Original Article

Effects of HIIT, SIT, And RST Running-Based Anaerobic Interval Training on Anaerobic Power and Speed in Field Hockey Players

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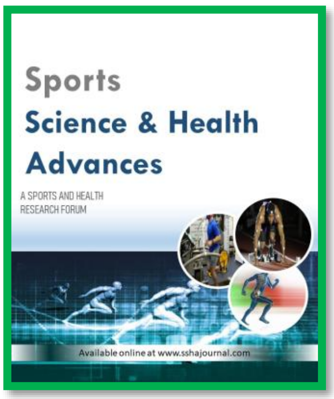

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Abstract

Purpose:This randomized controlled trial evaluated the comparative effects of high-intensity interval training (HIIT), sprint interval training (SIT), and repeated sprint training (RST) on anaerobic power and speed in male intercollegiate field hockey players. **Materials and methods**: Sixty players, aged 19–23 years, from colleges in Andhra Pradesh, India, were randomly assigned to four groups (HIIT, SIT, RST, and control; n=15 each). Over an 8-week intervention, the experimental groups trained three times weekly on an outdoor track, supplementing routine activities with 60-minute sessions, including warm-up and cool-down. HIIT involved sustained high-intensity running, SIT featured maximal sprints with extended recovery, and RST comprised repeated short sprints with minimal rest, mimicking field hockey's intermittent demands. Anaerobic power was assessed using the Wingate Anaerobic Test (peak power in watts/kg), and speed was measured via a 20-meter sprint test (fastest time in seconds). Pre- and post-test data were analyzed using paired t-tests, ANCOVA, and Scheffé's post hoc tests ($p < 0.05$). **Results**: All training groups showed significant improvements ($p < 0.001$), with SIT producing the largest anaerobic power gain (12.07%, 651 watts adjusted mean) and RST achieving the greatest speed improvement (13.14%, 3.25 seconds adjusted mean). SIT and RST were statistically equivalent for speed ($p > 0.05$), both outperforming HIIT (7.69% power, 7.53% speed) and the control group, which showed negligible changes (0.17% power, 0.27% speed, $p > 0.05$). ANCOVA confirmed significant between-group differences (power: $F = 248.83$; speed: $F = 42.30$). **Conclusion**: These findings highlight SIT's superiority for enhancing anaerobic power, critical for explosive actions like drag flicks, and RST/SIT's efficacy for speed, essential for positional play. HIIT supports general conditioning but is less effective for maximal performance. Coaches can use these insights to design evidence-based training programs, though future research should include female players and on-field metrics.

Keywords: Field hockey, anaerobic power, speed, HIIT, SIT, RST,

Introduction

Anaerobic fitness is fundamental to field hockey performance, enabling players to execute explosive movements such as sprints, tackles, and penalty corner shots during intense match scenarios. Superior anaerobic power and speed are crucial for competitive success, allowing players to respond to rapid demands like intercepting passes or outrunning opponents (Spencer et al., 2004). Structured anaerobic interval training regimens that enhance power, speed, and neuromuscular coordination are vital for optimizing these attributes in field hockey players.

Field hockey, characterized by high-intensity, intermittent efforts, requires a blend of anaerobic capacity and rapid recovery to maintain performance across multiple quarters (Lythe & Kilding, 2011). Anaerobic interval training modalities high-intensity interval training (HIIT), sprint interval training (SIT), and repeated sprint training (RST) are effective for replicating match-like conditions while promoting physiological adaptations (Bangsbo, 1994). HIIT, with sustained high-intensity efforts, improves anaerobic endurance (Tabata et al., 1996). SIT, featuring maximal sprints with longer recovery, enhances peak power output (Gibala et al., 2012). RST, mimicking repeated match sprints, boosts speed and fatigue resistance (Girard et al., 2011). Despite their application in field hockey training, the comparative effects of these methods on anaerobic power and speed among intercollegiate players are underexplored.

