RevChi REAF REVISTA CHILENA DE REHABILITACIÓN Y ACTIVIDAD FÍSICA
Universidad Autónoma de Chile

UNIVERSIDAD AUTÓNOMA DE CHILE
MÁS UNIVERSIDAD

Vol 5 · Nº 1 · 2025

ISSN 2735-7287
DOI: 10.32457/reaf1.2970
Recibido: 15 de marzo de 2025 **/ Aceptado:** 13 de mayo de 2025

Anaerobic Performance and Athletic Talent in Elite Taekwondo Athletes

Rendimiento anaeróbico y talento deportivo en taekwondistas de elite

Guillermo Andrés Sáez Abello[1]
Andrés Mauricio Ariza Viviescas[2]
Paul Sebastián Once Saca[3]
Felipe Andrés Rosas Treuque[4]

Correspondencia a Andrés Mauricio Ariza Viviescas: andrecio1@hotmail.com

Abstract

Introduction: It is paramount to analyze the profile and physiological needs of taekwondo athletes to optimize and enhance their sports performance. **Objective:** To determine the relationship between anaerobic performance variables in the rast test and athletic talent. **Methodology:** A quantitative research of quasi-experimental observational design with a descriptive-correlational approach was conducted. This study was carried out on Elite Taekwondo athletes affiliated with the United States Taekwondo National Governing Body

1 PhD. en Educación, Centro de investigación y capacitación EDUCATKD, Manizales, Colombia.
2 MSc en Ciencias del Deporte, Centro de investigación y capacitación EDUCATKD, Bucaramanga, Colombia.
3 MSc en Educación Física y Entrenamiento Deportivo, Centro de investigación y capacitación EDUCATKD, Cuenca, Ecuador.
4 Tecnico de Nivel Superior en preparación Física, Centro de investigación y capacitación EDUCATKD, Santiago de Chile, Chile

(USAT) during the year 2023. Anaerobic performance was assessed using the Rast test, and athletic talent was considered as the position in the national ranking**. Results:** High negative relationships were identified in the variables of minimum power (-0.088) and fatigue index (-0.093), approaching significance ($p<0.057$) and ($p<0.044$) respectively. The other variables showed low to moderate negative correlations that were not significant. Additionally, a minimum power of 293.89 W, a maximum power of 390.37 W, and an average power of 346.16 W were observed. Furthermore, a relative power of 7.41 W adjusted for the athlete's body mass was noted. In terms of anaerobic capacity, a value of 2052.23 W with a 25th percentile confidence interval (CI) of 1410.76 and a 75th percentile CI of 2849.17 was obtained. The fatigue index in the population was 4.39. Lastly, a median athletic talent score of 8.00 was found, indicating a high level of talent closely associated with top positions in the USA ranking**. Conclusion:** Greater anaerobic performance in terms of power and fatigue index is related to a better ranking position. These associations underscore the importance of anaerobic performance variables in competitive taekwondo performance and support the notion that superior power and fatigue resistance are linked to higher rankings.
Keywords: anaerobic performance, anaerobic capacity, athletic talent, taekwondo athlete

