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Original Article

The effect of physiological, psychological and technical parameters on the final ranking of judo athletes in the game

CHRISTOS NASIOUDIS[1], ATHANASIOS XRONOPOULOS[2], GEORGE PANAYIOTOU[3], ALEXANDRA LAILOGLOU[4], KONSTANTINOS SOTIROPOULOS[5]
[1]Department of Physical Education & Sport Science, Democritus University of Thrace, GREECE
[2]Department of Physical Education & Sport Science, Aristotle University of Thessaloniki, GREECE
[3]Laboratory of Exercise, Health and Human Performance, Sports Science and Physical Education Program, Department of Life Sciences, School of Sciences, European University Cyprus, Nicosia, CYPRUS
[4]University of Macedonia, Physical Education Office, Thessaloniki, GREECE
[5]School of Physical Education & Sport Science, National and Kapodistrian University of Athens, GREECE

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Abstract
Judo is a highly demanding Olympic combat sport that requires a complex integration of physical, technical, tactical, and psychological preparation. This study aimed to investigate (a) the physiological, psychological, and technical characteristics of elite Greek judo athletes and (b) their contribution to final competition rankings. A total of 82 elite judo athletes (63 males, 19 females), aged 18–35 years (M = 22.21, SD = 4.14), participated in comprehensive assessments, including (a) physiological attributes such as muscular strength, anaerobic capacity, lactic acid concentration, flexibility, endurance, and isometric pull strength; (b) psychological skills evaluated using the Athletic Coping Skills Inventory-28; and (c) technical and tactical performance, analysed through video observation of competition matches. A total of 1,082 throwing attempts across different judo techniques were recorded, with an average effectiveness score of 3.24. Discriminant analysis revealed that psychological skills and mean effectiveness of techniques were the strongest predictors of final rankings, whereas overall physiological attributes and the number of throws had less impact. Athletes who ranked higher in competition demonstrated superior technical efficiency and psychological preparedness, suggesting that these factors are critical for success in elite judo. Findings indicate that (a) Greek judokas exhibit physiological characteristics comparable to their international counterparts, (b) they possess well-developed psychological skills, and (c) technical proficiency and psychological attributes play a more significant role in final competition ranking than physiological parameters or the total number of executed throws. These results emphasise the need for integrating psychological training with technical refinement in judo coaching programs. Future research should further explore the interplay between physical and psychological conditioning to optimise competitive performance in elite judo.
Key-Words: Isometric strength, anaerobic capacity, competition performance, psychological skills, technical effectiveness, tactical efficiency.

Introduction

Judo is an Olympic combat sport that requires an intricate balance of technical proficiency, physical conditioning, and psychological resilience to achieve competitive success. Unlike many other sports, where victory is often determined by superior strength or endurance alone, judo is a dynamic, weight-classified sport that relies on the precise execution of techniques, strategic adaptability, and the ability to withstand intense physical and mental pressures (Franchini, Del Vecchio, Matsushigue, & Artioli, 2011; Torres-Luque, Hernández-García, Escobar-Molina, Garatachea, & Nikolaidis, 2016). As a result, judo training and performance assessment require a multidimensional approach that integrates physiological, technical, and psychological parameters to optimise an athlete's ability to compete at the highest level.

Technical proficiency is one of the strongest predictors of success in judo. Athletes must master a diverse range of techniques, including standing throws (nage-waza) and groundwork (ne-waza), to effectively control their opponents. The efficiency of these techniques, rather than the sheer number of attempts, is often a distinguishing factor between elite and sub-elite competitors (Brandão Kashiwagura, Courel-Ibáñez, Brandão Kashiwagura, Agostinho, & Franchini, 2021). Recent research suggests that judokas who demonstrate higher throwing efficiency—measured as the ratio of successful throws to total attempts—achieve higher competition rankings (Ahmedov et al., 2024). Moreover, grip control is essential in determining tactical success in judo, as strong gripping ability allows an athlete to dictate the fight's pace and direction (Schoof, Sliedrecht, & Elferink-Gemser, 2024).

