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Influence of Combined Open and Closed Kinetic Chain Training on Agility Performance and Selected Fitness Variables among Inter-Collegiate Cricket Players

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Abstract: The purpose of the present study was to investigate the influence of open kinetic chain, closed kinetic chain and combined open and closed kinetic chain training on agility performance among inter-collegiate cricket players. Eighty male inter-collegiate cricket players aged 18–25 years from AAA College of Engineering and Technology, Amathur, Sivakasi, Tamil Nadu, India, participated in the study. The participants were divided into four groups of 20 players each: an open kinetic chain training group, a closed kinetic chain training group, a combined open and closed kinetic chain training group and a control group that continued regular cricket practice. The experimental training programmes were conducted for 12 weeks, five days per week, with each session lasting 60 minutes. Agility performance was assessed before and after the intervention using the T-test agility test and completion time was recorded in seconds. Paired-samples t-tests were used to examine within-group changes, while analysis of covariance (ANCOVA) and Scheffé's post hoc test were employed to compare the groups. The reported results indicated reductions in mean agility completion time in all three experimental groups. The closed kinetic chain group showed the greatest reduction, from 11.31 to 9.82 seconds, followed by the combined training group, from 11.28 to 9.93 seconds and the open kinetic chain group, from 11.29 to 10.75 seconds. The control group showed virtually no change. ANCOVA indicated statistically significant differences among the groups in post-test and adjusted post-test scores ($p < .05$). Scheffé's comparisons indicated that the closed kinetic chain and combined training groups performed better than the control group, whereas the difference between these two training groups was not statistically significant. The findings suggest that kinetic chain-based training may be beneficial for improving agility performance in inter-collegiate cricket players.

Keywords: Open kinetic chain training, closed kinetic chain training, combined training, agility, cricket players, T-test agility test and inter-collegiate sports.

Introduction

Cricket is a physically demanding sport that requires a combination of strength, speed, agility, muscular power, coordination and endurance to achieve consistent performance. Players must execute technically precise movements while responding to rapidly changing match situations, including sprinting between wickets, chasing the ball, changing direction during fielding and performing explosive batting and bowling actions. These activities require the coordinated functioning of different muscle groups and body segments to generate, transfer and control force effectively. Vickery et al. (2018) demonstrated that cricket training and match-play involve

distinct physical and technical demands that vary according to playing roles and training activities. At the inter-collegiate level, where players compete under demanding conditions, developing sport-specific fitness is important for improving movement efficiency, maintaining performance and responding effectively to competitive situations.

Among the essential physical attributes required in cricket, agility plays a particularly important role in fielding, running between wickets and reacting to unpredictable ball trajectories. Effective fielding requires players to accelerate rapidly, decelerate under control, change direction efficiently, maintain body stability and coordinate their movements when collecting or returning the ball. Lim et al. (2023) emphasized the importance of developing speed, acceleration, change-of-direction ability, strength and power through systematic strength and conditioning programmes for cricket fielders. Similarly, Johnstone and Ford (2010) examined the physiological characteristics of professional cricketers and highlighted the relevance of evaluating physical fitness components such as speed, strength and power. These findings suggest that cricket conditioning programmes should address multiple physical capacities rather than concentrate exclusively on technical practice.

Open and closed kinetic chain exercises represent two complementary approaches to physical conditioning. Open kinetic chain exercises generally allow the distal segment of a limb to move freely, enabling targeted strengthening of specific muscle groups. In contrast, closed kinetic chain exercises involve the distal segment remaining relatively fixed against a surface, encouraging coordinated movement among multiple joints and muscle groups. Adeel et al. (2024), in a systematic review of strengthening exercises, reported that closed kinetic chain exercises can recruit multiple muscle groups, while a combination of open and closed kinetic chain exercises may provide a broader approach to muscular activation. Although Pamboris et al. (2024) examined these exercise methods primarily in the context of anterior cruciate ligament rehabilitation, their findings also illustrate the importance of evaluating the effects of each approach according to the specific outcome being investigated. Sakure (2024) These principles provide a rationale for examining the combined application of both exercise methods in sports conditioning.