Resumen

Introducción: Es crucial analizar el perfil y las necesidades fisiológicas del taekwondista para optimizar y mejorar su rendimiento deportivo. **Objetivo:** determinar la relación de las variables del rendimiento anaeróbico en el test de Rast y el talento deportivo. **Metodología:** Investigación de naturaleza cuantitativa, que adopta un diseño observacional cuasiexperimental, con un enfoque descriptivo-correlacional. Este estudio se llevó a cabo en taekwondistas de elite pertenecientes a los campamentos deportivos vinculados a la entidad nacional de taekwondo en Estados Unidos (USAT), durante el transcurso del año 2023. Se evaluó el rendimiento anaeróbico a través del test de Rast, y el talento deportivo fue tenido en cuenta como la posición en el ranqueo nacional. **Resultados:** Se identificaron relaciones negativas altas en las variables de potencia mínima (-0,088) e índice de fatiga (-0,093) cercanas a la significancia ($p<0,057$) y ($p<0,044$) respectivamente. Las demás variables presentaron correlaciones negativas bajas a moderadas y no significativas. Asimismo, se identificó una potencia mínima de 293,89 W, una potencia máxima de 390,37 W y una potencia promedio de 346,16 w. Además, se observó una potencia relativa de 7,41 W ajustada según la masa corporal del atleta. En términos de capacidad anaeróbica, se obtuvo un valor de 2052,23 W con un RIC de 1410,76 en el percentil 25 y 2849,17 en el percentil 75. El índice de fatiga en la población fue 4,39. Por último, se encontró una mediana del talento deportivo de 8,00, indicando un nivel alto de talento, cercano a las principales posiciones en el ranking de Estados Unidos. **Conclusión:** Un mayor rendimiento anaeróbico en términos de potencia e índice de fatiga está relacionado con una mejor posición en el ranqueo. Estas asociaciones resaltan la importancia de las variables del rendimiento anaeróbico en el desempeño competitivo en el taekwondo y respaldan la idea de que

un mejor rendimiento en términos de potencia y resistencia a la fatiga está vinculado a una mejor posición en el ranqueo.
Palabras clave: rendimiento anaeróbico, capacidad anaeróbica, talento deportivo, taekwondistas

Introduction

Throughout its evolution, taekwondo as a sport has undergone significant changes in regulations and competition since its inclusion in the Olympic Games. This evolution has sparked growing interest in investigating various performance variables affecting practitioners of this sport (1). Notably, taekwondo competitions emphasize the prominence of high-speed movements, specifically in the execution of kicks and punches, as well as agility in footwork. These activities demand a considerable energy expenditure and are primarily linked to anaerobic capacity (1, 2).

Anaerobic capacity is defined as the physiological ability to perform intense, short-duration activities without primarily relying on oxygen supply. During these efforts, the anaerobic system is activated, generating energy through metabolic processes that do not involve complete cellular respiration (1, 3, 4). In the context of taekwondo, where short and intense bursts of physical activity are characteristic, such as rapid kicks, jumps, and movements, anaerobic capacity plays an essential role. The effectiveness of taekwondo practitioners in executing these explosive movements can be crucial for success on the tatami (1, 2, 3, 4).

Therefore, it is crucial to analyze the physiological profile and needs of taekwondo athletes to optimize and enhance their sports performance (2). The significance lies in taekwondo practitioners possessing significant anaerobic capacity and power in the lower limbs, crucial for providing an energy reserve for intermittent high-intensity actions, as seen in competitions (5). Numerous tools and validated assessments are available for analyzing anaerobic performance in taekwondo practitioners. Still, a test gaining notable attention is the "Running-based Anaerobic Sprint Test," abbreviated as "RAST" in English (6, 7, 8). The RAST has become a reliable and widely adopted resource for measuring anaerobic capacity and power in athletes, including those in taekwondo (7, 9, 10, 11).

While it is evident that the RAST was not specifically designed for taekwondo practitioners, given the existence of other tests evaluating anaerobic capacity using movement patterns more aligned with the sport, this sprint-based test could still be reliable

within this population. Justification lies in taekwondo being a sport of intermittent efforts, where athletes engage in intense actions like attacks, defenses, and counterattacks in very short intervals, aligning with the effort required in the RAST (6, 7, 8). Furthermore, many methods for evaluating these athletes involve invasive procedures and the use of sophisticated equipment, limiting their widespread application due to access restrictions (8). In line with this, the anaerobic speed test based on running originates from the 30-second Wingate test and is considered a valid field assessment (6, 8). The RAST is used to measure anaerobic power in athletes and demonstrates a degree of reliability, both relative and absolute, in taekwondo practitioners (8). Advocates for this tool in these populations also note that, although both nonspecific and specific taekwondo training can lead to general improvements in power and aerobic capacity, both nonspecific and specific tests can be employed to assess and monitor such improvements (12).

