The effectiveness of speed, agility, quickness training vs high-intensity interval training in improving speed and agility on badminton players

La eficacia del entrenamiento de velocidad, agilidad y rapidez frente al entrenamiento por intervalos de alta intensidad para mejorar la velocidad y la agilidad en jugadores de badminton

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Abstract

Introduction: Badminton is a fast-paced racket sport which requires player to possess quick reaction, high-speed hitting ability, and rapid movement. These abilities are related to speed and agility which are one of the essential motor demands in badminton.
Objective: This study aims to compare the effect of high-intensity interval training (HIIT) versus speed agility quickness (SAQ) training on agility and speed among badminton players. Methodology: Thirty amateur badminton players participated in this quasi-experimental study. They were split into three groups: the HIIT, the SAQ, and the control group. Players in each group received eight weeks of intervention. The Illinois Agility Test was used to measure agility, and the 30-meter sprint test was used to measure speed. Statistical analysis was performed using SPSS software, version 24. Paired t-test was used to compare pre-post differences in each group. Intergroup comparison was evaluated using one-way ANOVA test.
Results: Significant improvements in speed were found in SAQ (p=0,012) and HIIT (p=0,000). The increase in agility were found in all groups but only HIIT found to be statistically significant (p=0.000). Highest improvement in speed was observed in SAQ (3.36%) while highest agility was found in HIIT (3.10%).
Discussion: HIIT is known as a potent exercise that activates aerobic and anaerobic energy systems, facilitating player with the chance to enhance the power and speed in badminton and other racket sports by focusing on high-strength muscle fibers. Meanwhile, SAQ training was designed specifically to increase players' change-of-direction speed and agility performances as well as their ability to sprint and run faster during a game.
Conclusions: Both HIIT and SAQ training were equally effective in improving speed and agility in badminton players. These trainings can be used as evidence-based approach to improve skills in badminton players for optimal performance.

Keywords

Agility; badminton; change of direction; HIIT; SAQ; speed.

Resumen

Introducción: El bádminton, un deporte de raqueta rápido, exige reacciones rápidas, golpes potentes y movimientos ágiles. La velocidad y la agilidad son habilidades motoras esenciales en este deporte.
Objetivo: Este estudio compara el HIIT y el entrenamiento SAQ para determinar su impacto en la velocidad y la agilidad de los jugadores de bádminton.
Metodología: Treinta jugadores de bádminton amateur participaron en un estudio cuasiexperimental, divididos en grupos HIIT, SAQ y control. Cada grupo recibió 8 semanas de intervención. Se midió la agilidad (prueba de Illinois) y la velocidad (sprint de 30 metros). Se utilizó SPSS (v.24) para análisis estadísticos: prueba t pareada (pre-post) y ANOVA unidireccional (entre grupos).
Resultados: Se encontraron mejoras significativas en la velocidad en SAQ (p = 0,012) y HIIT (p = 0,000). El aumento de la agilidad se encontró en todos los grupos, pero solo el HIIT resultó estadísticamente significativo (p = 0,000). La mayor mejora en la velocidad se observó en SAQ (3,36 %), mientras que la mayor agilidad se encontró en HIIT (3,10 %).
Discusión: El HIIT activa los sistemas de energía aeróbica y anaeróbica, mejorando la potencia y velocidad al enfocarse en las fibras musculares de alta fuerza. El entrenamiento SAQ está diseñado para aumentar la velocidad de cambio de dirección, la agilidad y la velocidad de carrera.
Conclusiones: Tanto el entrenamiento HIIT como el SAQ fueron igualmente efectivos para mejorar la velocidad y la agilidad en los jugadores de bádminton. Estos entrenamientos se pueden utilizar como un enfoque basado en la evidencia para mejorar las habilidades de los jugadores de bádminton para un rendimiento óptimo.

Palabras clave

Agilidad; badminton; cambio de dirección; HIIT; SAQ; velocidad.

Introduction

Badminton is considered as one of the oldest and most popular dynamic sports in the world, played by over 200 million people regardless of age and gender (Chandra et al., 2023). It is known as the fastest racket-sports—the speed can reach 400 km/h)—features high-intensity, short interval, and agile footwork (Lu et al., 2022; Phomsoupha & Laffaye, 2015). The players must be able to react immediately to the rapid-moving of shuttlecock and continuously shifting direction as they move throughout the game (Wong et al., 2019). In addition, they also need to make quick decision based on the prediction of the opponents' movement direction in a split of second (Alam et al., 2010; Lu et al., 2022). Therefore, it demands quickness from the players in planning and executing movements, (de Freitas & Junior, 2012), as well as the ability to control dynamic balance, including landing stability, lunges, and rapid adjustment such as deceleration, acceleration, and change of direction (CoD) of body trunk (Hong et al., 2014). Given the demands, players are required to have speed, agility, and good aerobic endurance which are one of the essential motor demands of the game (Mukesh et al., 2021).