Corresponding Author: CHRISTOS NASIOUDIS, E-mail: ax1113ln@gmail.com

Tactical decision-making is equally critical, as judokas must adapt their strategies based on the opponent's weaknesses and match conditions. Successful competitors exhibit superior reaction times, situational awareness, and the ability to adjust throwing techniques mid-match (da Silva Batista et al., 2024). Studies have highlighted the importance of analysing technical and tactical patterns in elite judo competitions to develop more efficient training methodologies (Campos et al., 2022; Bagadirova, 2020).

Although judo is primarily a technical sport, it also places significant physiological demands on athletes, requiring a combination of strength, power, flexibility, aerobic endurance, and anaerobic capacity. Judo matches are characterised by high-intensity, intermittent efforts, with athletes engaging in repeated bursts of maximal exertion interspersed with brief recovery periods (Franchini, Brito, Fukuda, & Artioli, 2014). As such, anaerobic power and muscular endurance are key determinants of performance, particularly during prolonged matches or tournaments where multiple bouts occur within a short time frame (Detanico, Dal Pupo, Franchini, & Dos Santos, 2015). Studies indicate that elite judokas exhibit superior lower-body power, particularly in countermovement and squat jumps, which are critical for executing explosive throwing techniques (Franchini et al., 2011; Torres-Luque et al., 2016). Additionally, isometric strength in grip and upper-body muscles is crucial in controlling opponents and resisting counterattacks (Osipov, Kudryavtsev, Iermakov, & Jagiello, 2017). Research also suggests that lactate tolerance and anaerobic threshold levels distinguish elite judokas from lower-ranked competitors, highlighting the importance of energy system development in training programs (Manolachi, Potop, Manolachi, & Dorgan, 2021).

Furthermore, gender and weight category differences can influence the relative contribution of strength, endurance, and flexibility to judo performance. Ahmedov et al. (2024) compared technical and tactical parameters across various weight categories and found that lighter athletes relied more on speed and agility, while heavier judokas depended on strength and power. These findings suggest that training programs should be tailored to account for individual physiological profiles and weight-class-specific demands.

In addition to technical and physiological attributes, psychological preparedness is a critical factor influencing competitive outcomes in judo. High-performance athletes must manage stress, maintain focus under pressure, and demonstrate resilience in unpredictable match conditions (Rossi et al., 2022). Research has consistently linked self-confidence, emotional regulation, and cognitive flexibility with higher competition rankings (Ziv & Lidor, 2013; Rossi et al., 2022). A systematic review by Rossi et al. (2022) emphasised that mental toughness and psychological coping strategies differentiate elite judokas from sub-elite athletes. Top-performing competitors tend to exhibit higher motivation levels, goal-setting skills, and adaptability when faced with challenges (Korobeynikov, Korobeynikova, Romanyuk, Dakal, & Danko, 2017). Psychological stressors such as pre-match anxiety and fear of failure can negatively impact performance, underscoring the need for mental preparation techniques in judo training (Brandt et al., 2021).

Moreover, studies examining reaction time, cognitive processing speed, and decision-making accuracy have explored the psychophysiological relationship in judo (Matsumoto et al., 2001). Athletes with faster reaction times and superior cognitive processing abilities anticipate opponent movements more effectively, leading to higher rates of successful attacks and defensive manoeuvres. This highlights the importance of integrating cognitive training and psychological skill development into judo training regimens.

Although extensive research has independently examined judo's technical, physiological, and psychological aspects, few studies have investigated their combined impact on competition performance. The relative contributions of throwing effectiveness, anaerobic power, grip strength, psychological resilience, and cognitive adaptability remain underexplored concerning the final ranking. Additionally, limited research has focused on Greek judo athletes, making it essential to assess their performance characteristics compared to international standards.

