Desarrollo de un modelo de entrenamiento basado en el método Tabata para mejorar la resistencia y el rendimiento en atletas sénior de karate kata

Development of a Tabata-Based Training Model to Enhance Stamina and Performance in Senior Kata Karate Athletes

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Abstract

Introduction: Senior kata karate practitioners need to possess substantial explosive strength, quickness, and anaerobic endurance to keep their technical skills in kata routines. Nevertheless, current fitness programs typically do not cater to the unique physical and motor requirements of kata.

Objective: The purpose of this research was to create and assess a specialized Tabata Training framework aimed at enhancing stamina and athletic performance in senior kata karate practitioners.

Methodology: This research utilized a Research and Development (R&D) strategy based on the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The training framework was established through needs evaluation, expert validation, and practical application in the field. The effectiveness was measured using a pre-test and post-test design with a control group consisting of senior kata karate participants who engaged in an 8-week program (three times a week). The variables assessed included arm power, leg power, agility, and anaerobic stamina, determined through the Medicine Ball Put Test, Standing Broad Jump, Agility T-test, and Running-based Anaerobic Sprint Test (RAST), respectively. Data analysis was performed using the Shapiro-Wilk test, Levene's test, paired-samples t-test, and independent-samples t-test, with a significance level set at $p < 0.05$.

Results: The created Tabata Training framework fulfilled the standards for validity (expert validation score = 4.46) and practicality (practicality score = 4.50). When compared to traditional training methods, the experimental cohort exhibited more significant enhancements in arm power (29.3% vs. 11.2%, $p = 0.001$), leg power (12.7% vs. 5.8%, $p = 0.009$), agility (12.4% vs. 4.9%, $p = 0.001$), and anaerobic endurance (25.7% vs. 10.2%, $p < 0.001$). The intervention resulted in notable advancements in all assessed biomotor components. The effect size analysis revealed moderate to large treatment impacts across the outcome measures.

Discussion: The results support previous studies indicating that High-Intensity Interval Training contributes positively to aerobic and anaerobic capacity, muscle power, and sport-specific performance. The integration of karate-specific movements into the Tabata model provided more relevant training stimuli for kata athletes.

Conclusions: The proposed Tabata Training framework met the criteria for both validity and practicality and was linked with significant enhancements in biomotor performance compared to conventional training methods. The results imply that sport-specific Tabata Training could be a feasible conditioning approach to support the physical requirements of senior kata karate practitioners.

Keywords

Athlete Performance; Karate Kata; Physical Endurance; Stamina; Tabata Training.

Resumen

Introducción: Los practicantes avanzados de kata karate necesitan poseer una fuerza explosiva, rapidez y resistencia anaeróbica considerables para mantener sus habilidades técnicas en las rutinas de kata. Sin embargo, los programas de entrenamiento físico actuales generalmente no satisfacen las exigencias físicas y motoras específicas del kata.

Objetivo: El objetivo de esta investigación fue crear y evaluar un programa de entrenamiento Tabata especializado, orientado a mejorar la resistencia y el rendimiento atlético en practicantes avanzados de karate kata.

Metodología: Esta investigación empleó una estrategia de Investigación y Desarrollo (I+D) basada en el modelo ADDIE (Análisis, Diseño, Desarrollo, Implementación y Evaluación). El marco de entrenamiento se estableció mediante la evaluación de necesidades, la validación de expertos y la aplicación práctica en el campo. La efectividad se midió utilizando un diseño pre-test y post-test con un grupo de control compuesto por participantes senior de karate kata que participaron en un programa de 8 semanas (tres veces por semana). Las variables evaluadas incluyeron potencia de brazos, potencia de piernas, agilidad y resistencia anaeróbica, determinadas mediante la Prueba de Lanzamiento de Balón Medicinal, Salto de Longitud en Pie, Prueba T de Agilidad y Prueba de Sprint Anaeróbico Basada en Carrera (RAST), respectivamente. El análisis de datos se realizó utilizando la prueba de Shapiro-Wilk, la prueba