The main hypothesis of this study aims to investigate whether performance in the RAST is related to a higher national ranking, linked to greater sporting talent. There is ample evidence suggesting that this association may be supported. These two aspects could be interconnected, as demonstrated in a study by Lui and He in 2022, analyzing RAST performance in elite taekwondo athletes. The results indicated a positive correlation between RAST performance and competitive success in taekwondo, suggesting that a higher level of anaerobic capacity and power could provide advantages in competitions (11).

Moreover, the RAST has been used to track training progression in taekwondo athletes. A study by Barbas and colleagues in 2020 examined the effects of a high-intensity training program on the anaerobic capacity of young taekwondo athletes. The results demonstrated significant improvements in anaerobic performance after the implementation of the training program, indicating that the RAST could be a valuable tool for evaluating and monitoring anaerobic training progress in taekwondo athletes (13). Additionally, the RAST can serve as a tool for talent selection and detection in the field of taekwondo. A study by Li and colleagues in 2018 evaluated performance in this test in young taekwondo athletes and found that those with superior RAST performance also showed better performance in taekwondo competitions, supporting the utility of the RAST as a potential indicator of talent and performance in taekwondo (14). Considering the aforementioned points, the objective of this study was to determine the relationship between anaerobic performance variables in the RAST and sporting talent.

Methodology

Design

A quantitative research study was conducted using a quasi-experimental observational design approach to describe and establish correlations within a group of elite taekwondo athletes. The study focused on participants from sports camps organized by the United States Taekwondo Association (USAT) during the year 2023.

Population and sample

The sample selection was non-random, with taekwondo athletes conveniently chosen by the researchers based on accessibility through Taekwondo camps associated with the USAT. Athletes without metabolic, cardiovascular, or musculoskeletal risks (determined through a brief interview and the use of the PAR-Q questionnaire) (15) were selected. Participants, being minors, obtained voluntary authorization from themselves and their parents or legal guardians to participate. Those who had experienced injuries or discomfort during physical assessments or had not completed all phases of the process were excluded. The final sample consisted of (n=470) taekwondo athletes from different categories.

Procedure

Formal permission was sought through a letter addressed to the directors and coaches of each taekwondo camp associated with USA Taekwondo (USAT). After authorization, the study procedures and objectives were explained, and participants, being minors, were provided with consent and assent forms for completion. Sociodemographic data such as age, gender, and group were also collected.

Data collection occurred in the morning during the preparatory period of each taekwondo camp when athletes were not in competition. Before assessing athletes, protocols and tests were explained, and a pilot test, conducted by exercise and sports science professionals, familiarized participants with the tests.

Regarding the sports talent variable, each taekwondo practitioner's position in the national ranking of USA Taekwondo (USAT) within their respective category was evaluated. Proximity to the top positions of the ranking inferred a higher level of sports talent.

Weight measurements were taken using a TANITA BC-585F scale to obtain participants' body mass, essential for the Running-based Anaerobic Sprint Test (RAST) calculations. Athletes were instructed to wear loose clothing and stand barefoot on the scale, with three weight measurements taken to avoid erroneous influences. Afterward, a supervised warm-up, consisting of mobility exercises and increased heart rate through ballistic movements, was conducted, corresponding to a perceived effort intensity of 2 to 3 on the modified Borg scale.

Upon completing the warm-up, the RAST was administered. This test protocol measures power and anaerobic capacity through repeated sprints (6). The RAST is widely used for assessing performance due to its precision, simplicity, non-invasiveness, and cost-effectiveness, supported by various studies (7, 8, 16).

Participants individually underwent the RAST, performing six maximum sprints over a 35-meter distance, with 10-second recovery periods between each sprint. Three evaluators recorded sprint times to ensure accuracy. The average of the evaluators' results was calculated for each sprint. The participant's exact time for each sprint, including hundredths of a second, was recorded.