Speed is a crucial attribute for badminton players due to several key factors that significantly impact performance during the game (Ihsan et al., 2024). One of the primary reasons why speeds is vital in badminton is the ability to hit the shuttlecock at its highest point. Players who can move quickly can adjust themselves to strike the shuttle while it is still ascending, maximizing their shot options—such as clearing, dropping, or smashing (Wismanadi et al., 2024). Conversely, slower players may find themselves hitting the shuttle when it has already begun to descend, which can lead to less effective shots and require more effort to execute. Speed also enhances a player's reaction time, enabling them to respond to their opponent's shots more effectively and more agile (Deng et al., 2023).

The importance of agility in badminton could not be overemphasized. Agility, described as a fast whole body movement that changes velocity or direction in response to a stimuli (Wong et al., 2019), is a critical variable for exceptional success in badminton competitions (Singh et al., 2011). Agility is needed to execute many technical movements such as jumping, stroking, and shifting position (Donie et al., 2023). Players must be able to move quickly around the court over short distance, switch between defensive and offensive actions, and return shots from all angles (Prachita et al., 2023). To succeed in the sport, the players also need to stop momentum on a dime, reverse direction quickly, and maintain balance (Shedge et al., 2024). Thus, agile footwork is critically needed for badminton players, especially during attacking and defending maneuvers (Singh et al., 2011).

Given its importance, training programs for badminton typically focus on improving physical conditions, including speed and agility. Several studies have been dedicated to enhance physical performance through various training methods (Deng et al., 2023; Falch et al., 2019; Hariyanto et al., 2021, 2022; Lee et al., 2024; Putera et al., 2023). Among these methods, Speed-Agility-Quickness or SAQ is frequently recommended by researchers. SAQ training is a strategy of progressive exercises and instruction aimed at developing fundamental motor abilities in athletes so that they can perform better at higher speeds and with more precision (Prachita et al., 2023). SAQ training is claimed to increase response time, acceleration, and agility (Chandrakumar & Ramesh, 2015). It is beneficial for athletes and non-athletes alike, offering enhancements in performance, injury prevention, and overall physical fitness. Meanwhile, due to the nature of the game that demands for high-intensity use of joints for various movements in short time, badminton player requires both aerobic and anaerobic capacities (Ko et al., 2021). Thus, high intensity interval training (HIIT) was used by athletes to enhance cardiovascular endurance (Kilit & Arslan, 2019). By focusing on high-strength muscle fibers, HIIT activates both the anaerobic and aerobic energy systems, giving athletes the chance to improve their strength, speed, and power particularly in sports that require rapid movement and quick directional changes (Panissa et al., 2021).

Regardless of the mechanism, many athletes and players use HIIT or SAQ to improve their performances in sports (Liu et al., 2024). Previous researches have demonstrated the benefits of HIIT and SAQ in terms of athletic performance, however, the duration of training sessions has been much longer (> 12 weeks). In addition, fewer researches have been done to compare the two different types of training in increasing players' speed and agility, especially in racket games. Therefore, we conduct this study to investigate the effect of HIIT and SAQ on speed and agility, and to analyze which of these methods is more effective in improving these variables on young amateur badminton players. We hypothesized that SAQ and HIIT training have better impact on speed and agility than conventional training.