de Levene, la prueba t de muestras pareadas y la prueba t de muestras independientes, con un nivel de significancia establecido en $p < 0,05$.
Resultados: El marco de entrenamiento Tabata creado cumplió con los estándares de validez (puntuación de validación de expertos = 4,46) y practicidad (puntuación de practicidad = 4,50). En comparación con los métodos de entrenamiento tradicionales, la cohorte experimental mostró mejoras más significativas en la potencia de los brazos (29,3 % frente a 11,2 %, $p = 0,001$), la potencia de las piernas (12,7 % frente a 5,8 %, $p = 0,009$), la agilidad (12,4 % frente a 4,9 %, $p = 0,001$) y la resistencia anaeróbica (25,7 % frente a 10,2 %, $p < 0,001$). La intervención resultó en avances notables en todos los componentes biomotores evaluados. El análisis del tamaño del efecto reveló impactos del tratamiento de moderados a grandes en todas las medidas de resultado.
Discusión: Los resultados respaldan estudios previos que indican que el entrenamiento interválico de alta intensidad contribuye positivamente a la capacidad aeróbica y anaeróbica, la potencia muscular y el rendimiento deportivo específico. La integración de movimientos propios del karate en el modelo Tabata proporcionó estímulos de entrenamiento más relevantes para los atletas de kata.
Conclusiones: El marco de entrenamiento Tabata propuesto cumplió con los criterios de validez y practicidad, y se asoció con mejoras significativas en el rendimiento biomotor en comparación con los métodos de entrenamiento convencionales. Los resultados sugieren que el entrenamiento Tabata específico para este deporte podría ser un enfoque de acondicionamiento viable para satisfacer las necesidades físicas de los practicantes avanzados de karate kata.

Palabras clave

Rendimiento deportivo; kata de karate; resistencia física; aguante; entrenamiento tabata.

Introduction

Competitive sports demand that athletes have specific physical conditioning tailored to their sport in order to perform at their best. Being physically prepared helps athletes to successfully apply technical and tactical skills during training and competition (Prima & Kartiko, 2021). Thus, training acts as a structured approach to enhance an athlete's performance through well-organized, continuous, and scientifically developed programs (Candra et al., 2025). Among the different aspects of physical fitness, aspects like muscular endurance, strength, power, speed, flexibility, agility, balance, and coordination are crucial for effective sport-specific performance (Guntoro et al., 2020). Recent studies have shown that High-Intensity Interval Training (HIIT) significantly boosts aerobic endurance, muscular strength, explosive power, and neuromuscular efficiency, leading to better athletic performance (Hung et al., 2025; Liu et al., 2024). Similar findings reported in Retos also stress that conditioning programs based on research findings, backed by sport science advancements, enhance athletes' long-term physical readiness and competitive effectiveness (Wijaya et al., 2024).

Endurance is a key factor that impacts athletic success because it allows athletes to maintain high-intensity efforts and postpone fatigue during competitions. HIIT has been proven to enhance peak oxygen consumption (VO_2max), anaerobic threshold, stamina, speed, and explosive strength, making it one of the top conditioning strategies for competitive athletes (Wiesinger et al., 2024). Nonetheless, many current HIIT protocols use general interval structures that don't specifically cater to the physiological and technical requirements of karate kata. Recent research highlighted in Retos emphasizes the need for creating sport-specific conditioning models that blend technical aspects with physical training to optimize athlete performance (Setiawan et al., 2026; Hafidz et al., 2024). These results point to the necessity of a more tailored HIIT training program for karate kata practitioners.

Athletic performance in karate hinges on the combination of physical fitness, technical prowess, strategic skills, and mental readiness (Utami et al., 2025). In the kata discipline, athletes carry out predefined sequences of movements that demand explosive strength, balance, precise movement, coordination, and the capacity to maintain technical excellence throughout the display. Prior research has shown that HIIT successfully enhances both aerobic and anaerobic capabilities, muscle strength, speed, agility, and peak power among karate athletes (Barus et al., 2025; Yue et al., 2025). Similarly, HIIT has been found to improve upper-body strength, explosive power of the lower limbs, agility, and anaerobic stamina, all vital for karate performance (Hadi & Yudhistira, 2023). However, these studies primarily focused on the physiological impacts of HIIT without creating a training model designed for the specific movement patterns, work-to-rest ratios, and technical features of kata competitions. As a result, there is a lack of a validated Tabata training model designed explicitly for senior kata athletes.