After collecting necessary data, relevant calculations were performed:

To determine relative power:

$$Body\ mass\ (kg) * distance\ (m)^2 \div time\ (s)^3$$

To calculate anaerobic capacity:

$$Sum\ of\ the\ six\ sprint\ power\ outputs$$

To calculate fatigue index:

$$(Maximum\ power - Minimum\ power) \div Total\ time\ for\ the\ 6\ sprints$$

Ethical considerations

The study strictly adhered to the guidelines outlined by the National Research Act of 1974 (17), also known as the Biomedical Research Act, and respected the rights guaranteed by the 2013 Declaration of Helsinki (18). Participants were provided detailed information about the study's purpose, procedures, voluntary nature of participation, and the confidentiality of their personal data. Informed and signed consent was obtained from each participant to ensure compliance. Participant codes were assigned in the database to preserve privacy rather than using their names directly.

Statistical analysis

All data were entered into Excel and later transferred to the statistical software SPSS Version 25. Categorical variables were described in percentages and frequencies. The Kolmogorov-Smirnov test was used to assess normality for samples larger than 50. Continuous variables with a normal distribution were expressed as mean and standard deviation (SD), while those with non-normal distribution were expressed as median and interquartile range (IQR). To evaluate the relationship between variables, the Spearman's Rho was used, considering a bilateral significance level set at $p \leq 0.05$.

Results

The group of taekwondo practitioners from the USAT in the United States that was analyzed showed diversity in terms of categories, composed of (n=153) cadet athletes, (n=149) junior athletes, and (n=168) senior athletes. Regarding gender, (n=265) males and (n=205) females were included in the study. The average age of the athletes was 15.2 ± 3.75 years.

Table 1. Sociodemographic characteristics of the population

Characteristics	**N**	**%**
Athletes' gender		
Male	265	56,38
Female	205	43,62
Total	470	100
Athletes' category		
Cadet	153	32,55
Junior	149	31,7
Senior	168	35,74
Total	470	100
	M	**SD**
Age of athletes	15,28	±3,75

*Note: M = mean; SD = standard deviation

According to the results presented in Table 2, it can be observed that the majority of the key variables in this study exhibited a non-normal distribution, as their significance was $p<0.005$. Therefore, we reject the H0 (null hypothesis) and accept the H1 (alternative hypothesis). Only the relative power variable showed a normal distribution (0.018).

Table 2. Kolmogorov-Smirnov test for fundamental variables

Characteristics	N	Test Statistic	Significance
Minimum Power (W)	470	0,107	0,000
Maximum Power (W)	470	0,099	0,000
Average Power (W)	470	0,109	0,000
Relative Power (W)	470	0,046	0,018*
Anaerobic Capacity (W)	470	0,104	0,000
Fatigue Index (W/s)	470	0,161	0,000
Sports Talent	470	0,203	0,000

According to the results presented in Table 3, a minimum power of 293.89 W, a maximum power of 390.37 W, and an average power of 346.16 W were identified. Additionally, a relative power of 7.41 W was observed, adjusted according to the athlete's body mass. In terms of anaerobic capacity, a value of 2052.23 W was recorded with an IQR of 1410.76 at p25 and 2849.17 at p75. The total fatigue index for the population was 4.39. Finally, the central measure of sports talent was found to be 8.00, indicating a high level of sports talent, close to the top positions in the USAT ranking.

Table 3. Measures of central tendency and dispersion of fundamental variables

Characteristics	N	ME	IQR
Minimum Power (W)	470	293,89	P25=191,71; P75=403,24
Maximum Power (W)	470	390,37	P25=276,42; P75=557,96
Average Power (W)	470	346,16	P25=237,24; P75=490,03
Anaerobic Capacity (W)	470	2052,23	P25=1410,76; P75=2859,17
Fatigue Index (W/s)	470	4,39	P25=2,55; P75=8,37
Sports Talent	470	8,00	P25=4,00; P75=18,00
	N	**M**	**SD**
Relative Power (W)	470	7,41	2,84

*Note: M = mean; ME = median; SD = standard deviation; IQR = interquartile range; P25 = 25th percentile; P75 = 75th percentile; W=watts; w/s = watts/seconds

Regarding the Spearman's Rho correlation of the fundamental variables in this study, high negative relationships were identified in the variables of minimum power (-0.088) and

fatigue index (-0.093), and close to significance (p<0.057) and (p<0.044) respectively. The other variables showed low to moderate negative correlations and were not significant.

