STUDIA UBB EDUCATIO ARTIS GYMN., LXXI, 1, 2026, pp. 5-20
(RECOMMENDED CITATION)
DOI:10.24193/subbeag.71(1).01

Effect of Mixed Training Module on Key Physical Attributes of Sprinters

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Article history: Received 2026 January 30; Revised 2026 March 03; Accepted 2026 March 05; Available online 2026 March 30; Available print 2026 April 30

ABSTRACT. Introduction: In university-level sprint training, athletes are often exposed to fragmented or non-systematic training approaches, which may limit the development of key physical attributes related to sprint performance. **Objective:** The present study aimed to examine the effects of a 12-week mixed module training programme (MMTP) on selected physical attributes and 100-m sprint performance in university-level sprinters. **Methods:** A quasi-experimental comparative design was employed. Twenty-eight male university sprinters (age: 20–25 years) were assigned to an experimental group (EG, n = 18) that followed the MMTP and a control group (CG, n = 10) that continued regular physical activity. Pre- and post-tests were conducted for 100-m sprint performance, vertical jump, standing long jump, 20-m sprint, and Illinois Agility Test. Data were analysed using analysis of covariance (ANCOVA). **Results:** After 12 weeks, the EG showed statistically significant improvements in 100-m sprint performance and all selected physical attributes compared with the CG ($p < 0.05$). **Conclusion:** The findings suggest that a structured mixed module training programme may be an effective applied approach for improving sprint-related physical attributes in university-level sprinters.

Keywords: *Sprint performance; mixed training; explosive strength; agility; university athletes.*

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INTRODUCTION

Sprint performance is a key determinant of success in track and field, and its development depends on multiple physical attributes such as speed, explosive strength, acceleration, and agility (Majumdar & Robergs, 2011). At the university level, sprinters often come from diverse training backgrounds and may not have consistent exposure to structured, long-term training programmes (Haugen et al., 2019).

In many university sport settings, particularly within developing sporting systems, training is frequently constrained by time availability, competition schedules, and access to facilities (Ndirangu et al., 2022). As a result, coaches often combine different training elements within a single programme to address multiple performance-related demands simultaneously (Oliver et al., 2024).

Previous research has demonstrated that combined training approaches—including strength training, plyometric exercises, sprint drills, and high-intensity interval training—can improve various performance characteristics in athletes (Aloui et al., 2021; Oliver et al., 2024; Yuan et al., 2024; Niering et al., 2025). Such approaches have been applied across different sports and competitive levels, showing positive effects on sprint speed, explosive power, and agility. However, most existing studies have examined specific combinations of training components or have focused on elite athletes or well-controlled laboratory-based settings (Kambitta Valappil et al., 2025; Wiesinger et al., 2025).

Despite the growing body of literature on combined training, relatively limited attention has been given to applied, context-specific mixed training programmes designed for university-level sprinters operating under real training conditions (Loturco et al., 2017; Stellingwerff et al., 2025). In particular, few studies have examined structured mixed-module training implemented during short-term competitive preparation phases, such as university training camps (Girard & Brocherie, 2025; Stellingwerff et al., 2025).

Understanding the effectiveness of such programmes is important for coaches and practitioners working in resource-limited environments who require practical training models capable of simultaneously addressing multiple physical attributes (Haugen et al., 2019; Weldon et al., 2022; Larkin et al., 2022).

The mixed module training programme (MMTP) in the present study was designed to integrate different training components within a structured and progressive framework (Issurin, 2010; Bompa & Buzzichelli, 2018). The programme emphasised balanced exposure to sprint-specific running, strength training, plyometrics, core exercises, and mobility work, with gradual progression across training phases (Cormie et al., 2011; Issurin, 2010; Ramirez-Campillo et al., 2023; Sañudo et al., 2019).

Rather than isolating individual physical qualities, the MMTP was intended to reflect common coaching practice in university-level sprint training, where multiple performance-related attributes must be developed concurrently within limited preparation periods (Haugen et al., 2019; Oliver et al., 2024; Liu et al., 2024).

Purpose

Therefore, the purpose of the present study was to examine the effects of a 12-week mixed module training programme on selected physical attributes and 100-m sprint performance in university-level sprinters.

Hypothesis

It was hypothesised that participation in the MMTP would be associated with greater improvements in sprint performance and related physical attributes compared with regular physical activity.