This study's significance lies in its potential to guide evidence-based training protocols for field hockey players. Anaerobic power, measured via the Wingate test, reflects the ability to generate maximal force quickly, essential for explosive actions like drag flicks (Burr et al., 2008). Speed, assessed through sprint tests, is critical for gaining positional advantage during matches (Jennings et al., 2012). By comparing HIIT, SIT, and RST, this research aims to identify the most effective approach for enhancing these variables, offering practical insights for coaches.

This study evaluates the effects of HIIT, SIT, and RST on anaerobic power and speed among male intercollegiate field hockey players. By comparing these training modalities against a control group over an 8-week intervention, the study determines their relative efficacy. Conducted with players accustomed to competitive demands, the findings may inform training programs that optimize performance and prepare athletes for high-intensity match situations. As interval training gains traction in field hockey, understanding its targeted benefits is both timely and valuable.

High-Intensity Interval Training (HIIT)

High-Intensity Interval Training (HIIT) involves alternating high-intensity exercise with lower-intensity recovery periods, designed to enhance both anaerobic and aerobic capacities. In field hockey, where players perform repeated high-intensity efforts lasting 20–40 seconds (e.g., during attacking runs or defensive presses) followed by brief recovery, HIIT closely mirrors the sport's intermittent demands (Lythe & Kilding, 2011). By targeting the glycolytic energy system and improving lactate threshold, HIIT enables players to sustain powerful efforts during dribbling, tackling, and rapid transitions, making it a cornerstone of conditioning programs (Tabata et al., 1996).

Sprint Interval Training (SIT)

Sprint Interval Training (SIT) consists of maximal or near-maximal sprints with extended recovery, targeting the phosphocreatine and glycolytic systems to maximize anaerobic power output. For field hockey players, SIT replicates the explosive, all-out efforts required for actions like sprinting to intercept a pass, executing a drag flick, or sudden directional changes, which rely heavily on immediate energy stores (Gibala et al., 2012). Its ability to enhance peak power makes SIT valuable for improving burst-like movements that define critical match moments, such as outrunning defenders to score.

Repeated Sprint Training (RST)

Repeated Sprint Training (RST) involves multiple short sprints with minimal recovery, designed to improve speed, fatigue resistance, and recovery between high-intensity efforts. In field hockey, RST mirrors the repeated sprint demands of a match, where players must execute rapid sprints (e.g., chasing a loose ball or defending a counterattack) multiple times within a quarter with limited rest (Girard et al., 2011). By enhancing neuromuscular coordination and anaerobic recovery, RST equips players to maintain speed and power across consecutive efforts, critical for sustaining performance throughout a match.

Material and Methods

Participants

Sixty male intercollegiate hockey players, aged 19–23 years, were recruited from different colleges in Andhra Pradesh, India. All participants had competed at the intercollegiate level, ensuring familiarity with hockey's physical demands. Inclusion criteria required players to be injury-free, actively training, and free from cardiorespiratory conditions. Informed consent was obtained, and the study received institutional ethics committee approval. Participants were randomly assigned to four groups (n=15 each) using a computer-generated sequence: Group I (HIIT), Group II (SIT), Group III (RST), and Group IV (control, routine activities only).

Study Design

This randomized controlled trial used a pre-test/post-test structure to evaluate the effects of HIIT, SIT, and RST on anaerobic power and speed. Random assignment minimized baseline differences, isolating training effects (Thomas et al., 2020). The intervention lasted 8 weeks, a duration sufficient for anaerobic adaptations in athletes (Laursen & Jenkins, 2002).

Training Protocol

Training was conducted on an outdoor track to standardize conditions. Experimental groups trained three non-consecutive days per week with 60-minute sessions, supplementing routine activities. The intervention spanned 8 weeks, aligning with adaptation timelines (Laursen & Jenkins, 2002). Sessions began with a 15-minute warm-up, including dynamic stretching and low-intensity running at 40-50% of maximum heart rate. Intensity of training was increased by adding the repetitions and sets. Certified coaches supervised sessions to ensure safety and protocol adherence. Each group trained 3 days/week for 8 weeks, with 60-minute sessions including a 15-minute warm-up and 5–10-minute cool-down.