Table 4. Spearman's Rho Correlation between the variables of interest

Characteristics	Sports talent	
	Spearman's Rho coefficient	P value
Minimum Power (W)	-0,088	0,057
Maximum Power (W)	-0,054	0,242
Average Power (W)	-0,059	0,209
Relative Power (W)	-0,052	0,258
Anaerobic Capacity (W)	-0,009	0,849
Fatigue Index (W/s)	-0,093	0,044

Discussion

The purpose of this study was to determine the relationship between anaerobic performance in the RAST test and athletic talent, understood as the athlete's ranking position. In response to the above, high negative relationships could be identified in the variables of minimum power (-0.088) and fatigue index (-0.093) with athletic talent, with these two being the closest to significance (p <0.057) and (p <0.044), respectively. The other variables presented low to moderate and non-significant negative correlations. This suggests inversely proportional relationships, meaning that higher anaerobic performance in terms of power, anaerobic capacity, and fatigue index correlates with a better ranking position (closer to the first position).

The observation that higher anaerobic performance, measured in terms of power and fatigue index, is associated with a higher-ranking position reflects the importance of these anaerobic components in competitive performance. This finding aligns with the widely accepted notion that anaerobic capacities play a crucial role in high-intensity and short-duration situations, as commonly encountered in many sports disciplines, including taekwondo. The inversely proportional relationship identified in this study emphasizes the need to focus on the development and improvement of anaerobic capacities to achieve optimal performance in competition. Athletes with higher power and a lower fatigue index are better positioned to maintain consistent and outstanding performance throughout a competition. It is relevant to consider that these results may have significant practical implications for athletes' training planning and preparation. Emphasizing the development of anaerobic capacities could enhance athletes' ability to sustain high performance during situations of intense effort and rapid energy demands.

It is noteworthy that these findings are supported by statistically significant values, reinforcing the validity of the observed correlations. The proximity to significance with values of $p < 0.057$ for minimum power and $p < 0.044$ for the fatigue index underscores the importance of these results and suggests that experimental studies could potentially confirm these relationships more conclusively.

On the other hand, regarding the variable of average power and the results obtained in its measure of central tendency, it was observed that the value of 346.16 obtained by taekwondo practitioners was close when compared to football players, who, in an intervention, obtained an average power of 377 ± 36.2 (19). However, our result in this variable was lower compared to cyclists and sprint athletes whose average power was 492.00 and 422.77, respectively. Still, this figure was higher compared to volleyball players and Pencak Silat athletes (Indonesian martial arts) with figures of 206.68 and 305.41, respectively (20, 21).

According to the above comparisons, it can be indicated that taekwondo is a sport that combines short and explosive bursts of physical activity with moments of recovery and tactical movement. Cyclists and sprint athletes, on the other hand, are involved in more continuous and linear activities where sustained power over prolonged periods is essential. The intermittent nature of bursts in taekwondo could influence lower average power compared to more continuous activities. Cyclists and sprint athletes often focus on specific training to improve power and speed, leading to greater development of these qualities. Taekwondo practitioners, although also training for power, may dedicate part of their training to other technical and tactical aspects of the sport, which could influence lower average power in comparison. Athletes in speed-related sports often specialize earlier in their athletic careers, allowing them to focus on the development of specific capacities such as power and speed. Taekwondo practitioners may have more diversified training due to the multidisciplinary nature of taekwondo, which could impact lower average power compared to more specialized sports.

Moreover, in comparison with volleyball players from Santosa et al.'s 2019 study, who had lower power results than taekwondo practitioners, this can be explained by the fact that actions in volleyball can be more continuous and of longer duration, while in taekwondo, shorter and explosive bursts of activity are performed. This means that taekwondo practitioners focus on developing power and the ability to exert intense efforts in a short period (1, 2, 22).