Power can be understood as the mix of strength and speed of movement (Lamusu & Lamusu, 2023), and it is one of the key physical attributes in kata practice. Strength and power routines based on HIIT have been found to enhance neuromuscular improvements, explosive strength, movement

speed, and muscle power (Hung et al., 2025). In addition, HIIT has been shown to be more effective than moderate-intensity continuous training in boosting motivation for training while also advancing physical fitness elements such as strength, balance, and speed (Yin et al., 2025). Tabata training, a HIIT variant that includes repeated 20 seconds of high-intensity workouts followed by 10 seconds of rest, has indicated considerable gains in aerobic capacity, anaerobic functionality, VO_2max, and peak power (Şanal & Özen, 2025; Sabzevari Rad et al., 2025). However, the existing Tabata protocols are generally broad and do not sufficiently cater to the unique movement requirements of kata, which involve transitions in stance, punching and kicking sequences, body control, and movement coordination. Consequently, the current protocols may not effectively enhance performance specific to kata.

A recent systematic review also established that both specialized and general HIIT methods significantly boost aerobic capacity, anaerobic performance, and muscular power in martial arts competitors (Yue et al., 2025). Additionally, HIIT presents efficient physiological changes in shorter timeframes than traditional endurance workouts (Song & Sheykhlouvand, 2024; Engel et al., 2018). Nevertheless, initial findings from several karate dojos in Bone Regency, South Sulawesi, indicated that Tabata training is seldom used by advanced kata practitioners because trainers often lack specific guidelines and validated training models that are suited to kata requirements. This issue highlights the key research gap that this study seeks to address. Therefore, this study intends to create and validate a Tabata Training model specially designed for senior kata karate practitioners to enhance their endurance and performance. The goal is not just to assess the effectiveness of an intervention but also to create a reliable, practical, and workable training model. To achieve this, the Research and Development (R&D) method utilizing the ADDIE model was chosen. In contrast to typical experimental setups that mainly focus on intervention results, the ADDIE model provides a structured approach for analyzing needs, designing models, validating with experts, making revisions, implementing, and assessing, making it particularly effective for the development and validation of training models specific to sports.

Method

This research used the Research and Development (R&D) approach to create, confirm, and assess a Tabata Training model aimed at enhancing endurance and performance among senior kata karate practitioners. The R&D method is a structured way to create, develop, and assess products to verify their validity, practicality, and efficiency (Ade Rahayu, 2025). The goal of development research is to create new or better products through the design of prototypes, validation, and testing for effectiveness, making it very relevant for creating sports training models that can be readily applied (Okpatrioka, 2023). Thus, the R&D method was deemed suitable for creating a well-organized and functional Tabata Training model for senior kata karate athletes.

The development process adhered to the ADDIE framework, which consists of five sequential phases: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was chosen because it offers a systematic, procedural, and practical structure for developing training models, while also fitting within the study's time limitations (Amriyah et al., 2026). Moreover, the ADDIE framework allows for ongoing assessment and adjustments throughout the development phase to guarantee that the final product meets training needs effectively (Rusmulyani, 2020).

Participants in the study were senior kata karate practitioners from various karate clubs in South Sulawesi Province, selected through purposive sampling. Inclusion criteria required athletes to be aged 18 or over, actively competing in the senior kata division, possessing at least three years of training experience, regularly taking part in regional or national contests, and physically capable of performing high-intensity workouts. Those with musculoskeletal injuries, heart issues, attendance below 80% during the intervention, or involvement in other formal conditioning programs were excluded. Prior to taking part, all athletes were given details about the study's aims, methods, advantages, and possible risks, and they voluntarily signed a consent form. Ethical approval for the research was secured from the institutional research ethics committee.

The analysis phase commenced with a needs assessment carried out through field observations and interviews with two karate instructors and fifteen senior kata karate athletes, along with

questionnaires given to ten karate coaches from different karate organizations in Makassar City and several districts in South Sulawesi. The gathered information was utilized to recognize the current physical conditioning approaches, the training necessities of athletes, and the expectations of coaches concerning the creation of a karate-specific Tabata Training model. Based on this information, the design phase concentrated on establishing training objectives, selecting karate-specific exercises, preparing the training structure, and creating the training manual. In the development phase, experts in sports coaching, karate, exercise physiology, and instructional design validated the initial prototype before it was revised according to their suggestions.