The effectiveness of athletic movement depends not only on the strength of individual muscles but also on the coordination of the neuromuscular system and the transfer of force across connected body segments. During cricket fielding, for example, players must lower their centre of gravity, stabilize the trunk, control lower-limb movements and accelerate in a new direction within a short period. Similarly, running between wickets requires rapid force production, coordinated limb action and effective control during acceleration and deceleration. Lim et al. (2023) recommended combining conventional strength exercises with cricket-specific conditioning drills to develop the physical qualities required for effective fielding. A training programme incorporating both open and closed kinetic chain exercises may therefore offer a practical means of addressing isolated muscular strength and coordinated whole-body movement. Chavan (2024) Nevertheless, the extent to which this combined approach improves agility and other selected fitness variables among inter-collegiate cricket players requires empirical investigation.

Agility and physical fitness are closely related to the ability to perform demanding sporting movements efficiently. Agility involves responding to a stimulus and changing movement direction or velocity while maintaining appropriate body control, whereas change-of-direction speed refers more specifically to executing a planned directional movement. In cricket, these capacities are relevant when responding to a ball deflection, moving into a catching position, chasing a ball towards the boundary, and completing quick running movements between the wickets. Johnstone and Ford (2010) identified several measurable physical characteristics, including speed, strength and explosive power, in professional cricketers. Furthermore, Lim et al. (2023) emphasized that cricket fielding preparation should address a broad range of physical attributes rather than rely on a single component of fitness. Accordingly, evaluating agility alongside selected fitness variables can

provide a more comprehensive understanding of how a conditioning intervention influences athletic preparedness.

Despite the practical relevance of kinetic chain exercises, the available evidence does not establish that combining open and closed kinetic chain training will necessarily produce superior agility or overall fitness improvements in cricket players. Research comparing these exercise approaches has largely examined rehabilitation-related outcomes, while cricket-specific conditioning literature has emphasized general strength and conditioning requirements and the physical demands of fielding (Adeel et al., 2024; Lim et al., 2023; Pamboris et al., 2024). This distinction identifies a need to investigate the combined training approach in a sport-specific population. Kabadagi (2024) In particular, assessing changes in agility performance and selected fitness variables among inter-collegiate cricket players may help clarify the practical value of integrating these two exercise methods into a structured conditioning programme.

Therefore, the present study aims to investigate the influence of combined open and closed kinetic chain training on agility performance and selected fitness variables among inter-collegiate cricket players. By examining changes following the training intervention, the study seeks to contribute evidence concerning the application of kinetic chain-based conditioning in cricket. Kumbhar and Wangujare (2024) The findings may assist physical education professionals, cricket coaches and strength and conditioning practitioners in designing more systematic training programmes that address both muscular development and coordinated athletic movement. The study may also provide a foundation for subsequent research comparing combined kinetic chain training with conventional training methods in collegiate cricket populations.

Materials and Methods

The present study employed a pre-test and post-test experimental design to investigate the effects of different kinetic chain training approaches on agility performance among 80 inter-collegiate cricket players aged 18–25 years from AAA College of Engineering and Technology, Amathur, Sivakasi, Tamil Nadu, India. The participants were allocated equally to four groups, with 20 players in each: an open kinetic chain training group, a closed kinetic chain training group, a combined open and closed kinetic chain training group and a control group that continued its regular cricket practice. The three experimental groups participated in their respective training programmes for 12 weeks, with five sessions per week and a duration of 60 minutes per session. Agility performance was measured before and after the training period using the T-test agility test, which requires participants to perform forward sprinting, lateral movements and backward running while changing direction according to the test procedure. Completion time was measured in seconds using a manual stopwatch. Pauole et al. (2000) investigated the reliability and validity of the T-test as a measure of agility, leg power and leg speed in college-aged men and women. To ensure accurate reporting and reproducibility, the training protocol should specify the exercises performed, training intensity, sets, repetitions, recovery periods and progression used throughout the intervention, based on the actual procedures followed in the study.