Regarding the fatigue index, taekwondo practitioners obtained a median of 4.39. Compared to a study conducted by Santosa et al. in 2019, these values were similar to those obtained in sports such as American football (4.21), higher than sprint runners (5.55),

lower than volleyball players (1.96), and similar to Pencak Silat practitioners (4.64) (20). The finding of a more favorable fatigue index in taekwondo practitioners compared to track runners can be attributed to several factors intrinsic to each sport and the specific physical demands of each discipline. Taekwondo practitioners may train specifically to develop intermittent fatigue resistance, allowing them to recover more quickly between moments of high intensity. On the other hand, in sprint athletics, runners engage in shorter but intense distances where power and speed are essential. Sprint runners' training often focuses on improving anaerobic power and explosive capacity, leading to faster fatigue accumulation during these high-intensity efforts. Fatigue resistance could be lower in this context since sprint runners focus on producing maximum energy in a short period. (23) The characteristics of taekwondo, such as explosive movements and rapid direction changes, may require more selective and efficient muscle activation, contributing to lower fatigue accumulation compared to more constant movement (3, 4, 24).

Furthermore, there is a similarity with disciplines such as American football and Pencak Silat. Both taekwondo and American football and Pencak Silat are sports that require intermittent high-intensity efforts. In American football, like taekwondo, players engage in short and explosive bursts of activity during plays and physical confrontations. In Pencak Silat, an Indonesian martial art, fast and explosive movements are required during combat. These disciplines involve constant direction changes and agile movements, resulting in rapid depletion of energy reserves due to continuous acceleration and deceleration. Although they vary in action duration and the precise nature of movements, all rely heavily on anaerobic energy systems to supply the necessary energy for explosive and high-intensity efforts (25, 26, 27, 28).

In contrast to differences with volleyball players, volleyball matches tend to be prolonged, with possible long sets and points that can extend. This means that volleyball players need to maintain a sustained level of energy and performance over an extended period. In contrast, taekwondo matches are short-lived, with short and explosive bursts of activity and interspersed breaks (1, 2, 22, 29).

Limitations and strengths

One of the main limitations of this study lies in its merely descriptive correlational approach, as it focused on presenting results by establishing relationships without seeking causality or effects among the findings. Despite this limitation, the study has a considerable sample of evaluated participants. Therefore, it is suggested that future research adopts an experimental approach, allowing for comparisons between experimental and control groups.

Discussions are restricted due to the absence or limited availability of literature on the RAST test in combat sports, making it difficult to make comparisons. Most studies of this type have focused their attention on other sports disciplines or have carried out contrasts between different tests that assess anaerobic performance. This fact emphasizes the existence of a gap in the literature, which can be interpreted as an opportunity to continue and deepen this line of research.

Conclusion

In conclusion, it can be stated that higher anaerobic performance in terms of power and fatigue index is related to a better ranking position (i.e., closer to the first position). These associations highlight the importance of anaerobic performance variables in competitive taekwondo and support the idea that better performance in terms of power and fatigue resistance is linked to a higher ranking position.

This finding is consistent with the widely accepted notion that anaerobic capacities play an essential role in high-intensity and short-duration situations, as encountered in combat sports such as taekwondo. The inversely proportional relationship identified suggests that higher anaerobic performance correlates with a higher ranking position.

Funding sources

None

Conflicts of interest

The authors declare that there are no conflicts of interest.

Autor's contribution

Andrés Mauricio Ariza Viviescas: formal analysis, conceptualization, methodology, investigation, writing – original draft.

Guillermo Andrés Sáez Abello: supervision, project administration, funding acquisition, writing – review & editing.

Paul Sebastián Once Saca: data curation, resources, visualization, investigation.

Felipe Andrés Rosas Treuque: software, validation, methodology, writing – review & editing.