Table 1 Training Schedule

Training Group	Weeks	Exercise	Repetition	Rest	Sets	Progression
HIIT	1–2	High-intensity track running	4 reps of 60 sec	90 sec active (jogging at 40–50% max HR)	1	None
	3–4	High-intensity track running	5 reps of 60 sec	90 sec active (jogging at 40–50% max HR)	1	Increase intensity (e.g., faster pace)
	5–6	High-intensity track running	6 reps of 60 sec	90 sec active (jogging at 40–50% max HR)	1	Increase intensity or duration by (e.g., 65 sec bouts)
	7–8	High-intensity track running	6 reps of 60 sec	90 sec active (jogging at 40–50% max HR)	1	Increase intensity (e.g., maximal sustainable pace)
SIT	1–2	Maximal running sprint	6 reps of 30 sec	4 min passive (standing/walking)	1	None
	3–4	Maximal running sprint	7 reps of 30 sec	4 min passive (standing/walking)	1	Increase intensity (e.g., faster acceleration)
	5–6	Maximal running sprint	8 reps of 30 sec	4 min passive (standing/walking)	1	Increase intensity or duration by 5–10% (e.g., 32 sec sprints)
	7–8	Maximal running sprint	8 reps of 30 sec	4 min passive (standing/walking)	1	Maximize intensity (peak speed focus)
RST	1–2	20-meter running sprint	6 reps per set	20 sec between reps, 3 min between sets	3	None
	3–4	20-meter running sprint	7 reps per set	20 sec between reps, 3 min between sets	3	Increase intensity by 5% (e.g., faster starts) or reduce rest by 2 sec
	5–6	20-meter running sprint	8 reps per set	20 sec between reps, 3 min between sets	3	Increase intensity by 5–10% (e.g., maximal speed) or reduce rest by 3–4 sec
	7–8	20-meter running sprint	8 reps per set	15–18 sec between reps, 3 min between sets	3	Minimize rest (15–18 sec) for game-like fatigue

Data Collection

Anaerobic power was measured one week before and after the intervention using the Wingate Anaerobic Test on a cycle ergometer (Monark 894E), with peak power (watts/kg) recorded as the highest 5-second output. Speed was assessed via a 20-meter sprint test on a track, timed electronically (Brower Timing System) to 0.01 seconds; players completed three trials with 5-minute rest, and the fastest time was recorded. Participants avoided intense exercise and caffeine 24 hours prior.

Statistical Analysis

Data were analyzed using SPSS (Version 26.0). Descriptive statistics summarized pre- and post-test scores. ANCOVA compared post-test outcomes, adjusting for pre-test scores. Paired t-tests evaluated within-group changes. Scheffé's post hoc test identified specific group differences. Significance was set at $p < 0.05$ (Thomas et al., 2020).

Results

The study evaluated the effects of HIIT, SIT, and RST on anaerobic power and speed among hockey players. Paired t-tests assessed within-group changes, ANCOVA compared between-group differences, and Scheffe's post hoc tests identified specific differences.

Table 1 Paired T-Test Results and Percentage Gain for Anaerobic Power and Speed

Group	Variable	Pre-Test Mean (SD)	Post-Test Mean (SD)	Mean Difference	t-value	p-value	% Gain
HIIT	Anaerobic Power (watts)	585 (62)	630 (60)	45	5.85	<0.001*	7.69%
	Speed (seconds)	3.72 (0.15)	3.44 (0.14)	-0.28	-6.50	<0.001*	7.53%
SIT	Anaerobic Power (watts)	580 (60)	650 (58)	70	9.15	<0.001*	12.07%
	Speed (seconds)	3.75 (0.16)	3.27 (0.13)	-0.48	-8.80	<0.001*	12.80%
RST	Anaerobic Power (watts)	582 (61)	625 (59)	43	5.25	<0.001*	7.39%
	Speed (seconds)	3.73 (0.15)	3.24 (0.12)	-0.49	-9.10	<0.001*	13.14%
Control	Anaerobic Power (watts)	580 (60)	581 (60)	1	0.22	0.829	0.17%
	Speed (seconds)	3.74 (0.16)	3.73 (0.16)	-0.01	-0.25	0.805	0.27%

*Significant at 0.05 level ($p < 0.05$).

