

Effects of High-Intensity Interval Training on Physiological and Performance Variables in Taekwondo Athletes: A Systematic Review

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Abstract:

Taekwondo is a high-intensity Olympic combat sport requiring aerobic endurance, anaerobic power, agility, speed, reaction time, and technical proficiency. High-Intensity Interval Training (HIIT) has gained considerable attention as a time-efficient training method for improving athletic performance. This systematic review examines the effects of HIIT on physiological and performance-related variables among Taekwondo athletes. Findings indicate that HIIT significantly improves maximal oxygen uptake (VO_2max), lactate threshold, repeated-sprint ability, agility, explosive power, and recovery efficiency, providing superior adaptations compared to traditional continuous training. Variability in training protocols and participant characteristics limits direct comparisons across studies; future research should focus on standardised protocols and long-term interventions in competitive Taekwondo populations.

Keywords: High-Intensity Interval Training, HIIT, Taekwondo, VO_2max , Agility, Performance, Combat Sports.

1. INTRODUCTION

Taekwondo has been an official Olympic sport since 2000 and places complex physiological demands on athletes. Competition requires repeated bouts of explosive kicking, rapid directional changes, defensive movements, and tactical decision-making under physical fatigue. Successful performance depends simultaneously on aerobic endurance for recovery between exchanges, anaerobic power for explosive actions, muscular strength, agility, flexibility, reaction time, and psychological resilience.

During competition, athletes alternate between short-duration, high-intensity actions and brief recovery intervals, engaging both aerobic and anaerobic energy systems. The anaerobic system drives explosive kicking and rapid accelerations, while the aerobic system facilitates inter-round recovery. Training programmes must therefore address both energy systems to optimise performance and delay fatigue.

High-Intensity Interval Training (HIIT) consists of repeated bouts of near-maximal exercise interspersed with structured recovery periods. Compared with traditional continuous training, HIIT requires less time while producing substantial physiological adaptations, including improved cardiovascular fitness,

enhanced metabolic efficiency, increased mitochondrial density, and greater muscular power and endurance. Its structural resemblance to the intermittent demands of Taekwondo competition makes it a particularly attractive conditioning approach (Franchini et al., 2020; Milanović et al., 2015).

Several studies have reported positive HIIT-related improvements in VO_2max , heart rate recovery, lactate threshold, anaerobic capacity, and body composition. Beyond physiological benefits, HIIT may also enhance neuromuscular efficiency, speed, agility, and explosive power — all essential for competitive Taekwondo. Despite growing evidence, findings remain inconsistent due to protocol variations and differing participant characteristics. This systematic review therefore synthesises available evidence to provide coaches, athletes, and researchers with a clear understanding of HIIT effectiveness and its practical implications for Taekwondo performance.

2. METHODOLOGY

A systematic literature review was conducted using electronic databases including Google Scholar, PubMed, Scopus, Web of Science, and ResearchGate. Search terms included 'High-Intensity Interval Training,' 'HIIT,' 'Taekwondo,' 'combat sports,' ' VO_2max ,' 'anaerobic power,' 'agility,' 'reaction time,' and 'athletic performance.' Studies published between 2015 and 2025 involving Taekwondo athletes and reporting physiological or performance outcomes were included. Non-peer-reviewed articles, non-athlete populations, and studies with insufficient methodological detail were excluded. Titles and abstracts were screened independently, followed by full-text review and data extraction.

Table 1: Summary of Key Studies Included in the Systematic Review

Author	Year	Sample	Duration	Variable(s)	Key Finding
Santos et al.	2022	TKD athletes	6 weeks	VO_2max	Significant aerobic improvement
Seo et al.	2019	Competitive TKD	8 weeks	Physical performance	Improved aerobic/anaerobic fitness
Chaabene et al.	2018	Combat athletes	6 weeks	Agility, reaction time	Superior agility vs. conventional training
Loturco et al.	2018	TKD athletes	8 weeks	Lower-body power	Increased kicking speed and power output
Franchini et al.	2020	Combat athletes	12 weeks	Aerobic/anaerobic	HIIT $\geq$ MICT for physiological adaptations
Hammami et al.	2021	Combat athletes	8 weeks	Fitness indices	Sport-specific HIIT superior for power and agility

TKD = Taekwondo; MICT = Moderate-Intensity Continuous Training.

3. RESULTS AND FINDINGS

3.1 Aerobic Capacity (VO_{2max})

Aerobic capacity is critical for recovery between high-intensity exchanges and for sustaining technical output throughout competition. Santos et al. (2022) reported that six weeks of HIIT significantly enhanced aerobic fitness in competitive Taekwondo athletes, with VO_{2max} values improving by a mean of 8.3%. Franchini et al. (2020) similarly observed improved oxygen utilisation and cardiovascular efficiency following HIIT, demonstrating greater gains than moderate-intensity continuous training groups. Enhanced VO_{2max} supports faster inter-round recovery and allows athletes to sustain high-intensity performance in the closing stages of bouts, a decisive competitive advantage.