Method

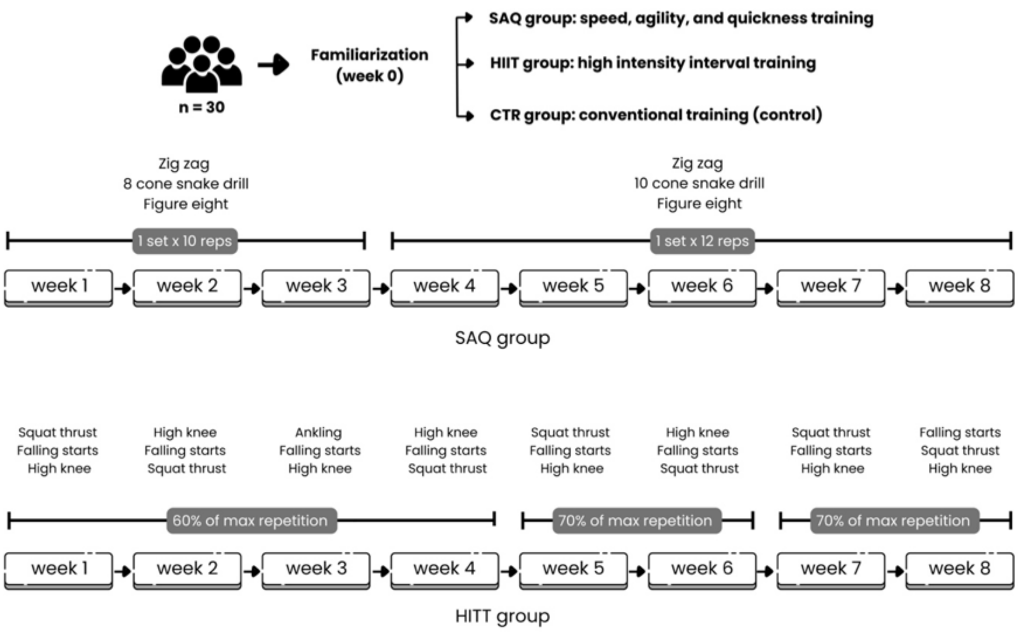
Study Design and Participants

This study used quasi-experimental design, involving thirty male badminton players aged 19-20 years. The inclusion criteria were as follow: (1) registered as an active member of badminton club; (2) the dominant arm or leg used is right side; (3) willing to complete the whole research and training protocol and the tests; and (4) Never participated in SAQ or HIIT training during last three months. Participants who had any serious injuries on lower extremity during last two years were excluded from the study. Before signing the informed consent, all participants were educated about the potential risks and benefit. Participation of this study was voluntarily; they could withdraw any time. All research procedures were carried out in compliance with the Declaration of Helsinki.

Research Protocol

An a priori power analysis was conducted using G*Power (Heinrich-Heine-Universität Düsseldorf, Germany) to determine the required sample size. With an alpha level of 0.05, power (1−β) of 0.80, and an expected medium effect size (f = 0.25) for repeated measures ANOVA (within-between interaction), the minimum total sample size estimated was 27 participants. Thus, the final sample size of 30 was deemed sufficient to detect statistically significant differences with adequate power. Thirty subjects were then divided into three groups, which were HIIT (n=10), SAQ (n=10), and CTR (n=10) based on their technical skill rankings in order to prevent imbalanced groupings and to start statistically evenly. Body height (cm) and weight (kg) were measured on the first testing day using an electronic scale (DB-150A, CAS, South Korea) and stadiometer (Seca 213, California, US). Body mass index was then computed as weight/height squared (kg/m2). All measurement devices were properly calibrated before used.

Figure 1. Study protocol



Each subject in the same group was given respected training method for eight consecutive weeks. HIIT group received high intensity interval training consisted of squat thrust, falling starts, ankling, and high knee. Meanwhile, SAQ group received zig zag, 10 cone snake drill, and figure eight. Last group, which was coded as CTR (or conventional training) served as control, where participants employed conventional training included running and dynamic stretches followed by various shorts and matches with co-player. The overviews of HIIT and SAQ trainings are summarized in Table 1 and 2, respectively.

Table 1. The detail of 8-week high intensity interval training

Week	Training Method	Set and Repetition	Duration	Rest	Intensity
1	Squat thrust Falling starts High knee	3 x 2	30 s 120 s 30 s	2 min	60%
2	High knee Falling starts Squat thrust	3 x 2	30 s 120 s 30 s	2 min	60%
3	Ankling Falling starts High knee	3 x 2	10 s 120 s 30 s	3 min	60%
4	High knee Falling starts Squat thrust	3 x 2	30 s 120 s 30 s	3 min	60%
5	Squat thrust Falling starts High knee	3 x 2	30 s 120 s 30 s	4 min	70%
6	High knee Falling starts Ankling	3 x 2	30 s 120 s 0 s	4 min	70%
7	Squat thrust Falling starts High knee	3 x 2	30 s 120 s 30 s	4 min	80%
8	Falling starts Squat thrust High knee	3 x 2	120 s 30 s 30 s	4 min	80%