This study aimed to evaluate elite Greek judo athletes' physiological, psychological, and technical characteristics and determine which parameters are most strongly associated with competition success and final ranking. Finally, it seeks to provide insights for optimising training programs by identifying the key attributes contributing to elite-level performance. By bridging this research gap, this study will contribute to a more comprehensive understanding of the multifaceted nature of judo performance and help enhance training methodologies for competitive success.

Methods

Participants

A total of 82 elite Greek judo athletes (63 males, 19 females) aged 18–35 years (M = 22.21, SD = 4.14) participated in this study. All participants were high-level competitors who qualified for the Greek National Judo Championship. The sample included judokas across all weight categories, ensuring a comprehensive analysis of physiological, psychological, and technical attributes. Male participants were categorised into lightweight (60 kg, 66 kg, 73 kg), and heavyweight (78 kg, 81 kg, 90 kg, 100 kg, 100+ kg) divisions. In comparison, female participants were divided into lightweight (48 kg, 52 kg, 57 kg) and middleweight (63 kg, 70 kg, 78 kg) categories.

Participants were recruited through invitations to judo clubs and national team training centres, consisting of a convenient sample. Inclusion criteria required athletes to be active competitors at the national or international level, have a minimum of five years of competitive experience, and be injury-free at the time of testing. Athletes with injuries or medical conditions affecting performance were excluded. All participants provided written informed consent, and the Institutional Review Board Committee approved the study, following the ethical principles of the Declaration of Helsinki.

Study Design and Procedures

This study followed a cross-sectional design to assess elite judo athletes' physiological, psychological, and technical performance characteristics and their influence on final competition rankings. Data collection was conducted in three phases. The first phase involved baseline physiological and psychological assessments in a controlled environment. The second phase focused on competition performance analysis, using video recordings of matches. The final phase integrated all collected data for statistical analysis, determining the predictive relationships between performance variables and final rankings.

Measurements took place at the athletes' training grounds to ensure familiarity. Initially, participants completed the Athletic Coping Skills Inventory-28 (ACSI-28) and had their height, body mass, and BMI (kg/m²) recorded. A 5-minute cycling warm-up (60 W), lower-limb stretching, and 2 minutes of jumping exercises preceded the vertical jump tests (SJ, CMJ), where athletes performed three trials with 45-second rest intervals, maintaining a consistent posture, with the best attempt recorded.

Following this, isometric handgrip strength and Wingate anaerobic power tests were conducted, with blood lactate levels measured 4 minutes post-Wingate. The handgrip test consisted of three trials per hand, with 2-minute rest intervals, and the best result recorded. Torso-shoulder flexibility (Fleishman's test), hip flexibility (Sit-and-Reach test), muscular endurance (Burpee test), and isometric pull strength (three trials per hand) were also assessed. Finally, aerobic capacity was evaluated using the Queens College Step Test, with heart rate monitored via Polar sensors.

Physiological Measurements

Assessments and Procedures

Several physiological attributes, including muscular strength, anaerobic capacity, flexibility, endurance, and aerobic power, were assessed using standardised tests and validated instruments. Anthropometric measurements, including height and weight, were obtained using a Seca 228 stadiometer and a Philips HP 5324 electronic scale, respectively, while body mass index (BMI) was calculated as kg/m². Lower limb power was assessed using the Countermovement Jump (CMJ) and Squat Jump (SJ) tests (Byrne & Eston, 2002) performed on an electronic jump mat following the procedures described in Bosco (1991). Both tests had been previously validated for reliability (CMJ r = .91, SJ r = .90) (Vitasalo, 1985).

Upper body strength was evaluated using isometric handgrip strength (Baker et al., 2002), measured with a Takei Grip-D TKK 5101 dynamometer (r = .90) (Kabitsis, 1990), while pulling strength was assessed using a Lafayette Model 32526 dynamometer, attached to a custom-made apparatus which mimics judo gripping. Participants stood on the apparatus, holding the tackle block with one hand and gripping the steel-wire handle with the other, elbows at shoulder height. With feet stable and knees slightly bent, they applied maximal pulling force for at least three seconds, minimising body movement (Figure 1). Measurements were taken for both arms. Designed to mimic judo pull-throwing mechanics, the test showed a correlation coefficient of r = .81 and a reliability coefficient of r = .88.