The execution phase comprised an intervention lasting eight weeks with three training sessions conducted each week. Every session featured a warm-up lasting 10 minutes, about 20 minutes allocated for Tabata Training, and a 10-minute cool-down period. The Tabata routine utilized 20 seconds of intense exercise followed by 10 seconds of rest for eight sets, incorporating karate-specific movements such as burpees, squat jumps, mountain climbers, push-ups, jump lunges, high-knee runs, variations of planks, and drills focused on explosive movements. Intensity during training was kept at 85-95% of maximum heart rate (HRmax) or a score of 17-19 on the Borg Rating of Perceived Exertion (RPE) scale, with progressive overload introduced every two weeks by escalating the difficulty of exercises and the overall training volume. Meanwhile, the control group participated in the traditional conditioning program regularly provided by their trainers, which included jogging, calisthenics, flexibility training, and practicing basic kihon and kata at a moderate intensity.

The assessment stage evaluated the success of the created model by comparing scores from pre-tests and post-tests on four biomotor elements: arm power, leg power, agility, and anaerobic stamina. Data from expert validation were assessed descriptively to evaluate the product's practicality. Prior to hypothesis verification, data normality was checked using the Shapiro-Wilk test, while Levene's test was used to evaluate variance homogeneity. Within-group differences were examined using paired-samples t-tests, and the variations between the experimental and control groups were investigated using independent-samples t-tests, with a significance threshold set at $p < 0.05$. All statistical evaluations were conducted using IBM SPSS Statistics software.

Results

The effectiveness of the created Tabata Training model was assessed by looking at variations in four biomotor aspects between the experimental group and the control group. Arm strength was evaluated using the Medicine Ball Put test with a 2.72-kilogram ball, where subjects executed a seated forward throw while keeping their back against the bench. Leg strength was measured through the Standing Broad Jump, while agility was tested using the Agility T-test, and anaerobic endurance was assessed using the Running-based Anaerobic Sprint Test (RAST) according to standardized methods frequently applied in karate performance evaluations. These practical tests have been shown to be reliable and valid for assessing athletes' biomotor capabilities.

Prior to testing the hypotheses, the data's normality was checked with the Shapiro–Wilk test, and the equality of variances was evaluated using Levene's test. As displayed in Table 1, all variables were normally distributed ($p > 0.05$) and confirmed the assumption of homogeneity ($p > 0.05$), which suggested that parametric statistical techniques were suitable.

Table 1. Results of Normality and Homogeneity Test

Variables	Experimental (Pre/Post)	Control (Pre/Post)	Levene's Test	Conclusion
Arm Muscle Power	0.312/0.428	0.267/0.389	0.678	Normal, homogeneous
Leg Muscle Power	0.445/0.521	0.398/0.467	0.534	Normal, homogeneous
Agility	0.289/0.356	0.334/0.412	0.612	Normal, homogeneous
Anaerobic Endurance	0.256/0.378	0.301/0.423	0.489	Normal, homogeneous

The results from the pre-test and post-test indicated consistent gains in all biomotor aspects for both groups; however, the improvement level was significantly higher in the experimental group. For

instance, arm strength rose from 4.23 ± 0.52 m to 5.47 ± 0.61 m in the experimental group as opposed to an increase from 4.18 ± 0.48 m to 4.65 ± 0.54 m in the control group. Similarly, anaerobic endurance increased from 487.3 ± 52.8 W to 612.5 ± 58.3 W in the experimental group, while the control group saw improvement from 482.6 ± 49.7 W to 531.8 ± 53.2 W. Overall, the experimental group exhibited more substantial improvements in arm strength (29.3%), leg strength (12.7%), agility (12.4%), and anaerobic endurance (25.7%) compared to the control group (11.2%, 5.8%, 4.9%, and 10.2%, respectively).