Table 2. The detail of 8-week speed, agility, and quickness

Week	Training Method	Set and Repetition	Training : Rest Ratio
1	Zig zag 8 cone snake drill Figure eight	1 x 10	1 : 3
2	Zig zag 8 cone snake drill Figure eight	1 x 10	1 : 3
3	Zig zag 10 cone snake drill Figure eight	1 x 10	1 : 3
4	Zig zag 10 cone snake drill Figure eight	1 x 12	1 : 3
5	Zig zag 10 cone snake drill Figure eight	1 x 12	1 : 4
6	Zig zag 10 cone snake drill Figure eight	1 x 12	1 : 4
7	Zig zag 10 cone snake drill Figure eight	1 x 12	1 : 4
8	Zig zag 10 cone snake drill Figure eight	1 x 12	1 : 4

Each training session began with a 5-minute warm-up that included stretching, low-intensity running, and sprints with integration of badminton-specific movements. All players reached >85% of their individual HRmax for HRmax for both types of training sessions. The subject's heart rate was continuously monitored using Polar Heart Rate (Polar H10 Bluetooth Heart Rate Sensor & Fitness Tracker, Kempele, Finland), and they received verbal encouragement if the heart rate decreased or if they appeared exhausted. Testing protocols were approved by a university's institutional review board for the protection of human beings.

Testing Procedure

Speed and agility were assessed twice, on the first day before the training protocol began (pre-test) and on the eighth week after the last training session ended (post-test). Speed of lower limb was assessed using 30-m sprints. Each subject lined up behind the start line with position was set in split start, and they started running on the command of "go". Each subject was given three chances to do sprint test, with 5 to 7 minutes rest in between, and the best result was recorded for the final score.

Agility was measured using Agility T-Test. Bells were set at the bases of three cones (B, C, and D) to monitor the consistency and precision of test execution. The subjects began with both feet behind the starting point A. Each subject rushed forward 9.14 meters (10 yards) to point B and rang a bell at the foot of a cone with their right hand. Afterward, they shuffled 4.57 meters (5 yards) to the left, touching a bell at the foot of a cone (C) with their left hand. Subjects then shuffled 9.14 m to the right, touching a bell at the foot of a cone (D) with their right hand. After that, they shuffled 4.57 meters back to point B on the left and used their left hand to touch a bell. The subjects subsequently crossed the finish line at point A and started running backward. Three experimental trials were conducted, and times were recorded using an electronic timing device (Brower Timing device, Salt Lake City, UT) to the closest hundredth of a second. On either side of the starting line, two electronic timing sensors were placed three meters apart and facing each other. They were both supported by tripods and adjusted to be roughly 0.75 meters above the ground. The clock began when the subjects passed the electronic sensors and stopped immediately as the subject re-crossed the sensor plane. If a participant did not face forward at all times, crossed his or her feet when shuffling, or failed to ring the bell at the base of each cone, the test was repeated. The fastest trial was recorded for statistical analysis.

Statistical Analysis

The Statistical Package for Social Sciences (SPSS) version 30 (SPSS Inc., Chicago, IL, USA) was used for data analysis. Descriptive statistics were calculated for all experimental variables. Prior to inferential analysis, the normality of data distribution was assessed using the Shapiro-Wilk test. A paired-sample t-test was conducted to compare the measured variables before and after the 8-week intervention within each group. The effect size was calculated using Cohen's d to assess the magnitude of observed changes. To examine differences between groups, a one-way analysis of variance (ANOVA) was conducted. The assumptions of ANOVA—normality, homogeneity of variances, and independence—were tested. Homogeneity of variances was assessed using Levene's test. Statistical significance was determined at $p < 0.05$.

Results

Thirty subjects have completed their respective training program for eight weeks. No serious discomfort, spine or lower limb injuries, and no reported drop-outs during the experimental period. Baseline characteristic of subject is presented in Table 3. The average age of overall subjects was 19.85 ± 2.01 years. The average bodyweight and height were 60.05 ± 3.78 kg and 165.74 ± 3.45 cm, respectively. Subjects who had the highest bodyweight was in HIIT group (60.81 ± 3.54 kg), while the highest height was in SAQ group (166.82 ± 2.60 cm). Meanwhile, the average body mass index was 22.10 ± 1.26 kg/m2, with the highest BMI was those in HIIT group (22.61 ± 1.78 kg/m2).