MATERIALS AND METHODS

Study Design

The present study employed a quasi-experimental comparative design with pre- and post-intervention measurements. Two groups of university-level sprinters were compared: an experimental group that participated in a mixed module training programme (MMTP) and a control group that continued their regular physical activity.

Ethical Approval and Consent

The study protocol was reviewed and approved by the Departmental Research Committee of the Department of Physical Education and Sport Science, Visva-Bharati University. All participants were informed about the objectives, procedures, potential risks, and benefits of the study, and written informed consent was obtained prior to participation. All procedures were conducted in accordance with the principles of the Declaration of Helsinki.

Participants

Twenty-eight (N = 28) male university-level sprinters aged between 20 and 25 years participated in the study. All participants were actively involved in inter-university athletics competitions and had prior experience with structured sprint training. Participants were recruited from Visva-Bharati University, Santiniketan, West Bengal, India.

Baseline demographic and anthropometric characteristics of the participants are presented in Table 1.

Table 1. Participants' demographic and anthropometric characteristics

Variable	EG (N = 18)	CG (N = 10)	t (df = 26)	p
Age (Years)	23.1 ± 1.44	23.2 ± 0.98	-0.24	0.812
Height (cm)	175.0 ± 2.39	173.0 ± 5.95	0.841	0.408
Weight (kg)	71.3 ± 5.45	71.6 ± 4.54	-0.16	0.874
BMI (kg/m²)	23.4 ± 1.94	23.9 ± 2.67	-0.63	0.534

Note: EG = Experimental Group; CG = Control Group; cm = centimetres; kg = kilograms; kg/m² = Weight in kilograms / (Meter × Meter); df = Degree of Freedom; N = Number of Participants.

Group Allocation

Athletes who were participating in a university training camp in preparation for the All-India Inter-University Athletics Championships were assigned to the experimental group (EG, n = 18). The remaining athletes, who were not part of the training camp during the study period, formed the control group (CG, n = 10). Group allocation was based on logistical and training constraints rather than random assignment.

Control Group Activity

Participants in the control group continued their regular physical activity throughout the study period. This typically included general sprint drills, running-based conditioning, and routine physical training sessions conducted approximately 3–4 days per week. The control group did not follow a structured or periodized training programme comparable to the MMTP implemented in the experimental group.

Mixed Module Training Programme (MMTP)

MMTP was developed based on established training principles, including progressive overload, variation, and balanced integration of multiple training components. The programme was informed by existing literature on combined and periodized training approaches and was structured to reflect practical coaching conditions at the university level.

The MMTP was implemented over 12 weeks and included sprint-specific running, resistance training, plyometric exercises, core stability training, and mobility work. Training intensity and volume were progressively adjusted across phases to accommodate adaptation and recovery.

A detailed overview of the MMTP is presented in Table 2 and Figure 1.

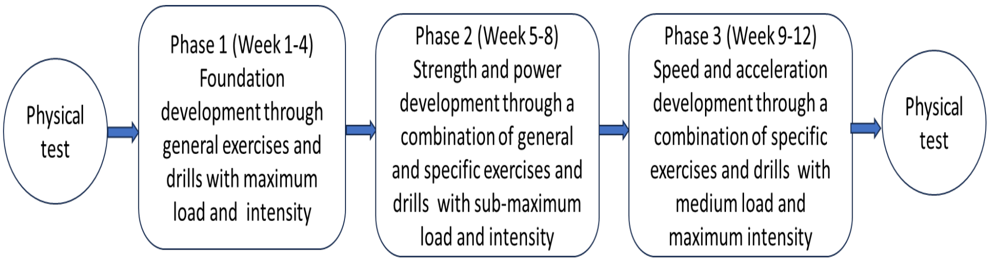

Fig. 1. Mixed Module Training Programme (MMTP) across 12 weeks for the EG

Table 2. 12 weeks Mixed Module Training Programme (MMTP)