Anaerobic power and capacity were determined using the Wingate Test on a Monark 843 cycle ergometer involving a maximum effort of 30 seconds with 7.5% body weight applied resistance. (Baker & Davies, 2002; Beneke, Pollmann, Bleif, Leithauser, & Hutler, 2002; Macintosh, Rishaug, & Svedahl, 2003). The test has demonstrated high reliability (r = .89 – .98) (Bar-Or, 1987; Coggan & Costill, 1984). Blood lactate concentration was measured four minutes post-exercise using an Accusport BM Lactate Analyzer (Callan et al., 2000; Imamura et al., 1999), a validated device with strong reliability (r = .95) (Pfitzinger & Freedson, 1998).

Figure 1. Evaluation of isometric pulling strength

Flexibility was assessed using two established tests. Hip flexibility was measured using the Sit-and-Reach Test (Baltaci, Un, Tunay, Besler, & Gerçeker, 2003; Jones, 2002), which has demonstrated strong test-retest reliability (r = .96 – .99) (Liemohn, Sharpe & Wasserman, 1994), while torso and shoulder flexibility were evaluated using the Fleishman Test (Fleishman, 1958; Marsh, 1993) (r = .90) (Kabitsis, 1990). General muscular endurance was assessed using the Burpee Test (Burpee, 1940; Hall & Lane, 2001; Simoneau, 1998), a widely used indicator of full-body endurance with strong validity (r = .92 for males, r = .85 for females) (Kabitsis, 1990). Aerobic capacity was estimated using the Queens College Step Test a validated predictor of $\dot{V}O_{2max}$ (r = .91). (Ashley, Smith, & Reneau, 1997; Baker & Davies, 2002; Mc Ardle, 1972).

Psychological Assessments

Psychological attributes were assessed using the Athletic Coping Skills Inventory-28 (ACSI-28) (Yoon, 2002), a validated questionnaire that measures seven key mental skills in sports: coping with adversity, peaking under pressure, goal setting, concentration, freedom from worry, confidence, and coachability. Each factor consists of four questions, scored on a 6-point Likert scale (1 = Never, 6 = Always), with the total ACSI-28 score serving as an overall psychological performance index. This tool has been extensively validated in combat sports, demonstrating strong internal consistency (Cronbach's α = .91) (Smith, Schutz, Smoll, & Ptacek 1995; Goudas, Theodorakis & Karamousalidis, 1998; Junge et al., 2000; Cresswell & Hodge, 2004; Bebetsos & Antoniou, 2003).

Technical Performance and Tactical Assessment

Competitive performance was analysed through video recordings of the Greek National Judo Championship. Matches were recorded using Panasonic National M7 and Canon MV400 cameras, and two independent researchers conducted the analysis. A structured technical-tactical assessment form was used to document key performance indicators, including the frequency of throws per technique type (Te-waza, Goshi-waza, Ashi-waza, Sutemi-waza, Ne-waza), the effectiveness of each technique, and overall competition ranking (gold, silver, bronze, fifth place, or non-finalist). The researcher's intra and inter-observer reliability was evaluated using Cohen's Kappa index, whichshowed values of 0.93 and 0.94 respectively (Altman et al., 1991).

Statistical Analysis

Data were analysed using IBM SPSS Statistics 28.0. Descriptive statistics were calculated for all variables, including mean, standard deviation, and range. Relationships between physiological, psychological, and technical indicators and competition ranking were examined using multiple statistical approaches. Discriminant analysis was employed to determine which variables best predict final ranking, while ANOVA and post-hoc comparisons were conducted to identify significant differences between ranking groups. Additionally, Pearson correlation coefficients were calculated to examine associations between performance indicators. A significance level of $p < .05$ was used for all statistical tests.