3.2 Anaerobic Power and Lactate Threshold

Taekwondo requires explosive movements driven predominantly by anaerobic energy pathways. HIIT consistently improves anaerobic power by increasing glycolytic enzyme activity, enhancing phosphocreatine resynthesis, and elevating lactate buffering capacity — directly translating to improved peak power output, repeated sprint ability, and fatigue resistance. Hammami et al. (2021) demonstrated that sport-specific HIIT protocols produced significantly greater anaerobic power gains than traditional training. Murphy et al. (2021) additionally reported that HIIT promotes mitochondrial adaptations supporting faster lactate clearance and improved fatigue resistance between bouts.

3.3 Agility, Speed, and Reaction Time

Chaabene et al. (2018) found that athletes undertaking structured HIIT demonstrated significantly superior agility compared with those following conventional methods, attributed to enhanced neuromuscular coordination and faster motor unit recruitment. Seo et al. (2019) confirmed that optimised work-to-rest ratios within HIIT produced the greatest improvements in sport-specific agility and reaction time. These qualities — essential for offensive and defensive actions in Taekwondo — improved through enhanced neuromuscular efficiency and motor unit synchronisation during high-intensity efforts.

3.4 Explosive Power

Loturco et al. (2018) demonstrated significant improvements in lower-body explosive power following high-intensity training, including increased vertical jump height, peak force production, and kicking speed. These neuromuscular gains are linked to increased rate of force development and fast-twitch muscle fibre recruitment, contributing to stronger kicks and greater scoring opportunities during competition. Herrera-Valenzuela et al. (2020) recommended integrating sport-specific plyometric elements within HIIT sessions to maximise explosive power development in Taekwondo athletes.

3.5 HIIT vs. Traditional Training

Comparative analyses consistently favour HIIT over traditional steady-state training for Taekwondo-specific adaptations. Key advantages include reduced total training time, greater sport specificity, simultaneous aerobic and anaerobic system development, and superior recovery adaptations. Franchini et al. (2020) concluded that HIIT produces comparable or superior physiological adaptations relative to moderate-intensity continuous training across all key performance variables. Slimani et al. (2020) confirmed through systematic review that HIIT is the preferred conditioning modality for combat sport athletes seeking simultaneous improvements in aerobic and anaerobic performance.

4. DISCUSSION

The reviewed literature consistently demonstrates that structured HIIT is an effective strategy for improving aerobic capacity, anaerobic power, agility, reaction time, explosive strength, and recovery efficiency in Taekwondo athletes. Enhanced VO_2max facilitates faster inter-round recovery and enables athletes to maintain high-intensity technical output in the closing stages of bouts. Improvements in anaerobic performance directly support the explosive kicking, jumping, and rapid directional changes central to competitive Taekwondo.

Gains in agility, reaction time, and neuromuscular efficiency translate into more effective offensive and defensive actions during matches. The explosive power improvements reported by Loturco et al. (2018) and Hammami et al. (2021) are particularly relevant, given that scoring in Taekwondo depends on delivering powerful, accurate kicks under pressure. HIIT therefore appears uniquely suited to simultaneously addressing the multidimensional physiological demands of the sport.

Variability in training duration, exercise intensity, work-to-rest ratios, and participant characteristics — including competition level, age, and sex — limits direct cross-study comparisons and hampers identification of optimal HIIT parameters. Beyond physical adaptations, HIIT may also positively affect psychological factors such as motivation, mental toughness, and competitive confidence, all of which are important for combat sport performance. These psychological adaptations warrant further empirical investigation within Taekwondo populations specifically.

5. PRACTICAL APPLICATIONS AND RESEARCH GAPS

Based on the reviewed evidence, coaches should incorporate HIIT two to three times per week within periodised Taekwondo programmes. Sessions should replicate competition movement patterns — including short explosive sprints, lateral direction changes, and kicking drills — with work-to-rest ratios of approximately 1:2 to 1:3. Progressive overload, adequate inter-session recovery, and integration with technical training are essential to maximise adaptation and minimise injury risk.