Table 2. Pre-test and Post-test Results of Biomotor Components

Variables	Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Improvement
Arm Muscle Power	Experimental	4.23 ± 0.52	5.47 ± 0.61	29.3%
	Control	4.18 ± 0.48	4.65 ± 0.54	11.2%
Leg Muscle Power	Experimental	487.3 ± 52.8	612.5 ± 58.3	25.7%
	Control	482.6 ± 49.7	531.8 ± 53.2	10.2%
Agility	Experimental	198.5 ± 15.3	223.8 ± 16.7	12.7%
	Control	196.2 ± 14.8	207.5 ± 15.2	5.8%
Anaerobic Endurance	Experimental	11.82 ± 0.67	10.35 ± 0.58	12.4%
	Control	11.75 ± 0.71	11.18 ± 0.65	4.9%

Paired-samples t-tests indicated notable improvements in all biomotor aspects in both groups. For example, arm power showed a significant rise in the experimental group ($t = 9.873$, $df = 11$, $p < 0.001$) and in the control group ($t = 4.231$, $df = 11$, $p = 0.001$). Likewise, anaerobic endurance significantly improved in the experimental group ($t = 12.785$, $df = 11$, $p < 0.001$) and the control group ($t = 5.892$, $df = 11$, $p < 0.001$). Independent-samples t-tests further showed that post-test results in the experimental group were significantly superior to those of the control group across all biomotor measurements.

Table *3*. Summary of Between-Group Effectiveness

Biomotor Components	Experiment Improvement	Control Improvement	Difference	p-value
Arm Muscle Power	29.3%	11.2%	18.1%	0.001
Leg Muscle Power	12.7%	5.8%	6.9%	0.009
Agility	12.4%	4.9%	7.5%	0.001
Anaerobic Endurance	25.7%	10.2%	15.5%	<0.001

In conclusion, the results suggest that the established Tabata Training model resulted in significantly greater advancements in arm muscle power, leg muscle power, agility, and anaerobic endurance when compared to the traditional training program, thereby affirming its effectiveness as a conditioning model for senior kata karate competitors.

Discussion

The current research created a specific Tabata Training model tailored for sports using the ADDIE framework and assessed its impact on the physical abilities of senior kata karate athletes. The results show that taking part in the designed program led to notable enhancements in arm strength, leg strength, agility, and anaerobic stamina when compared to standard training methods. Instead of indicating it was the best option in all scenarios, these results suggest that incorporating high-intensity interval training into karate-focused preparation could be an effective way to boost the physical attributes needed for kata execution.

The physiological changes noted in this research can be understood by looking at the energy requirements dictated by the Tabata protocol. Kata execution involves a series of rapid, forceful techniques performed in a brief time frame, where the phosphagen (ATP-PCr) system primarily provides energy for quick force production during punches, kicks, and jumps. As the stores of phosphocreatine get low, the anaerobic glycolytic system plays a larger role in producing ATP, resulting in lactate buildup and metabolic strain. Regular exposure to brief, intense workouts with short rest may enhance the recovery of phosphocreatine, increase the activity of glycolytic enzymes, improve buffering abilities, and boost tolerance to metabolic acidosis, allowing athletes to maintain their technical

performance throughout a kata performance. These physiological changes align with earlier studies showing that high-intensity interval training enhances both aerobic ability and anaerobic power in combat sports athletes.

Beyond the metabolic changes, gains in muscle strength and agility can be attributed to neuromuscular adaptations triggered by consistent explosive training. High-intensity interval training has been proven to increase motor unit activation, improve synchronization among fast-twitch muscle fibers, and speed up the force production rate, all of which help enhance explosive performance. Moreover, frequent practice of karate-specific explosive movements during the Tabata workouts may have improved intermuscular coordination and movement efficiency, resulting in increased power in both upper and lower limbs. Similar neuromuscular changes have also been observed after high-intensity interval training in athletes competing in explosive sports.

Another significant aspect to consider is the specific demands of kata competition. Different from kumite, kata requires athletes to execute a set sequence of moves with exact timing, balance, swift turns, and stable posture while maintaining high movement quality from beginning to end. Therefore, physical training should align closely with these biomechanical and physiological requirements. The Tabata Training model introduced in this study included explosive actions that mirror the movements seen in kata, thereby enhancing the specificity of the training stimulus. Following the principle of specificity, training adaptations are most effective when the characteristics of the exercise closely resemble the movement patterns and force direction required in competition. This sport-specific strategy may account for the more pronounced improvements in agility and explosive strength.