References

Vargas PC. Respuestas y adaptaciones fisiológicas en el entrenamiento de taekwondo. Una revisión sistemática. Pensam. Mov. Rev. Cienc. Ejerc. Salud. 2013;11(2):1-19. https://www.redalyc.org/pdf/4420/442042965005.pdf

Pieter W. Detección de talentos en practicantes de taekwondo. J. Asian Martial Arts. 2010;19(3):8-29. https://dialnet.unirioja.es/servlet/articulo?codigo=3384967

Bridge CA, Jones MA, Drust B. The activity profile in international taekwondo competition is modulated by weight category. Int. J. Sports Physiol. Perform. 2011;6(3):344-57. DOI: https://doi.org/10.1123/ijspp.6.3.344

Bridge CA, McNaughton LR, Close GL, Drust B. Taekwondo exercise protocols do not recreate the physiological responses of championship combat. Int. J. Sports Med. 2013;34(7):573-81. DOI: https://doi.org/10.1055/s-0032-1327578

Lin, W. L., Yen, K. T., Lu, C. Y. D., Huang, Y. H., & Chang, C. K. (2006). Anaerobic capacity of elite Taiwanese Taekwondo athletes. *Science & sports*, *21*(5), 291-293. DOI: https://doi.org/10.1055/s-0032-1327578

Keir DA, Thériault F, Serresse O. Evaluation of the Running-Based Anaerobic Sprint Test as a Measure of Repeated Sprint Ability in Collegiate-Level Soccer Players. J Strength Cond Res. 2013 Jun;27(6):1671–8. DOI: https://doi.org/10.1519/JSC.0b013e31827367ba

Zagatto AM, Beck WR, Gobatto CA. Validity of the running anaerobic sprint test for assessing anaerobic power and predicting short-distance performance. J. Strength Cond. Res. 2009;23(6):182-7. DOI: https://doi.org/10.1519/JSC.0b013e3181b3df32

Tayech A, Mejri MA, Chaabene H, Chaouachi M, Behm DG, Chaouachi A. Test-retest reliability and criterion validity of a new Taekwondo Anaerobic Intermittent Kick Test. J. Sports Med. Phys. Fitness. 2018;59(2):230-7. DOI: https://doi.org/10.23736/S0022-4707.18.08088-3

Rodríguez-Rosell D. Effects of 6 weeks of combined electromyostimulation and plyometric training on muscle strength and anaerobic performance in male basketball players. J. Strength Cond. Res. 2019;33(2):393-403. DOI: https://doi.org/10.1519/JSC.0000000000002912

Barbas I, Fatouros IG, Douroudos II, Chatzinikolaou A, Michailidis Y, Draganidis D, et al. Effects of an 8-week high-intensity training program on the anaerobic performance and body composition of young taekwondo athletes. Sports. 2020;8(3):38. DOI: https://doi.org/10.3390/sports8030038

Liu R, He L. The relationship between physical fitness and competitive performance of Taekwondo athletes. PLoS One. 2022;17(6):e0267711. DOI: https://doi.org/10.1371/journal.pone.0267711

Ouergui I, Messaoudi H, Chtourou H, Wagner MO, Bouassida A, Bouhlel E, et al. Repeated sprint training versus repeated training with high-intensity techniques in adolescent taekwondo athletes: A randomized controlled trial. Int. J. Environ. Res. Public Health. 2020;17(12):4506. DOI: https://doi.org/10.3390/ijerph17124506

Seo MW, Jung HC, Song JK, Kim HB. Effect of 8 weeks of pre-season training on body composition, physical fitness, anaerobic capacity, and isokinetic muscle strength in male and female collegiate taekwondo athletes. J Exerc Rehabil. 2015;11(2):101–7. DOI: https://www.doi.org/10.12965/jer.150196

Li P, De Bosscher V, Pion J, Weissensteiner JR, Vertonghen J. Is international junior success a reliable predictor for international senior success in elite combat sports? Eur. J. Sport Sci. 2018;18(4):550-9. DOI: https://doi.org/10.1080/17461391.2018.1444094

Shephard RJ. PAR-Q, Canadian Home Fitness Test, and exercise screening alternatives. Sports Med. 1988;5(3):185-95. DOI: https://doi.org/10.2165/00007256-198805030-00005

