SJFI, as

well as men and women. This is consistent with the normative SJFT data presented for senior and junior women (11), senior and junior men (25), and junior and cadet men and women (10). The modified SJFT specificity would enable future studies to present normative values for the modified SJFI. This new data can help coaches use the modified SJFT to classify their athletes' levels and monitor their physical fitness progress. The different components of the modified SJFT (SJFI, TNT,  $HR_{exe}$ , and  $HR_{rec}$ ) can be employed to evaluate different aspects of a judoka. The TNT, as well as the throws in series A, B, and C can be a proxy for technical and neuromuscular performance; the HR dynamics can be used to assess the cardiorespiratory performance, and the SJFI is a holistic evaluation for specific judo performance.

Although we found a high agreement between the original and modified SJFT, we observed no agreement between them, with all paired variables being statistically different. Because the SJFT requires *Tori* to execute two different actions, throws and six-meter runs between repetitions, there are two levels of analysis concerning the external load parameters. Contrary to expectations, the participants performed less TNT in the modified SJFT than in the original. This suggests that while the dummies were lighter than the human *Ukes*, the modified SJFT presented a higher technical difficulty. This study's findings are partially in line with Helm et al. (26), who analyzed the ecological validity of muscle activities during judo-specific movements using the ergometer JERGo<sup>®</sup> system compared to the *Uke*. The research revealed "small-to-moderate"  $r$  values and non-significant differences ( $p > 0.05$ ) in muscle activity, predominantly during long time intervals (0 - 100 ms, 0 - 200 ms); nevertheless, an absence of relationship was found in the trapezius ( $p > .05$ ,  $r = .41 - .53$ ) in the lifting arm. This proposes that the use of mechanical devices as an alternative for humans can change the biomechanics of the technique. Regarding the modified SJFT, the change in the biomechanics can be explained because dummies are inanimate objects that are unable to contribute to the thrower technique during the lifting movement (i.e., *Tsukuri*). In contrast, the human *Ukes* seem to assist the thrower during the execution of the *Ippon-seoi-nage* technique by pushing up with their legs when the throw is attempted. Additionally, the center of gravity of the dummies was lower than that of their human counterparts, creating a more challenging lifting pattern. These situations can explain the possible higher technical difficulty, as the *Tori* is accustomed to humans collaborating with the *Tsukuri* movement. However, the

absence of Uke cooperation and the altered load distribution of dummies may modify the biomechanical and physiological demands of the Ippon-seoi-nage, raising questions about the ecological validity of the modified test.

While the modified test appears to have a higher technical demand due to lower TNT outcomes, it also seems to elicit less physiological load, thus producing lower HR values. The original SJFT produced higher  $HR_{\text{exe}}$  and  $HR_{\text{rec}}$  ( $187.98 \pm 12.60$  and  $165.64 \pm 19.03$ , respectively) than the modified test ( $183.87 \pm 14.67$  and  $160.32 \pm 21.60$ , respectively); however, they showed the same  $\Delta$  HR. This difference likely reflects the distinct physiological demands imposed by the substitution of human Ukes with dummies. Although the dummies increased the technical difficulty of executing the throws, the lower total number of throws reduced the overall running distance and, consequently, the cardiovascular load. Thus, the modified SJFT may emphasize neuromuscular and technical aspects of performance, while the original version places greater stress on aerobic components due to the higher number of six-meter runs. This distinction suggests that the two tests, although related, may assess slightly different physiological profiles, which should be taken into account when interpreting heart rate outcomes. Considering the similar  $\Delta$  HR in both tests, we can convert the HR absolute values to the percentages relative to  $HR_{\text{max}}$ , the latter considered as  $220 - \text{age}$  (years), therefore adjusting for age. We observed an  $HR_{\text{exe}}$  of 92.1% and 90.1% in the original and modified tests, respectively. The similar percentage of  $HR_{\text{max}}$  achieved in both tests can explain why there was no difference in  $\Delta$  HR, since both tests elicited values near the lower limit of the 90% to 100% band of  $HR_{\text{max}}$ . This is in line with Bosquet et al. (27), who declared that when athletes exceeded the second ventilatory threshold during a maximal test, no differences were observed in the one-minute HR recovery, regardless of the athletes' aerobic endurance or  $VO_{2\text{max}}$  status.

This study has some limitations. A key limitation is the absence of test-retest reliability analysis for the modified SJFT. Without reliability evidence, conclusions about validity must be considered preliminary. Additionally, the lack of agreement between the tests may be addressed using a correction factor, warranting future research lines. The convenience sample from a single region (Monterrey, Mexico) restricts external validity. Thus, the findings should be interpreted cautiously when extrapolated to other judo populations or competitive levels. Using a larger sample including judo players with more national and international experience can provide with more information about the

test's performance. The unequal group distribution limited the feasibility of stratified analyses (e.g., novice vs. advanced by gender). Therefore, only basic comparisons were conducted. Future research should employ balanced sampling or stratification.

Preliminary evidence suggests that the modified SJFT may serve as a useful alternative for evaluating performance, though further research is required to establish its reliability and ecological validity. The findings indicate that the modified SJFT has potential to differentiate judokas according to their performance level, given its high-intensity intermittent structure that resembles real match demands. While the results showed comparable specificity to the original SJFT, systematic mean differences were also observed, highlighting that the two versions should not be considered interchangeable. Importantly, replacing human Ukes with dummies introduces both advantages (e.g., objective external load, reduced injury risk, and adjustable resistance) and potential limitations (altered biomechanics and physiological responses). Therefore, the modified SJFT should be regarded as a promising tool that warrants further investigation before being recommended for widespread application in athlete monitoring and training prescription.

### Authors' Contributions

G.H.C and D.G.H. designed and directed the project; G.H.C., D.G.H. and R.A.G.F. conceived and planned the experiments; D.G.H., Z.N.A.R. and L.F.R.S. carried out the experiments; G.H.C., R.A.G.F. and L.F.R.S. contributed to sample preparation; L.F.R.S., G.H.C., R.A.G.F. and Z.N.A.R. analyzed the data; G.H.C., D.G.H., R.A.G.F. and L.F.R.S. contributed to interpreting the results, took the lead in writing the manuscript with input from all authors. All authors discussed the results and commented on the manuscript.

### Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

### Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

### Acknowledgments



We appreciate the enthusiastic participation of the judokas of the state of Nuevo Leon, Mexico but especially their coaches for allowing us to carry out this research.

### Declaration of Interest

The authors report no conflict of interest.

### Funding

According to the authors, this article has no financial support.

### Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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