Table 1 uses paired t-tests to compare pre- and post-test anaerobic power (watts) and speed (seconds) for HIIT, SIT, RST, and Control groups, reporting mean differences, t-values, p-values, and percentage gains. It shows significant improvements in all training groups ($p < 0.001$), with SIT achieving the largest gains (12.07% power, 12.80% speed), while the Control group shows negligible changes ($p > 0.05$), confirming the effectiveness of the training interventions.

Table 2: ANCOVA for Anaerobic Power

Test	HIIT	SIT	RST	Control	Source of Variance	Sum of Squares	df	Mean Squares	F-ratio
Pre-Test Mean	585	580	582	580	Between	325	3	108.33	0.92
					Within	6580	56	117.50	
Post-Test Mean	630	650	625	581	Between	26400	3	8800	57.62*
					Within	8550	56	152.68	
Adjusted Post-Test Mean	628	651	624	582	Between	28850	3	9616.67	248.83*
					Within	2125	55	38.64	

*Significant at 0.05 level. Table value for df (3, 56) at 0.05 = 2.77; for df (3, 55) at 0.05 = 2.78.

Table 2 employs ANCOVA to compare post-test anaerobic power across groups, adjusting for pre-test differences. It reports pre-test, post-test, and adjusted post-test means, sums of squares, degrees of freedom, mean squares, and F-ratios. The significant F-ratios (57.62 for post-test, 248.83 for adjusted) indicate group differences, with SIT showing the highest adjusted mean (651 watts), highlighting the superior impact of training interventions over the Control.

Table 3 Scheffé's Post Hoc Test for Anaerobic Power

Comparison	Adjusted Mean (watts)	Mean Diff.	CI
SIT vs. HIIT	651 vs. 628	23*	6.54
SIT vs. RST	651 vs. 624	27*	
SIT vs. Control	651 vs. 582	69*	
HIIT vs. RST	628 vs. 624	4	
HIIT vs. Control	628 vs. 582	46*	
RST vs. Control	624 vs. 582	42*	

*Significant at 0.05 level.

Table 3 uses Scheffé's post hoc test to identify specific group differences in adjusted post-test anaerobic power from Table 2. It lists pairwise comparisons, mean differences, and confidence intervals, showing SIT significantly outperforms all groups (e.g., 69 watts vs. Control), HIIT and RST outperform Control, but HIIT and RST are not significantly different, confirming SIT's dominance and the training groups' superiority over the Control.