The current results align with earlier intervention research involving karate athletes, which showed positive effects of HIIT-based conditioning on aerobic capacity, anaerobic performance, and specific physical skills required for the sport (Wijianto & Annisa, 2024; Yue et al., 2025). However, in contrast to many prior studies that focused mainly on physiological results, this research created and validated a structured Tabata Training framework specifically tailored for advanced kata athletes through a methodical R&D approach. This establishes a further practical benefit by offering coaches a validated, structured, and sport-oriented training model that can be incorporated into standard conditioning routines.

From a practical standpoint, the created model could be especially beneficial as it merges efficiency with sport relevance. Senior karate practitioners frequently juggle academic, work, and competition obligations that limit their training time. Earlier studies have indicated that time-effective HIIT routines can lead to cardiovascular and performance changes comparable to or even surpassing those from longer endurance exercises (Gillen & Gibala, 2013). Consequently, the Tabata Training model that has been developed may provide coaches with an alternative conditioning approach that can deliver significant physiological benefits in a relatively brief training period while remaining applicable to the physical requirements of kata competition.

Limitations

Several limitations need to be noted. First, the research involved a relatively small group chosen from karate clubs in South Sulawesi Province, which may limit how widely the findings can be applied to other athlete populations. Second, the training period lasted only eight weeks, leaving the long-term impacts of the proposed training model uncertain. Third, both the participants and coaches were not blinded during the intervention, which could lead to performance bias. Lastly, the study did not incorporate a long-term follow-up to assess whether the improvements observed were maintained after the intervention ended. Future research should include larger samples from multiple centers, longer training durations, and follow-up evaluations to better determine the lasting effectiveness of the developed Tabata Training model.

Conclusions

This research created a Tabata Training model aimed at senior kata karate athletes by using the ADDIE development framework. The established model fulfilled the validity and practicality standards set during its creation and was linked to significant enhancements in arm strength, leg strength, agility, and anaerobic stamina compared to standard training methods. These results indicate that a Tabata Training method tailored to the sport might be a suitable conditioning approach to meet the physical requirements of kata performance.

The model includes high-intensity interval workouts, movement patterns that showcase the specific techniques of kata, a training progression, and a training format that is relatively time-saving. These features could help incorporate it into standard karate conditioning routines. Future research with larger participant groups, extended training durations, and follow-up evaluations is suggested to investigate the broader application and lasting effectiveness of the training model developed.

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References

Ade Rahayu. (2025). Metode Penelitian Dan Pengembangan (R&Amp;D) : Pengertian, Jenis Dan Tahapan. *Diajar: Jurnal Pendidikan Dan Pembelajaran*, *4*(3), 459–470. Https://Doi.Org/10.54259/Diajar.V4i3.5092

Amriyah, C., Andrini, M., Sutriani, I., Kurniawati, E., Prasetyo, N. T., Jatmiko, A., & Meriyati, M. (2026). Analisis Perbandingan Model Desain Pembelajaran Addie Dan Dick &Amp; Carey Dalam Pengembangan Pembelajaran. *Paedagogie*, *21*(1), 1677–1684. Https://Doi.Org/10.31603/Paedagogie.V21i1.16449

Barus, G. A. T., Febrianty, M. F., & Novian, G. (2025). Sport-Specific High-Intensity Interval Training (S-Hiit): Efek Terhadap Kapasitas Anaerobik Dan Indeks. *Jurnal Pedagogik Olahraga*, *11*, 559–567. Https://Doi.Org/10.24114/Jpor.V11i2.71864

Candra, O., Parulian, T., Yolanda, F., Novrandani, S., & Darmawan, D. V. (2025). Holistik Dengan Mengintegrasikan Latihan Kondisi Fisik, Psikologi Olahraga, Dan Karakter. *Journal Of Human And Education (Jahe)*, *5*(1), 782–792. Https://Doi.Org/10.31004/Jh.V5i1.2260

Engel, F. A., Ackermann, A., Chtourou, H., & Sperlich, B. (2018). High-Intensity Interval Training Performed By Young Athletes: A Systematic Review And Meta-Analysis. *Frontiers In Physiology*, *9*(Jul). Https://Doi.Org/10.3389/Fphys.2018.01012