Phase	Day	Session	Key Exercises/Drills*	Intensity
Phase 1 (Weeks 1–4)	1-4	AM	30 min slow CR; Core Circuit (20 reps × 4)	50%
		PM	4×300 m, 4×150 m, 4×100 m	70-80 %
	2-5	AM	WT (80-85%, 1RM) 10–12 reps × 3 each variation	50-60 %
		PM	RR [{3× (40, 50, 60, 70 m with Sledge)} ×6] Core Circuit (20 reps × 4)	70-80 %
	3-6	AM	30 min fast CR; Core Circuit (20 reps × 4)	70%
		PM	SL (400 -200 -100– 200-400) X 3, 5×100 m TR	65-85 %
Phase 2 (Weeks 5–8)	1-4	AM	30 min CR; Core Circuit (20 reps × 4)	60-70 %
		PM	Same as Phase 1 with increased intensity	75-90 %
	2-5	AM	WT (70-75%, 1RM) 12–15 reps × 3 each variation	70-75 %
		PM	30 Min Plyometrics; RR {(1×40, 50, 60, 70 m with Sledge) ×6}; Core Circuit (20 reps × 4)	75-85 %
	3-6	AM	Fartlek run 30 min; Core Circuit (20 reps × 4)	75-80 %
		PM	4×200 m; 8×50 m; 2×100 m;	70-90 %
Phase 3 (Weeks 9–12)	1-4	AM	WT (60-65%, 1RM) 15–18 reps × 3 each variation	80-90 %
		PM	2×120 m; 3×90 m; 6×60 m, 6×40 m; Core Circuit, (25 reps × 5)	maximal

Phase	Day	Session	Key Exercises/Drills*	Intensity
	2-5	AM	20 min fast CR; Core Circuit, (25 reps × 5)	80-90 %
		PM	40 min Plyometrics; RR [{3× (40, 50, 60, 70 m with Sledge)} ×6]; BC	maximal
	3-6	AM	WT (60-65%, 1RM) 15–18 reps × 3 each variation	80-90 %
		PM	acceleration sprints: 6× (30,40,50,60) m, 3× (70,80) m; Core Circuit, (25 reps × 5)	maximal
Rest: Anaerobic activities = 30 sec./1 min; Aerobic activities = 2 – 3 min/5 – 7 min.				

Note: Day: 1-4 = Monday & Thursday, 2-3 = Tuesday and Friday. 3-6 = Wednesday & Saturday; AM = Morning; PM = Evening; CR = Continuous Run; Core Circuit = 5 abdominal + 5 back variations; m = Meter; WT = Weight Training (5 upper + 5 lower limbs Alternatively); RM = Repetition Maximum; RR = Resistance Run; SL = Speed Ladder; TR = Tempo Run; Reps = Repetitions; min = minutes; sec. = seconds; Rest = between repetitions/between sets; Anaerobic activities = Sprint, plyometric, strength training, etc.; Aerobic activities = ≥ 150 meters running.

Training sessions were conducted six days per week. Each training day included a morning session (approximately 90 minutes) and an evening session (approximately 120 minutes), incorporating warm-up, main training activities, and cool-down periods. The training schedule was designed to align with the preparation phase for the inter-university competition.

Outcome Measures and Data Collection Procedures

Pre- and post-intervention assessments were conducted to evaluate sprint performance and selected physical attributes. All tests were performed under standardised field or indoor conditions, following established protocols, and participants completed a standardised warm-up prior to testing.

100-m Sprint Test

Sprint performance was assessed using a 100-m sprint test conducted on a standard outdoor track. Participants performed maximal-effort sprints from starting blocks, and sprint time was recorded using manual timing. Two trials were performed, and the best time was used for analysis (Healy et al., 2022).

Vertical Jump Test (VJT)

Lower-limb explosive power was assessed using the vertical jump test. Participants performed maximal vertical jumps from a semi-squat position, and jump height was calculated as the difference between standing reach and maximal jump reach. Multiple trials were allowed, and the best performance was recorded (Zecirovic et al., 2021).

Standing Long Jump (SLJ)

Horizontal explosive power was measured using the standing long jump test. Participants performed a two-footed horizontal jump from a standing position, and jump distance was measured from the take-off line to the nearest landing point. The best of three trials was used for analysis (Porter et al., 2010).

20-m Sprint Test

Acceleration ability was assessed using a 20-m sprint test performed from a stationary start. Sprint time was manually recorded, and the best performance from the two trials was used for analysis (Kurtoğlu et al., 2024).