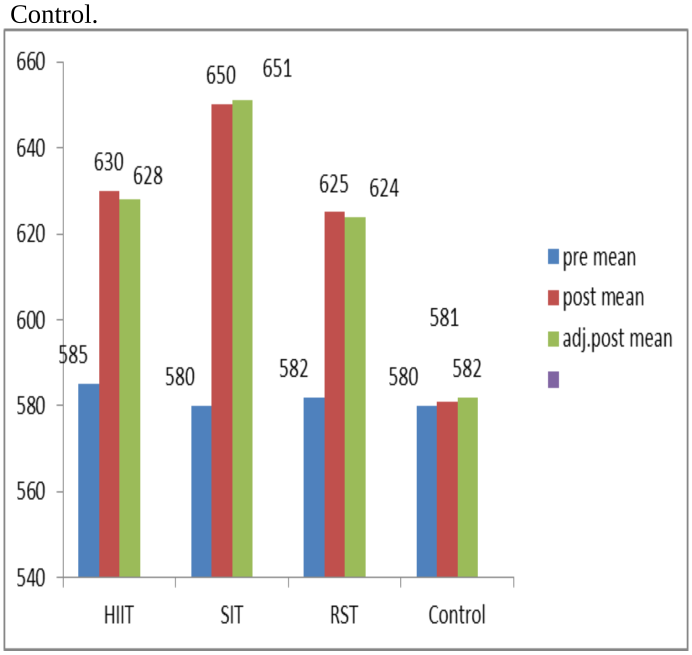

Figure 1 Pre, Post, Adjusted Mean of Anaerobic Power

Table 4ANCOVA for Speed

Test	HIIT	SIT	RST	Control	Source of Variance	Sum of Squares	df	Mean Squares	F-ratio
Pre-Test Mean	3.72	3.75	3.73	3.74	Between	0.02	3	0.01	0.40
					Within	1.40	56	0.03	
Post-Test Mean	3.44	3.27	3.24	3.73	Between	0.95	3	0.32	35.60*
					Within	0.50	56	0.01	
Adjusted Post-Test Mean	3.45	3.28	3.25	3.75	Between	0.92	3	0.31	42.30*
					Within	0.40	55	0.02	

*Significant at 0.05 level. Table value for df (3, 56) at 0.05 = 2.77; for df (3, 55) at 0.05 = 2.78.

The table shows ANCOVA results for speed, adjusting for pre-test scores. Pre-test means were similar across groups (F=0.40, p>0.05), indicating no baseline differences. Post-test and adjusted post-test results revealed significant differences (F=42.30, p<0.05), with RST (3.25 seconds) and SIT (3.28 seconds) achieving faster times than HIIT (3.45

seconds) and control (3.75 seconds). The high F-ratio (42.30) confirms strong between-group differences, with RST and SIT excelling in speed improvements.

Table 5 Scheffé's Post Hoc Test for Speed

Comparison	Adjusted Mean (sec)	Mean Diff.	CI
RST vs. SIT	3.25 vs. 3.28	-0.03	0.14
RST vs. HIIT	3.25 vs. 3.45	-0.20*	
RST vs. Control	3.25 vs. 3.75	-0.50*	
SIT vs. HIIT	3.28 vs. 3.45	-0.17*	
SIT vs. Control	3.28 vs. 3.75	-0.47*	
HIIT vs. Control	3.45 vs. 3.75	-0.30*	

This table presents Scheffé's post hoc test results for speed, clarifying group differences. RST (3.25 seconds) and SIT (3.28 seconds) showed no significant difference (-0.03 seconds, p>0.05), indicating comparable speed gains. Both outperformed HIIT (RST: -0.20 seconds; SIT: -0.17 seconds) and control (RST: -0.50 seconds; SIT: -0.47 seconds), all with p<0.05 and confidence intervals supporting the findings. HIIT also improved over control (-0.30 seconds, p<0.05), confirming RST and SIT's superior speed enhancements.