Table 3. Baseline characteristic of subjetcs

Variable	All (n=30)	SAQ	HIIT	CTR
Age (year)	19.85 ± 2.01	19.20 ± 1.64	20.08 ± 1.78	19.96 ± 1.91
Bodyweight (kg)	60.05 ± 3.78	59.75 ± 4.32	60.81 ± 3.54	59.90 ± 4.10
Height (cm)	165.74 ± 3.45	166.82 ± 2.60	164.43 ± 3.92	164.77 ± 3.26
Body mass index (kg/m^2)	22.10 ± 1.26	21.68 ± 1.44	22.61 ± 1.78	22.27 ± 0.99
Resting heart rate (bpm)	63.90 ± 2.10	63.60 ± 2.25	64.00 ± 3.35	64.10 ± 3.05

*Data given as mean ± SD

SAQ = Speed, Agility, Quickness group; HIIT = High Intensity Interval Training group; CTR = Control group. Data were displayed as mean ± standard deviation (SD)

Table 4 summarizes the result of paired t-test in measured variables after 8-weeks of training programs. Paired sample t-tests revealed significant improvements in speed for the SAQ group ($p = 0.012$, $d = 0.54$) and HIIT group ($p < 0.001$, $d = 1.35$), indicating medium to large effect sizes. For agility, a significant improvement was only found in the HIIT group ($p < 0.001$, $d = 1.57$), also indicating a large effect. In contrast, the control group showed a negligible and non-significant change ($p > 0.05$).

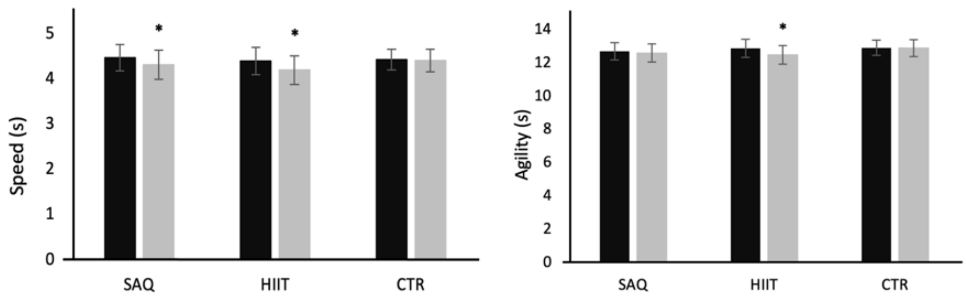
Table 4. Paired sample analysis of speed and agility before and after 8-weeks of treatment

Group		Speed				Agility			
		T score	Mean ± SD	p-value	Cohen's d	T score	Mean ± SD	p-value	Cohen's d
SAQ	Pre	3.115	4.47 ± 0.29	0.012*	0.54	1.966	12.70 ± 1.03	0.081	0.19
	Post		4.32 ± 0.32				12.50 ± 1.09		
HIIT	Pre	7.872	4.40 ± 0.30	0.000*	1.35	6.581	12.89 ± 1.08	0.000*	1.57
	Post		4.20 ± 0.32				12.49 ± 1.12		
CTRL	Pre	1.177	4.43 ± 0.23	0.269	0.08	0.182	12.91 ± 0.91	0.859	0.01
	Post		4.41 ± 0.25				12.90 ± 1.02		

*significantly different between pre and post-training
SAQ = Speed, Agility, Quickness group; HIIT = High Intensity Interval Training group; CTR = Control group.

Figure 2 illustrates the changes in speed (left panel) and agility (right panel) following an 8-week intervention across three groups. Overall, these results suggest that both SAQ and HIIT training effectively improved speed, whereas only HIIT training significantly enhanced agility over the 8-week period. This improvement was supported by the effect size that showed larger effect in HIIT group. The control group did not experience any notable changes in either variable, indicating the observed improvements were likely due to the interventions.

Figure 1. The changes in speed (left) and agility (right) after 8-weeks of treatment.



(*) significantly different with pre-test

Speed and agility in SAQ, HIIT, and CTR group increased, with highest improvement in speed was observed in SAQ (3.36%) and highest agility was found in HIIT (3.10%). However, further analysis using one-way Anova revealed that changes in speed and agility were not significantly different between pre-test and post-test ($p > 0.05$). It can be assumed that both training method proved to be statistically equal in increasing the measured variables (Table 5).

Table 5. Between group differences on Δ speed and agility

Group	Δ Speed (s)	%	p-value	Δ Agility (s)	%	p-value
SAQ	0.15	3.36	0.290	0.20	1.58	0.486
HIIT	0.20	4.55		0.40	3.10	
CTR	0.02	0.45		0.01	0.08	

*significantly different between groups
SAQ = Speed, Agility, Quickness group; HIIT = High Intensity Interval Training group; CTR = Control group.