Illinois Agility Test (IAT)

Agility was evaluated using the Illinois Agility Test, conducted according to standardised procedures. Participants completed the test course at maximal speed, and performance time was recorded. The best of the two trials was used for analysis (Salimi & Ferguson-Pell, 2020). A detailed layout of the Illinois Agility Test (IAT) is presented in Figure 2.

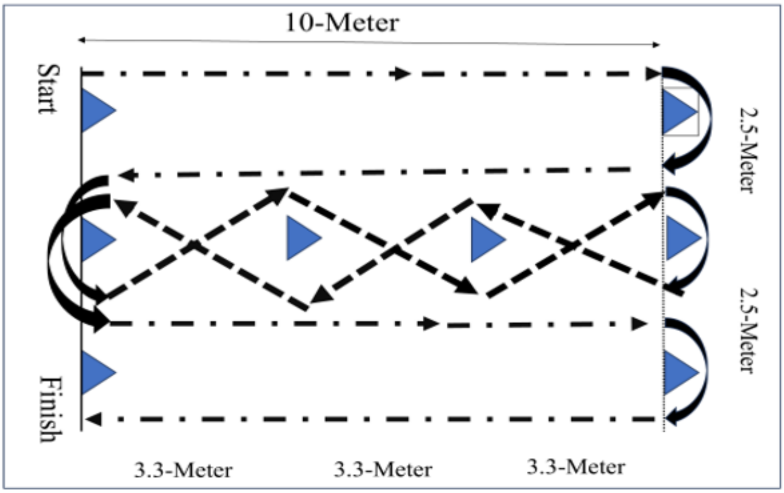

Fig. 2. Layout of Illinois Agility Test (IAT)

Manual timing was used for all sprint and agility tests; to reduce measurement variability, multiple timekeepers were employed, and median values were recorded.

Statistical Analysis

Data were analysed using jamovi statistical software (version 2.7.6). Descriptive statistics are presented as mean ± standard deviation. Baseline differences between groups were assessed using independent-sample t-tests.

Analysis of covariance (ANCOVA) was employed to examine post-intervention group differences while controlling for baseline values. Effect sizes were calculated to estimate the magnitude of between-group differences and were interpreted cautiously due to the sample size. Assumptions of normality and homogeneity of variance were checked prior to inferential analysis. Statistical significance was set at $p < 0.05$.

RESULTS

All participants in the experimental group completed the training programme, and no training-related injuries were reported.

Descriptive statistics (mean ± SD) for pre- and post-intervention physical performance variables for the experimental group (EG) and control group (CG) are presented in Table 3. The Shapiro–Wilk test indicated that all variables were normally distributed ($p > 0.05$), and Levene's test confirmed homogeneity of variance between groups ($p > 0.05$), supporting the assumptions required for ANCOVA.

Table 3. Physical performance characteristics (Mean ± SD) and Shapiro-Wilk of pre- and post-test scores for EG & CG and Levene's Test

Variables	Test	Mean ± SD		Shapiro-Wilk p		Levene's	
		EG (n=18)	CG (n=10)	EG (n=18)	CG (n=10)	F (df=1,26)	p (>0.05)
100-m Sprint (Sec)	Pre	12.00 ± 0.33	12.10 ± 0.38	0.50	0.98	1.18	0.29
	Post	11.80±0.30	12.10±0.37	0.91	0.19		
VJT (Cm)	Pre	58.8 ± 1.96	60.6 ± 2.25	0.30	0.19	0.14	0.71
	Post	63.9 ± 1.90	61.2 ± 2.58	0.30	0.19		
SLJ (Cm)	Pre	240.0 ± 3.42	240.0 ± 1.99	0.36	0.45	2.73	0.11
	Post	247.0 ± 4.32	241.0 ± 2.24	0.47	0.63		
20-m Sprint (Sec)	Pre	2.78 ± 0.04	2.81 ± 0.02	0.28	0.57	0.44	0.51
	Post	2.69 ± 0.02	2.78 ± 0.06	0.28	0.57		
IAT(Sec)	Pre	15.4 ± 0.27	15.6 ± 0.34	0.69	0.83	2.52	0.12
	Post	14.8 ± 0.32	15.5 ± 0.36	0.45	0.98		

Note: EG = Experimental Group; CG = Control Group; cm = centimetres; VJT = Vertical Jump Test; SLJ = Standing Long Jump; 20-Meter ST = 20-Meter Sprint Test; IAT = Illinois Agility Test.