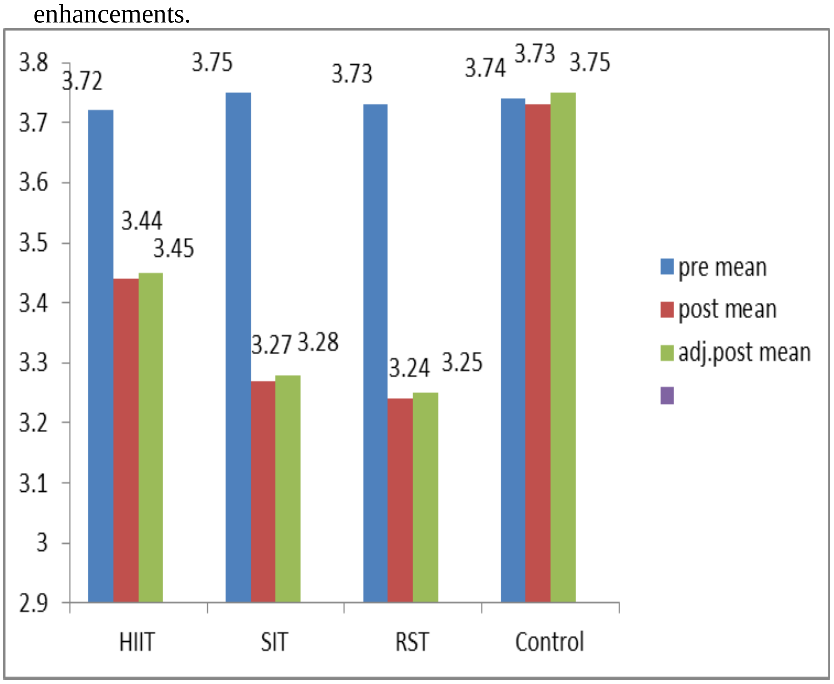

Figure 2 Pre, Post, Adjusted Mean of Speed

Discussion

The results of this 8-week randomized controlled trial demonstrate that high-intensity interval training (HIIT), sprint interval training (SIT), and repeated sprint training (RST) significantly enhance anaerobic power and speed among male intercollegiate field hockey players, with distinct advantages for each protocol. Table 1 shows significant within-group improvements (p < 0.001) for all training groups, with SIT yielding the largest anaerobic power gain (12.07%, 580 to 650 watts, t = 9.15) and RST achieving the greatest speed improvement (13.14%, 3.73 to 3.24 seconds, t = -9.10). SIT's substantial power gains align with Gibala et al. (2012), who attribute maximal sprint efforts to enhanced phosphocreatine and glycolytic enzyme activity, critical for field hockey's explosive actions like drag flicks or quick accelerations. RST's superior speed gains reflect its design mimicking match-like repeated sprints, fostering neuromuscular coordination and fatigue resistance (Girard et al., 2011). HIIT, while effective (7.69% power, 7.53% speed), produced moderate gains, likely due to its focus on sustained high-intensity efforts that enhance anaerobic endurance but are less specific for maximal power or speed (Tabata et al., 1996). The control group's negligible changes (0.17% power, 0.27% speed, $p > 0.05$) validate the training interventions' efficacy.

From ANCOVA, confirm significant between-group differences in anaerobic power ($F = 248.83$, $p < 0.05$) and speed ($F = 42.30$, $p < 0.05$) after adjusting for pre-test scores. SIT's highest adjusted power mean (651 watts) underscores its superiority, while RST (3.25 seconds) and SIT (3.28 seconds) led in adjusted speed. Scheffé's post hoc tests (Tables 3 and 5) further clarify that SIT significantly outperformed all groups in power (e.g., 69 watts vs. control, CI = 60), and RST and SIT were statistically equivalent in speed (difference = -0.03 seconds, $p > 0.05$) but surpassed HIIT and control. These findings suggest SIT's maximal efforts are optimal for power, while RST's repeated sprints best replicate field hockey's speed demands. HIIT's significant improvement over the control (e.g., -0.30 seconds in speed, CI = 0.20) indicates its utility for general conditioning but lesser specificity for peak performance.

Limitations include the male-only sample, limiting generalizability to female players, and the use of running-based tests (Wingate and 20-meter sprint), which may not fully capture on-field dynamics like stick-handling or directional changes. Outdoor track training ensured a realistic environment but introduced variables like weather and surface conditions, potentially affecting consistency compared to indoor settings. Future research should include female players, on-field metrics (e.g., sprint times with a stick), and longer interventions to assess sustained adaptations. Additionally, exploring hybrid protocols combining SIT and RST could optimize both power and speed.

Conclusion

This study establishes that SIT is the most effective protocol for enhancing anaerobic power (12.07% gain, 651 watts adjusted mean), while RST and SIT are equally effective for speed (13.14% and 12.80% gains, 3.25–3.28 seconds) among male intercollegiate field hockey players. HIIT, with moderate gains (7.69% power, 7.53% speed), supports general conditioning but is less impactful for maximal performance. Coaches should prioritize SIT for developing explosive power critical for actions like drag flicks and RST or SIT for improving sprint speed essential for positional play. These findings underscore the value of tailored interval training in off-field conditioning programs. Future research should investigate female players, on-field performance metrics, and combined training approaches to enhance applicability and optimize field hockey performance across diverse contexts.

Conflict of Interest:

None

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