Results

Physiological Parameters

The analysis of physiological characteristics among elite Greek judokas revealed substantial variability in key physical attributes, particularly in anaerobic power, strength, and flexibility. As shown in Table 1, the Countermovement Jump (CMJ) performance ranged from 20.70 cm to 47.80 cm (M±SD= 36.05±6.21cm), while the Squat Jump (SJ) ranged from 17.20 cm to 41.80 cm (M±SD= 31.29±5.41 cm). These findings suggest notable inter-individual differences in lower-limb explosive power, a crucial determinant in executing dynamic throws in judo.

Anaerobic power, expressed in relative peak power per body weight ($W \cdot kg^{-1}$), varied between 6.17 and 19.37 $W \cdot kg^{-1}$ (M±SD= 14.69±2.45 $W \cdot kg^{-1}$). The relative anaerobic work ranged from 78.3 $J \cdot kg^{-1}$ to 317.47 $J \cdot kg^{-1}$ (M±SD= 234.08±40.12 $J \cdot kg^{-1}$) while the fatigue index in the 30-second Wingate test ranged from 47.32% to 79.89%, reinforcing the substantial anaerobic demands of judo competition. Blood lactate concentrations, measured four minutes post-test, ranged from 8.90 $mmol \cdot l^{-1}$ to 15.90 $mmol \cdot l^{-1}$ (M±SD= 12.27±1.61 $mmol \cdot l^{-1}$), suggesting a high lactate tolerance capacity among the athletes.

Flexibility assessments revealed a broad range of hip flexibility values varied between 2.00 cm to 27.20 cm, (M±SD= 15.35±7.07 *cm)* and torso-shoulder flexibility values ranged from 7.00 cm to 87.00 cm, (M±SD= 40.44±19.22 cm,). General muscular endurance, evaluated through the Burpee test, ranged between 14 and 25 repetitions (M±SD= 19.87±2.70 *reps*). Isometric pull strength, a critical determinant of gripping ability in judo, showed notable inter-athlete variability, ranging from 14.25 kg to 90.03 kg (M±SD= 48.08±17.57 kg).

Finally, aerobic capacity ($\dot{V}O_{2max}$) values varied significantly, ranging from 31.82 $ml \cdot kg^{-1} \cdot min^{-1}$ to 69.33 $ml \cdot kg^{-1} \cdot min^{-1}$ (M±SD= 46.28±8.59 $ml \cdot kg^{-1} \cdot min^{-1}$), confirming that judokas rely predominantly on anaerobic metabolism during competition.

Table 1. Descriptive statistics of physiological performance indicators

Physiological parameters	N	Mean	Sd	Minimum	Maximum
Counter Movement Jump (CMJ) (cm)	82	36.05	6.21	20.70	47.80
Squat Jump (SJ) (cm)	82	31.29	5.41	15.20	41.80
Total anaerobic work (J)	82	234.08	40.12	78.93	317.47
Fatigue Indicator (30sec)	82	65%	6.35	47.32%	79.89%
Peak Power (W/kg)	82	14.69	2.45	6.17	19.37
Mean Power ($W \cdot kg^{-1}$)	82	7.87	1.28	2.63	10.27
Lactic acid ($mmol \cdot l^{-1}$)	82	12.27	1.61	8.90	15.90
Hip flexibility (cm)	82	15.35	7.07	2.00	27.20
Torso and shoulder flexibility (cm)	82	40.44	19.22	7.00	87.00
General muscular endurance (#rep)	82	19.87	2.70	14	25
Hand grip (kg)	82	46.70	11.27	21.80	72.45
Isometric pull strength (kg)	82	48.08	17.57	14.25	90.03
Anaerobic capacity ($ml \cdot kg^{-1} \cdot min^{-1}$)	82	46.28	8.59	31.82	69.33

Physiological Attributes and their Relation to Performance

Athletes' psychological skills were assessed using the Athletic Coping Skills Inventory-28 (ACSI-28). The results, presented in Table 2, indicate that confidence (M±SD= 4.88±0.71) and coachability (M±SD= 5.35±0.60) were the highest-scoring attributes, followed closely by goal setting (M±SD= 4.84±0.89) and concentration (M±SD= 4.82±.78). These findings suggest that elite Greek judokas demonstrate strong mental resilience, adaptability, and focus, which may contribute to their competitive success.