After adjusting for baseline values, ANCOVA revealed statistically significant between-group differences in all measured performance variables (Table 4). For the 100-m sprint, a significant group effect was observed ($F(1,25) = 60.55$, $p < 0.01$, $\eta^2p = 0.71$), with the experimental group demonstrating lower adjusted post-test sprint times than the control group.

Significant group effects were also observed for vertical jump ($F(1,25) = 64.87$, $p < 0.01$, $\eta^2p = 0.72$) and standing long jump performance ($F(1,25) = 86.57$, $p < 0.01$, $\eta^2p = 0.78$), with higher adjusted post-test values in the experimental group. Similarly, acceleration (20-m sprint) and agility (Illinois Agility Test) showed significant between-group differences in favour of the experimental group ($p < 0.01$).

Effect sizes indicated substantial between-group differences across all variables (Table 4).

Table 4. Analysis of Covariance and Post Hoc Mean Comparison

Variables	F (1,25)	p	η^2p	Adjusted Post Test Mean ± SE		MD ± SE	t (25)	ptukey	Cohen's d
				EG	CG				
100-m Sprint (Sec)	60.55	<0.01*	0.71	11.80 ± 0.018	12.04 ± 0.024	-0.236 ± 0.030	-7.78	<0.01*	3.12
VJT (Cm)	64.87	<0.01*	0.72	64.46 ± 0.28	60.11 ± 0.39	4.351 ± 0.502	8.67	<0.01*	3.75
SLJ (Cm)	86.57	<0.01*	0.78	247.27 ± 0.43	241.93 ± 0.57	6.340 ± 0.713	8.90	<0.01*	3.52
20-m Sprint (Sec)	40.84	<0.01*	0.62	2.69 ± 0.008	2.78 ± 0.010	-0.091 ± 0.013	-6.82	<0.01*	2.84
IAT(Sec)	122.06	<0.01*	0.83	14.90 ± 0.028	15.42 ± 0.038	-0.525 ± 0.047	-11.05	<0.01*	4.46

Note: EG = Experimental Group; CG = Control Group; cm = centimetres; VJT = Vertical Jump Test; SLJ = Standing Long Jump; 20-Meter ST = 20-Meter Sprint Test; IAT = Illinois Agility Test; MD = Mean Difference; * = Significant difference; η^2p = Partial eta square.

DISCUSSION

The purpose of the present study was to examine the effects of a 12-week mixed module training programme (MMTP) on selected physical attributes and 100-m sprint performance in university-level sprinters. The main findings indicate that the experimental group showed significantly greater improvements in sprint performance, explosive power, acceleration, and agility than the control group, which continued regular physical activity. These results suggest that a structured mixed training approach may be effective in enhancing sprint-related performance characteristics in university-level athletes.

Sprint Performance

The significant improvement observed in 100-m sprint performance in the experimental group may be associated with the structured, progressive organisation of the MMTP (Nicholson et al., 2021; Hicks et al., 2022). The programme combined sprint-specific running with complementary strength, plyometric, and conditioning exercises, reflecting common coaching practice in sprint training (Loturco et al., 2017; Aloui et al., 2021; Oliver et al., 2024). Rather than targeting a single performance component, the MMTP aimed to develop multiple physical attributes concurrently, which may be advantageous in university-level settings where training time and preparation periods are often limited (Issurin, 2010; Cormie et al., 2011; Haugen et al., 2019).

The lack of meaningful improvement in the control group further underscores the potential importance of structured, periodised training exposure. Athletes who continued general physical activity without a systematic training framework did not demonstrate comparable gains in sprint performance over the 12 weeks.

These findings are consistent with previous research showing that structured combined training programmes can improve sprint performance, whereas regular physical activity without systematic organisation may yield little or no improvement (Pavlenko & Pavlenko, 2020; Liu et al., 2025).

Explosive Power

Improvements in vertical jump and standing long jump performance suggest enhanced lower-limb explosive capacity in the experimental group following the MMTP (Xu et al., 2025; Zhou et al., 2024; Muñoz et al., 2024). The inclusion of resistance training and plyometric exercises across all phases of the programme likely contributed to these improvements by exposing athletes to repeated high-force and high-velocity movements (Zhu et al., 2024; Petrušič, 2024; Mănescu, 2025). Previous research has reported similar benefits of combined strength and plyometric training on jump performance in athletic populations, supporting the present findings (Zhao et al., 2026; Luo et al., 2025; Martín-Moya et al., 2023).