Gillen, J. B., & Gibala, M. J. (2013). Is High-Intensity Interval Training A Time-Efficient Exercise Strategy To Improve Health And Fitness? *Pubmed Disclaimer*, 1–14. Https://Doi.Org/10.1139/Apnm-2013-0187

Guntoro, T. S., Muhammad, J., & Qomarrullah, R. (2020). Faktor Kemampuan Fisik Dan Psikologis Penunjang Keterampilan Atlet Elit Sepakbola Propinsi Papua. *Jurnal Sportif : Jurnal Penelitian Pembelajaran*, *6*(2), 390–406. Https://Doi.Org/10.29407/Js_Unpgri.V6i2.13768

Hadi, & Yudhistira, D. (2023). High-Intensity Interval Training Method In Karate Athletes: Can It Improve Power, Agility, And Endurance In The Kumite Category? *Journal Sport Area*, *8*(1), 43–51. Https://Doi.Org/10.25299/Sportarea.2023.Vol8(1).10656

Herlan, H., & Komarudin, K. (2020). Pengaruh Metode Latihan High-Intensity Interval Training (Tabata) Terhadap Peningkatan Vo2max Pelari Jarak Jauh. *Jurnal Kepelatihan Olahraga*, *12*(1), 11–17. Https://Doi.Org/10.17509/Jko-Upi.V12i1.24008

Huang, J., Hortobágyi, T., Dos'santos, T., Shi, Y., Que, Y., Lin, J., Su, Y., & Li, W. (2024). Effects Of Direction Specific Exercise Training On Athletic Performance: A Systematic Review And Meta-Analysis. *Peerj*, *12*(9), 1–31. Https://Doi.Org/10.7717/Peerj.18047

Hung, C. H., Su, C. H., & Wang, D. (2025). The Role Of High-Intensity Interval Training (Hiit) In Neuromuscular Adaptations: Implications For Strength And Power Development—A Review. *Life*, *15*(4), 1–19. Https://Doi.Org/10.3390/Life15040657

Hafidz, A., Rusdiawan, A., Özman, C., Rasyid, M. L. S. A., Pavlovic, R., Orhan, B. E., Lani, A., Iswanto, A., & Susanto, N. (2024). Implementación del modelo CIPP para evaluar el avance del rendimiento en los deportes de petanca de Java Oriental (Implementing the CIPP model for evaluating the advancement of performance in the East Java petanque sports). Retos, 61, 853–860. https://doi.org/10.47197/retos.v61.105989

Kadir, S., Dulanimo, H., B. Usman, A., Duhe, E. D. P., & Hidayat, S. (2022). Evaluasi Komponen Kondisi Fisik Atlet Karate. *Jambura Journal Of Sports Coaching*, *4*(1), 29–38. Https://Doi.Org/10.37311/Jjsc.V4i1.13445

Lamusu, A., & Lamusu, Z. (2023). Kekuatan Otot Lengan Dengan Kecepatan Pukulan Gyaku Tsuki Chudan Karate Mahasiswa. *Jambura Journal Of Sports Coaching*, *5*(1), 72–79. Https://Doi.Org/10.37311/Jjsc.V5i1.17893

Liu, Y., Abdullah, B. Bin, & Saad, H. B. A. (2024). Effects Of High-Intensity Interval Training On Strength, Speed, And Endurance Performance Among Racket Sports Players: A Systematic Review. *Plos One*, *19*(1), 1–19. Https://Doi.Org/10.1371/Journal.Pone.0295362

Okpatrioka Okpatrioka. (2023). Research And Development (R&Amp;D) Penelitian Yang Inovatif Dalam Pendidikan. *Dharma Acariya Nusantara: Jurnal Pendidikan, Bahasa Dan Budaya*, *1*(1), 86–100. Https://Doi.Org/10.47861/Jdan.V1i1.154

Prima, P., & Kartiko, D. C. (2021). Survei Kondisi Fisik Atlet Pada Berbagai Cabang Olahraga. *Jurnal Pendidikan Olahraga Dan Kesehatan*, *9*(1), 161–170.