Peaking under pressure (M±SD= 4.29±1.27) and coping with adversity (M±SD= 4.51±1.02) also showed moderate values, highlighting the athletes' ability to maintain composure in high-stakes matches. The lowest scores were observed in freedom from worry (M±SD= 4.21±1.32), indicating that anxiety management may require further development in some athletes.

Table 2. Mean scores of psychological skills indicators

Psychological skills	N	Mean	Sd
Coping with Adversity	82	4.51	1.02
Peaking under pressure	82	4.29	1.27
Goal setting	82	4.84	.89
Concentration	82	4.82	.78
Freedom from worry	82	4.21	1.32
Confidence	82	4.88	.71
Coachability	82	5.35	.60
Total score	**82**	**4.70**	**.73**

Technical-Tactical Performance in Competition

Video analysis of the Greek National Judo Championship provided insights into the distribution and effectiveness of different judo techniques. In total, 1,082 throw attempts were recorded, with an overall effectiveness score of (Mean ± SD) 3.24±1.87. Table 3 details the frequency and effectiveness of various throwing techniques. Among the evaluated techniques, leg techniques (Ashi-waza) were the most frequently employed, with 363 attempts (by 72 athletes), followed by hand techniques (Te-waza) with 348 attempts (by 65 athletes). Self-sacrifice techniques (Sutemi-waza) accounted for 194 attempts (by 58 athletes), while hip techniques (Goshi-waza) and ground techniques (Ne-waza) were the least frequently used, with 89 (by 37 athletes) and 88 attempts (by 47 athletes), respectively.

Despite their lower usage rate, Ne-waza techniques exhibited the highest effectiveness score (M±SD= 5.50±4.42), suggesting that groundwork techniques contribute significantly to scoring opportunities when applied effectively. By contrast, Goshi-waza techniques had the lowest effectiveness score (M±SD= 2.47±3.32), indicating greater execution challenges in competition settings.

Table 3. Number of throws per technique and their effectiveness

Techniques	Athletes	Efforts	Mean Effectiveness	Sd
Leg Techniques (Ashi waza)	72	363	2.76	2.78
Hand Techniques (Te waza)	65	348	3.09	2.87
Self-sacrifice Techniques (Sutemi waza)	58	194	2.97	2.93
Hip Techniques (Goshi waza)	37	89	2.47	3.32
Field Techniques (Ne waza)	47	88	5.50	4.42
Total score	82	1082	3.24	1.87

Discriminant Analysis of Performance Predictors

A discriminant function analysis was conducted to identify the strongest predictors of final competition ranking using mean effectiveness, total number of throws, psychological skills index, and overall physiological parameters as independent variables. The results (Table 4) indicate that psychological preparedness and technical effectiveness were the strongest predictors of final ranking, while physiological attributes and total throwing attempts were less significant.

The first discriminant function accounted for 85.1% of the total variance ($X^2_{(16)}$ = 144.80, p < .001), while the second and third functions accounted for 8.9% ($X^2_{(9)}$ =36.74, p<.001) and 6.0% ($X^2_{(4)}$ =15.26, p<.01), respectively. This suggests that athletes with superior throwing effectiveness and psychological skills were significantly more likely to achieve higher competitive rankings.

Table 4. Summary of discriminant analysis results

Function	X^2	df	Sig.	% Total range
1	144.80	16	.001	85.1
2	36.74	9	.001	8.9
3	15.26	4	.004	6
4	.02	1	.872	.0

Further examination of group centroids (Table 5) revealed that first-place finishers scored significantly higher in mean effectiveness and psychological skills than fifth-place finishers and non-qualifiers. Notably, athletes with high scores in overall physiological parameters or total throws alone did not consistently achieve top rankings, reinforcing that physical attributes alone are insufficient for success in elite judo.