It is important to note that the present study did not aim to isolate the effects of individual training components. Instead, the observed improvements likely reflect the cumulative effect of the integrated training approach employed throughout the intervention period.

Acceleration and Agility

Acceleration ability, as assessed by the 20-m sprint, and agility performance, measured using the Illinois Agility Test, also showed significant improvements in the experimental group. These attributes are influenced by a combination of sprint mechanics, coordination, and the ability to rapidly generate and apply force during short-duration movements (J. He et al., 2025; Bustamante-Garrido et al., 2023; Singh et al., 2025; Z. He et al., 2025).

The MMTP incorporated sprint drills, resisted runs, and change-of-direction activities, which may have contributed to improved acceleration and agility performance. From an applied perspective, these findings support the use of integrated training models that address multiple movement demands relevant to sprinting rather than relying on isolated training modalities (Aldrich et al., 2024; Sal-de-Rellán et al., 2024; Li et al., 2025; Aboulfaraj et al., 2025).

Participant Performance Level and Context

Although the absolute sprint times of the participants were lower than those typically reported for elite sprinters, the athletes involved in the present study were representative of university-level competitors within the studied context. At this level, structured and well-organised training programmes may produce noticeable performance improvements, particularly when compared with less systematic training exposure.

Therefore, the results should be interpreted relative to the competitive level and training background of the participants rather than against elite performance benchmarks. The findings remain relevant for university and developmental sport settings where athletes are still progressing toward higher levels of performance.

Interpretation of the Multi-Component Training Approach

The multi-component nature of the MMTP does not allow attribution of performance improvements to any single training element. Instead, the findings reflect the combined effect of an integrated training approach that balances sprint-specific work with strength, plyometric, and conditioning exercises. This characteristic aligns with real-world coaching practice, where training programmes are rarely limited to a single modality (Haugen et al., 2019; Weldon et al., 2022).

From a practical standpoint, the effectiveness of the MMTP appears to be related to its overall structure, progression, and consistency rather than to isolated training variables.

Limitations

Several limitations should be acknowledged. The study employed a quasi-experimental design, and group allocation was based on logistical constraints rather than random assignment. The sample size was relatively small, and performance measurements were conducted using manual timing under field conditions, which may introduce measurement variability. Additionally, the integrated nature of the training programme limits the ability to determine the specific contribution of individual training components.

Future research employing larger samples, randomised designs, and advanced measurement tools may help to further clarify the effects and underlying mechanisms of mixed training programmes in sprint athletes.

Practical Implications

The findings of this study provide practical insights for coaches and practitioners working with university-level sprinters, particularly in environments with limited time and resources. The MMTP offers a structured and adaptable framework that integrates multiple training components within a single programme and may be useful during competitive preparation phases.

Coaches may consider adopting similar mixed training approaches that balance sprint-specific running with strength, plyometric, and conditioning exercises to enhance overall sprint-related performance.

CONCLUSION

The present study examined the effects of a 12-week mixed module training programme on selected physical attributes and 100-m sprint performance in university-level sprinters. The findings indicate that athletes who participated in the MMTP demonstrated greater improvements in sprint performance, explosive power, acceleration, and agility compared with those who continued regular physical activity.

These results suggest that a structured and progressive mixed training approach can be effective in university-level sprint training contexts, particularly where time, resources, and preparation periods are limited. The integrated nature of the MMTP reflects practical coaching environments and supports the development of multiple performance-related attributes within a single training framework.

Although the study was limited by its quasi-experimental design, small sample size, and field-based measurement procedures, the findings provide useful applied insights for coaches and practitioners working with developmental and university-level sprinters. Future research employing larger samples, randomised designs, and more precise measurement techniques may further clarify the effectiveness and optimisation of mixed training programmes for sprint performance.

AUTHOR CONTRIBUTIONS

Ashoke Mukherjee and Swarup Mahato contributed to the conception and design of the study. Ashoke Mukherjee conducted data collection and analysis. Both authors contributed to the interpretation of results and the writing and revision of the manuscript. All authors have read and approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

ACKNOWLEDGEMENT

The authors would like to thank the athletes who voluntarily participated in this study.

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