Andrade VL, Zagatto AM, Kalva-Filho CA, Mendes OC, Gobatto CA, Campos EZ, et al. Running-based anaerobic sprint test as a procedure to evaluate anaerobic power. Int. J. Sports Med. 2015;36(14):1156-62. DOI: https://doi.org/10.1055/s-0035-1548885

Oficina para la Protección de Sujetos Humanos (OHRP). 45 CFR Parte 46: Política Federal para la Protección de Sujetos Humanos [Internet]. 1974 [citado 2024]. Disponible en: https://www.hhs.gov/ohrp/regulations-and-policy/regulations/45-cfr-46/index.html

Asociación Médica Mundial. Declaración de Helsinki: Principios éticos para las investigaciones médicas en seres humanos. 2013;59. https://www.fundacionfemeba.org.ar/blog/farmacologia-7/post/declaracion-de-helsinki-2013-declaracion-de-helsinki-de-la-asociacion-medica-mundial-amm-principios-eticos-para-las-investigaciones-medicas-en-seres-humanos-42669

Guevara HAR. Evaluación de la potencia, capacidad anaeróbica e índice de fatiga en jugadoras de fútbol sala, categoría mayores, antes y después del periodo preparatorio. Expomotricidad. 2011;3(1):1–11. Disponible en: https://revistas.udea.edu.co/index.php/expomotricidad/article/download/331918/20787905

Santosa I, Setiowati A, Indrawati F. The running-based anaerobic sprint test of different type of sports. J. Phys. Conf. Ser. 2019;1387(1):012146. https://doi.org/10.1088/1742-6596/1387/1/012146

Subiela J, Torres S, Herrera A, Hernández N, Alexander P, Jimeno F. Características musculares y potencia anaeróbica y aeróbica máximas en ciclistas de competición. Arch. Med. Deporte. 2007;24(119):169-78. https://femede.es/documentos/Original_caract_musculares_169_119.pdf

Lidor R, Ziv G. Características físicas y fisiológicas de las jugadoras de voleibol: un trabajo de revisión. G-SE. 2013. Disponible en: https://g-se.com/es/caracteristicas-fisicas-y-fisiologicas-de-las-jugadoras-de-voleibol-un-trabajo-de-revision-1492-sa-b57cfb2721dfc0

Albuquerque JD, dos Santos JAR, Conceição F, Colaço PJ, da Silva DJL. Estudo de correlação entre indicadores de velocidade e perfil corporal em velocistas de atletismo. Rev. Eletrônica Esc. Educ. Física Desporto-UFRJ. 2008; 4(2) 35-44. https://revistas.ufrj.br/index.php/am/article/view/9121

Campos FAD, Bertuzzi R, Dourado AC, Santos VGF, Franchini E. Energy demands in taekwondo athletes during combat simulation. Eur. J. Appl. Physiol. 2012;112(4):1221-8. DOI: https://doi.org/10.1007/s00421-011-2071-4

Dongoran M, Nopiyanto Y, Saputro D, Nugroho A. Comparison of psychological skills of Pencak Silat and Boxing Athletes (Study on Indonesian Training Camp athletes). Int. Conf. 2019. DOI: https://doi.org/10.2991/icss-19.2019.210

Pincivero DM, Bompa TO. A physiological review of American football. Sports Med. 1997;23:247-60. https://doi.org/10.2165/00007256-199723040-00004

Prasetyo FY. The physical conditions of Pencak Silat athletes. In: IOP Conference Series: Materials Science and Engineering. IOP Publishing; 2017 Mar. Vol. 180, No. 1, p. 012261. DOI: https://doi.org/10.1088/1757-899X/180/1/012261

Hoffman JR. The applied physiology of American football. Int. J. Sports Physiol. Perform. 2008;3(3):387-92. https://doi.org/10.1123/ijspp.3.3.387

Sáez G. Relación entre potencia física muscular respecto del porcentaje de grasa y masa muscular en taekwondo. Cienc. Activ. Fís. UCM. 2016;17(2):29-34. https://revistacaf.ucm.cl/article/view/97