Table 5. Centroid values by final ranking group

Group centroids				
Final ranking	**1**	**2**	**3**	**4**
1	3.036	-.243	-.731	-1.285E-02
2	1.481	.219	1.034	-3.183E-02
3	1.136	3.544E-02	.272	2.961E-02
5	-1.210	1.150	-.301	-2.883E-03
Not Qualified	-1.561	-.458	-3.771E-02	-3.110E-03

The loadings indicate that mean effectiveness and the psychological skills indicator are strong predictors of an athlete's final ranking. Higher values in these variables significantly increase the likelihood of achieving a top placement in competition. In contrast, the predictive power of the total number of throws and the overall physiological parameters remains unclear. Athletes who score high in these two variables alone do not consistently achieve higher rankings, suggesting that technical efficiency and psychological preparedness play a more decisive role in competitive success (Table 6).

Table 6. Loadings' table

	1st place	2nd place	3rd place	5th place	Not Qualified
Psychological skills	36.590	33.804	32.673	26.139	26.813
Effectiveness	2.858	1.739	1.925	1.989	1.030
Physiological parameters	-7.090	-7.680	-6.997	-7.722	-5.265
Number of throws	.336	.575	.458	.481	.313

Classification Accuracy of Final Ranking

The discriminant model correctly classified 73.2% of the athletes' rankings, a significantly higher accuracy than random classification (20%). As presented in Table 7, the highest classification accuracy was observed for first-place finishers (81.8%) and fifth-place finishers (84.6%), suggesting that psychological preparedness and technical efficiency are robust predictors of high- and low-level performance outcomes.

Table 7. Classification accuracy of athletes based on discriminant model

	1st place	2nd place	3rd place	5th place	Not Qualified	Total of the sample
% Classification	81.8	62.5	66.7	84.6	71.9	73.2

Discussion

The findings of this study highlight the multifaceted nature of performance determinants in elite judo, emphasizing the interplay between technical efficiency, psychological preparedness, and physiological attributes. The results indicate that technical effectiveness and psychological skills are the strongest predictors of

competition ranking, while physiological parameters and the overall number of throws have a less pronounced influence. These findings align with previous research emphasizing the importance of technical-tactical proficiency and mental resilience in combat sports (Rossi et al., 2022; Ziv & Lidor, 2013).

Physiological Characteristics and Their Influence on Performance

Greek judo athletes demonstrated physiological attributes comparable to those of international competitors, as indicated by the values obtained in muscular strength, anaerobic capacity, endurance, flexibility, and isometric pull strength. Previous studies have reported similar findings evaluating elite judokas from various countries (Borkowski et al., 2001; Franchini et al., 2011; Torres-Luque et al., 2016). However, certain differences were observed in peak values of specific physiological variables, such as countermovement jump (CMJ) performance. Greek judokas showed slightly lower outputs than athletes from other nations. These discrepancies may be attributed to differences in training loads, periodization strategies, or competition schedules at the assessment time (Kons et al., 2021).

While physiological parameters are essential for maintaining performance across multiple bouts in a competition, their direct impact on final ranking appears to be secondary to technical proficiency and psychological preparedness. Previous research supports this observation, indicating that although anaerobic power, strength, and endurance contribute to performance, they do not solely determine competition outcomes (Franchini et al., 2014; Detanico et al., 2012). Furthermore, findings from this study reinforce that higher anaerobic thresholds and lactate tolerance may provide a competitive advantage, particularly in prolonged tournaments requiring multiple high-intensity matches (Manolachi et al., 2021).

The Critical Role of Technical Effectiveness

Technical efficiency was a dominant predictor of competition success, as athletes with higher mean effectiveness scores secured better rankings. This supports prior findings that execution precision differentiates top—performing judokas from lower—ranked competitors rather than the sheer number of attempted throws (Ahmedov et al., 2024; Brandão Kashiwagura et al., 2021).