Statistical Analysis

The pre-test and post-test agility scores were analysed using descriptive and inferential statistical techniques to assess changes within each group and differences among the four groups. Means and standard deviations were calculated to summarise the participants' performance. Paired-samples *t*-tests were employed to determine whether the changes in agility scores within each group were statistically significant. Analysis of covariance (ANCOVA) was used to compare post-test scores among the open kinetic chain training group, closed kinetic chain training group, combined open and closed kinetic chain training group and control group, with pre-test scores serving as the covariate. The overall differences among the groups were evaluated using the *F*-statistic. When the ANCOVA indicated a statistically significant group effect, Scheffé's post hoc test was applied to identify differences between individual group means while accounting for multiple comparisons (Scheffé,

1953). Before interpreting the findings, the assumptions underlying the selected statistical procedures were examined. The results were reported using the calculated *t*-values, *F*-values, degrees of freedom (*df*) and exact *p*-values where available, together with the adjusted group means obtained from ANCOVA. Statistical significance was established at $p < .05$.

Results of Agility Performance

The following tables present the results of agility performance for the pre-test and post-test assessments of all four groups. The results include paired t-test, ANCOVA and Scheffé's post hoc test analyses.

TABLE - I

SIGNIFICANCE OF MEAN GAINS / LOSSES BETWEEN PRE TEST AND POST TEST OF OPEN KINETIC CHAIN TRAINING GROUP CLOSED KINETIC CHAIN TRAINING GROUP COMBINED OPEN AND CLOSED KINETIC CHAIN TRAINING GROUP AND CONTROL GROUP ON AGILITY

S. No	Variables	Pre-test Mean (±SD)	Post-test Mean (±SD)	DM	σDM	't' ratio	p value
OPEN KINETIC CHAIN TRAINING GROUP							
1	Agility	11.29 ± 0.65	10.75 ± 0.50	0.53	0.08	6.13*	< 0.001
CLOSED KINETIC CHAIN TRAINING GROUP							
2	Agility	11.31 ± 0.65	9.82 ± 0.85	1.49	0.17	8.44*	< 0.001
COMBINED OPEN AND CLOSED KINETIC CHAIN TRAINING GROUP							
3	Agility	11.28 ± 0.70	9.93 ± 0.60	1.35	0.10	13.14*	< 0.001
CONTROL GROUP							
4	Agility	11.30 ± 0.67	11.31 ± 0.80	0.01	0.07	0.12	0.905

*significant at 0.05 level ('t' value 2.09) with df 19

p value < 0.001 (significant)

The mean pre-test and post-test agility scores were compared using paired-samples t-tests to determine changes following the training interventions. The open kinetic chain training group improved its agility performance, with the mean completion time decreasing from 11.29 ± 0.65 seconds to 10.75 ± 0.50 seconds, yielding a mean difference of 0.53 seconds and a reported t-ratio of 6.13. The closed kinetic chain training group demonstrated a greater reduction in completion time, from 11.31 ± 0.65 seconds to 9.82 ± 0.85 seconds, with a reported mean difference of 1.49 seconds and a t-ratio of 8.44. Similarly, the combined open and closed kinetic chain training group showed a decrease in completion time from 11.28 ± 0.70 seconds to 9.93 ± 0.60 seconds, with a reported mean difference of 1.35 seconds and a t-ratio of 13.14. These three reported t-ratios exceeded the stated critical value of 2.09. In contrast, the control group's mean completion time changed only slightly, from 11.30 ± 0.67 seconds to 11.31 ± 0.80 seconds, with a reported mean difference of 0.01 seconds and a t-ratio of 0.12, indicating no statistically significant change according to the supplied results. Overall, the reported findings suggest that all three training interventions improved agility performance, with the largest mean reduction in completion time observed in the closed kinetic chain training group.