Key research gaps include:

- Limited long-term studies involving elite or high-performance Taekwondo athletes
- Absence of standardised, sport-specific HIIT protocols
- Insufficient research on female Taekwondo athletes and sex-specific training responses
- Limited evidence on psychological adaptations, mental toughness, and injury prevention
- Need for studies integrating HIIT with technical and tactical Taekwondo skill development

6. CONCLUSION

High-Intensity Interval Training is an evidence-based, time-efficient conditioning method that significantly improves the physiological and performance variables critical for Taekwondo competition, including aerobic capacity, anaerobic power, agility, reaction time, and explosive lower-body strength. Its structural similarity to competition energy demands and its capacity for simultaneous multi-system development make it a highly valuable tool for coaches and conditioning specialists. Future research

should prioritise standardised protocol development, longitudinal investigations, sex-specific analyses, and psychological outcome measures to further strengthen the evidence base and optimise HIIT application for elite Taekwondo performance.

REFERENCES:

1. Andreato, L. V., Esteves, J. V., et al. (2020). Managing training load and injury risk in combat sports. *Sports Medicine*, 50(6), 1003–1014.
2. Bishop, D., Girard, O., & Mendez-Villanueva, A. (2011). Repeated-sprint ability and recovery. *Sports Medicine*, 41(9), 741–756.
3. Bridge, C. A., McNaughton, L. R., Close, G. L., & Drust, B. (2014). Taekwondo exercise protocols do not recreate the physiological demands of competition. *Journal of Sports Sciences*, 32(7), 671–677.
4. Buchheit, M., & Laursen, P. B. (2013). High-intensity interval training, solutions to the programming puzzle. *Sports Medicine*, 43(5), 313–338.
5. Campos, F. A. D., Bertuzzi, R., Dourado, A. C., Santos, V. G. F., & Franchini, E. (2020). Energy demands in Taekwondo athletes during simulated matches. *Journal of Sports Sciences*, 38(4), 417–425.
6. Chaabene, H., Negra, Y., Capranica, L., Bouguezzi, R., Hachana, Y., & Franchini, E. (2018). Effects of HIIT on agility and reaction time in combat sports athletes. *Journal of Strength and Conditioning Research*, 32(5), 1513–1520.
7. Franchini, E., Artioli, G. G., & Brito, C. J. (2020). High-intensity interval training in combat sports: Physiological responses and performance adaptations. *Sports Medicine*, 50(4), 667–689.
8. Franchini, E., Cormack, S., & Takito, M. Y. (2023). HIIT and performance adaptations in Olympic combat sports. *Sports*, 11(5), 96.
9. Gibala, M. J., Little, J. P., MacDonald, M. J., & Hawley, J. A. (2012). Physiological adaptations to low-volume, high-intensity interval training. *Journal of Physiology*, 590(5), 1077–1084.
10. Haddad, M., Chaouachi, A., Castagna, C., et al. (2011). Psychological responses to HIIT. *Journal of Sports Science and Medicine*, 10(1), 138–145.
11. Hammami, M., Gaamouri, N., Aloui, G., Shephard, R. J., & Chelly, M. S. (2021). Effects of sport-specific high-intensity interval training on physical performance in combat sport athletes. *Journal of Human Kinetics*, 78, 51–62.
12. Helgerud, J., Høydal, K., Wang, E., et al. (2007). Aerobic high-intensity intervals improve VO_2max more than moderate training. *Medicine & Science in Sports & Exercise*, 39(4), 665–671.
13. Herrera-Valenzuela, T., Valdés-Badilla, P., & Franchini, E. (2020). High-intensity interval training recommendations for combat sports athletes. *Strength and Conditioning Journal*, 42(4), 1–10.
14. Loturco, I., Pereira, L. A., Koba, R., et al. (2018). Muscle power determinants of kicking performance in Taekwondo athletes. *Journal of Strength and Conditioning Research*, 32(3), 1–9.

15. Milanović, Z., Sporiš, G., & Weston, M. (2015). Effectiveness of HIIT on cardiorespiratory fitness. *Sports Medicine*, 45(10), 1469–1481.
16. Murphy, P., O'Connor, D., & Smith, J. (2021). Mitochondrial adaptations and recovery responses following HIIT. *Sports Physiology Review*, 15(2), 110–121.
17. Santos, J. F. S., Herrera-Valenzuela, T., Franchini, E., & Loturco, I. (2022). Effects of HIIT on neuromuscular and aerobic performance in Taekwondo athletes. *Journal of Strength and Conditioning Research*, 36(5), 1342–1349.
18. Seo, M. W., Jung, H. C., & Song, J. K. (2019). Effects of work-to-rest ratio of HIIT on physical performance in Taekwondo athletes. *Journal of Sports Science & Medicine*, 18(3), 515–522.
19. Slimani, M., Miarka, B., Bragazzi, N. L., & Sellami, M. (2020). Effects of HIIT on physical fitness in combat sport athletes: A systematic review. *International Journal of Environmental Research and Public Health*, 17(19), 7135.