Discussion

Present study demonstrates that SAQ and HIIT had positive impact on specific physical performances, particularly in speed and agility which are essential for badminton players. We hypothesized that SAQ and HIIT method could improve speed and agility better than usual conventional training program was clearly supported by the findings, as the given 8-weeks of SAQ and HIIT resulted in a significantly larger increase especially in speed. Faster improvement indicates that the 8-weeks of intervention was successful in regards with performance enhancement in term of acceleration and quickness (Jovanovic et al., 2011).

Maximum sprint speed is a fundamental physical skill required by player in many type of sports, such as football basketball, and badminton (Gamble, 2011). The results showed that speed was significantly increased—or reduced sprint time—only in experimental groups who underwent eight weeks of SAQ training. It was in agreement with previous research done by Lee et al (2024) which demonstrated significant improvement in maximum sprint performance after 8-week of SAQ training. Other researches also revealed that SAQ training significantly reduced sprint time over long distance (Trecroci et al., 2016) and short distance (Polman et al., 2009). Present study also found that SAQ training that was able to increase agility, but the change was not significant. This finding was inconsistent with previous study which found significant increase in skill-related fitness including speed and agility in male basketball players after six weeks of SAQ training (Prachita et al., 2023). Another study conducted on cricket player found that SAQ training had positive effects on endurance and agility (Dhapola, 2017).

SAQ training was designed specifically to increase players' change-of-direction speed and agility performances as well as their ability to sprint and run faster during a game (Milanović et al., 2014). Through the combination of various movement exercises such as ladder drills, forward and backward running, and lateral shuffles, players can improve their motor coordination, reaction time, and rapid transitions through SAQ training. In other words, SAQ training focuses on high-rate, short-duration movement exercises that combine straight-line and multidirectional sprints (CoD speed) over a range of distances to improve maneuverability (Lee et al., 2024).

Meanwhile, present study observed that HIIT group had significant impact on speed and agility, which increased by 4.55% and 3.10%, respectively. This finding was similar with previous study which found an improvement in power, speed, and agility after six week of high-intensity interval training (Fajrin et al., 2018). Another systematic review reported that many studies observed a notable improvement in most performance test including 20-m and 30-m sprints after HIIT was applied to experimental groups (Liu et al., 2024). Some plausible explanations for this result associated with the nature of HIIT, which puts the body in a state favorable to fat loss, muscle retention, and even muscular growth (Fuentes-García et al., 2021). This improves force transmission and speed as a result, increasing the cross-sectional area of the muscle. The function of HIIT in building stronger core muscles is another potential explanation. Strategic adjustment of load and intensity improves the synergy of numerous muscle groups, assisting athletes in maintaining their coordinating movement and center of gravity whether for lateral speed bursts or short-term sprints (Kilit & Arslan, 2019; Ko et al., 2021). Additionally, HIIT is known as a potent exercise that activates aerobic and anaerobic energy systems, facilitating player with the chance to enhance the power and speed in badminton and other racket sports by focusing on high-strength muscle fibers (Panissa et al., 2021). HIIT also helps athletes to establish energy systems and muscle responses that are particular to their needs by increasing anaerobic capacity and simulating the pace and duration of activities specific to different sports (Liu et al., 2024; Zhu et al., 2023).

Like all research, present study has a number of limitations that may open up new directions for further investigation in the future. First, we concentrated on young amateur badminton players. Considering the diverse nature of different sports and variances in physical demands, generalizing the results to other populations in different type of sports (tennis, soccer, or basketball), age groups, or performance levels (elite or amateur) should be done cautiously. Further research can examine the applicability of SAQ and HIIT training to different age groups and sports, as well as its impact on sprint and agility performance, taking into account individual variances and specific player features.

Conclusions

In conclusion, SAQ and HIIT training have a positive impact on speed and agility in amateur badminton players, supporting the hypothesis that these methods are superior to conventional training. SAQ significantly increased sprint speed, in line with previous research. Although the impact of SAQ on agility was not significant, HIIT also showed an increase in speed and agility, likely due to its effects on the energy system, muscle growth, and core strength. Future research should explore the application of SAQ and HIIT across different sports, age groups, and skill levels, taking into account individual variations.

Coaches and trainers working with amateur badminton players can incorporate SAQ and HIIT protocols into their training regimens to enhance speed and agility performance. SAQ drills can be emphasized to specifically boost sprint speed, while HIIT can be utilized to improve overall conditioning and agility. Tailoring these training methods to the athlete's individual needs and monitoring their responses may optimize performance gains and reduce injury risk.

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