The distribution of throwing attempts across different technique categories revealed that Leg techniques (Ashi-waza) and Hand techniques (Te-waza) were the most frequently employed. In contrast, Ground techniques (Ne-waza) and Hip techniques (Goshi-waza) were used less frequently. This aligns with previous findings indicating that gripping control and standing throws are decisive factors in modern judo competitions (Schoof et al., 2024). The success rate of Ne-waza techniques was notably higher than that of standing techniques, which is consistent with previous research showing that ground techniques often lead to successful ippons when executed effectively (da Silva Batista et al., 2024).

Moreover, findings from discriminant analysis in this study confirm that technical effectiveness is a more reliable predictor of success than the overall number of executed throws. This suggests that athletes should prioritize refining their throw efficiency and adapting their technique selection based on tactical demands, rather than focusing solely on increasing the volume of attack attempts.

Psychological Preparedness as a Ky Determinant of Success

The results strongly indicate that psychological attributes significantly influence competitive ranking, reinforcing that mental resilience, emotional regulation, and focus are critical components of elite judo performance. Athletes who scored higher on the Athletic Coping Skills Inventory-28 (ACSI-28) exhibited better competitive outcomes, supporting previous research that linked psychological skills with success in combat sports (Rossi et al., 2022; Ziv & Lidor, 2013).

Confidence, goal setting, and concentration were the highest-scoring attributes among the psychological factors assessed. These findings align with studies emphasizing the role of cognitive processing speed and reaction time in anticipating opponent movements and successfully executing techniques under pressure (Matsumoto et al., 2001). Furthermore, mental skills such as coping with adversity and peaking under pressure were positively associated with competition ranking, reinforcing the idea that successful judokas can effectively manage stress and maintain focus during high-stakes matches (Korobeynikov et al., 2017).

Implications for Training and Coaching Strategies

The findings underscore the necessity for integrated training approaches that emphasize physical conditioning, technical refinement, and psychological skill development. Given that technical effectiveness and psychological resilience were the strongest predictors of competition success, training programs should:

1. Prioritize high-quality technical execution over high-volume throwing repetitions, ensuring athletes develop precise and adaptable techniques.
2. Incorporate structured mental training, including cognitive-behavioral strategies, visualization, and stress management techniques, to enhance mental resilience.
3. Tailor training to individual weight categories, as prior research has shown that lighter athletes rely more on speed and agility, while heavier athletes depend more on strength and power (Ahmedov et al., 2024).
4. Enhance competition-specific conditioning, focusing on lactate threshold development, anaerobic capacity, and grip endurance, which are essential for sustaining performance across multiple bouts (Franchini et al., 2014).

Limitations and Future Research

Although this study provides valuable insights into elite judo performance determinants, some limitations should be acknowledged. The sample was restricted to Greek judo athletes, which may limit generalizability to other national or international competitors. Additionally, the study utilized a cross-sectional design, which does not account for longitudinal adaptations resulting from different training methodologies. Future research should explore the long-term development of judo performance attributes through training interventions and assess the interaction between psychological, physiological, and technical parameters over multiple competition seasons.

Furthermore, while this study examined broad psychological skills, future research should delve deeper into specific cognitive functions, such as decision-making speed, visual attention, and anticipatory skills, which have been shown to play a role in combat sports success (Campos et al., 2022).

Conclusion

In conclusion, this study highlights the importance of technical effectiveness and psychological preparedness as key determinants of competition success in elite judo. While physiological attributes are crucial for sustaining high-intensity efforts, they do not singularly predict final rankings. Instead, judokas who exhibit superior technique efficiency and strong psychological coping mechanisms are likelier to achieve higher competitive placements. These findings emphasize the need for training methodologies integrating technical skill optimization, psychological resilience training, and targeted physiological conditioning to enhance elite judo performance. Future studies should further investigate long-term adaptations in technical, psychological, and physiological attributes, providing deeper insights into how training regimens can be refined to optimize success in combat sports.

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