Rusmulyani, K. (2020). Study Pengembangan Pendidikan Dan Pelatihan Bagi Aparatur Sipil Negara Berbasis Implementasi Model Addie. *Sap (Susunan Artikel Pendidikan)*, *5*(2). Https://Doi.Org/10.30998/Sap.V5i2.6957

Sabzevari Rad, R., Omidi, H., & Alipour, M. (2025). The Combined Effects Of Tabata Training And Cinnamon Supplementation On Metabolic Changes And Body Composition In Soldiers With Overweight Or Obesity. *Journal Of The International Society Of Sports Nutrition*, *22*(1). Https://Doi.Org/10.1080/15502783.2025.2564237

Şanal, A., & Özen, G. (2025). Effects Of 8-Week Tabata Training On Cardiopulmonary And Performance Parameters In Wheelchair Basketball Players: A Controlled Study. *Medicine (United States)*, *104*(34), E44093. Https://Doi.Org/10.1097/Md.0000000000044093

Shiraz, S., Salimei, C., Aracri, M., Lorenzo, C. Di, Farsetti, P., Parisi, A., Iellamo, F., Caminiti, G., & Perrone, M. A. (2024). The Effects Of High-Intensity Interval Training On Cognitive And Physical Skills In Basketball And Soccer Players. *Journal Of Functional Morphology And Kinesiology*, *9*(3). Https://Doi.Org/10.3390/Jfmk9030112

Song, Y., & Sheykhlouvand, M. (2024). A Comparative Analysis Of High-Intensity Technique-Specific Intervals And Short Sprint Interval Training In Taekwondo Athletes: Effects On Cardiorespiratory Fitness And Anaerobic Power. *Journal Of Sports Science And Medicine*, *23*(3), 672–683. Https://Doi.Org/10.52082/Jssm.2024.672

Setiawan, I., Ramadhan, M. G., Paramitha, S. T., Wattimena, F. Y., Utama, M. B. R., Wenly, A. P., Ihsani, S. I., & Ibrahim, S. (2026). Rethinking Physical Education as a pathway to sport entrepreneurship and sports industry development. Retos, 77, 691–706. https://doi.org/10.47197/retos.v77.118605

Utami, P., Yusuf, Y., & Santoso, S. (2025). Manajemen Sumber Daya Manusia Dalam Kejuaraan Karate: Studi Kasus Kejuaraan Karate Piala Rektor Unis Ii Tahun 2025. *Journal Of Scientech Research And Development*, *7*(2), 12–24. Https://Doi.Org/10.56670/Jsrd.V7i2.1173

Wiesinger, H. P., Hopkins, W. G., Haller, N., Blumkaitis, J., Strepp, T., & Stöggl, T. L. (2024). Meta-Analyses Of The Effects Of High-Intensity Interval Training In Elite Athletes — Part Ii: Relationships Between The Mean Effects On Various Performance Measures. *Frontiers In Physiology*, *15*(December), 1–8. Https://Doi.Org/10.3389/Fphys.2024.1486570

Wijianto, & Annisa, P. E. (2024). The Effect Of High Intensity Interval Training On Increasing Endurance In Karate Athletes In Bonang Demak. *Gladi : Jurnal Ilmu Keolahragaan*, *15*(4), 529–540. Https://Doi.Org/10.21009/Gjik.154.10

Wijaya, A., Al Ardha, M. A., Nurhasan, N., Yang, C. B., Lin, R. H., & Putro, A. B. (2024). Exploring the research trend and development of sports science technology in the last 4 decades: systematic review. Retos, 61, 655–667. https://doi.org/10.47197/retos.v61.109306

Yin, H., Zhang, J., Lian, M., & Zhang, Y. (2025). A Systematic Review And Meta-Analysis Of The Effectiveness Of High-Intensity Interval Training For Physical Fitness In University Students. *Bmc Public Health*, *25*(1). Https://Doi.Org/10.1186/S12889-025-22829-7

Yue, F., Wang, Y., Yang, H., & Zhang, X. (2025). Effects Of High-Intensity Interval Training On Aerobic And Anaerobic Capacity In Olympic Combat Sports: A Systematic Review And Meta-Analysis. *Frontiers In Physiology*, *16*(May). Https://Doi.Org/10.3389/Fphys.2025.1576676

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