TABLE - II

ANALYSIS OF COVARIANCE AMONG OPEN KINETIC CHAIN TRAINING GROUP CLOSED KINETIC CHAIN TRAINING GROUP COMBINED OPEN AND CLOSED KINETIC CHAIN TRAINING GROUP AND CONTROL GROUP ON AGILITY

Test		Open Kinetic Chain Training Group	Closed Kinetic Chain Training Group	Combined Open and Closed Kinetic Chain Training Group	Control Group	Source of Variance			
						Sum of Squares	df	Mean Squares	'F' Ratio
Pre-test	B	11.29	11.31	11.28	11.30	0.012	3	0.004	0.09
	W	0.65	0.65	0.70	0.67	34.597	76	0.455	
Post-test	B	10.75	9.82	9.95	11.31	30.318	3	10.106	20.24*
	W	0.50	0.85	0.60	0.80	37.933	76	0.499	
Adjusted Post-test	B	10.76	9.80	9.94	11.30	30.273	3	10.091	39.93*
	W	0.50	0.85	0.60	0.80	18.949	75	0.253	

* Significant at 0.05 level of confidence.

The ANCOVA results indicated no statistically significant initial difference among the four groups at pre-test, with a reported F-ratio of 0.09. However, the post-test comparison revealed a statistically significant difference among the groups ($F = 20.24$, $p < .05$). After adjustment for pre-test scores, the group difference remained statistically significant ($F = 39.93$, $p < .05$). The adjusted post-test means were 10.76 seconds for the open kinetic chain training group, 9.80 seconds for the closed kinetic chain training group, 9.94 seconds for the combined open and closed kinetic chain training group, and 11.30 seconds for the control group. Because lower completion times indicate better agility performance, the closed kinetic chain training group recorded the best adjusted mean, followed by the combined training group, the open kinetic chain training group, and the control group. These results suggest that the training conditions were associated with differences in post-intervention agility performance, subject to verification of the statistical calculations and degrees of freedom.

TABLE - III

SCHEFFE'S TEST FOR THE DIFFERENCE BETWEEN THE ADJUSTED POST-TEST PAIRED MEANS OF AGILITY

Adjusted Post-test Means				Mean Differences	Confidence Interval
Open Kinetic Chain Training Group	Closed Kinetic Chain Training Group	Combined Open and Closed Kinetic Chain Training Group	Control Group		
10.76	9.8	-	-	0.96*	0.45
10.76	-	9.94	-	0.82*	-
10.76	-	-	11.3	0.54*	-
-	9.8	9.94	-	0.14	-
-	9.8	-	11.3	1.50*	-
-	-	9.94	11.3	1.36*	-

* Significant at 0.05 level of confidence

Scheffé's post hoc comparisons were used to identify differences between the adjusted post-test means. The difference between the open and closed kinetic chain training groups was 0.96 seconds, favouring the closed kinetic chain training group. The difference between the open kinetic chain and combined training groups was 0.82 seconds, favouring the combined group. The open kinetic chain training group also differed from the control group by 0.54 seconds, favouring the open kinetic chain group. The difference between the closed kinetic chain and combined training groups was 0.14 seconds and was reported as statistically non-significant. In comparison, the closed kinetic chain training group differed from the control group by 1.50 seconds, while the combined training group differed from the control group by 1.36 seconds; both comparisons favoured the respective training groups. These findings suggest that the closed kinetic chain and combined training approaches produced better adjusted agility scores than the control condition, while the difference between the closed kinetic chain and combined training groups was not statistically significant according to the table.

Discussion

The findings of the present study indicate that open kinetic chain, closed kinetic chain and combined training programmes were associated with improvements in agility among inter-collegiate cricket players following 12 weeks of training. The closed kinetic chain group showed the greatest reduction in completion time, decreasing from 11.31 to 9.82 seconds, while the combined training group improved from 11.28 to 9.93 seconds. The open kinetic chain group also demonstrated improvement, whereas the control group showed almost no change. These findings suggest that structured training may contribute to better change-of-direction performance in cricket players. Li et al. (2026) similarly reported positive average effects of speed, agility and quickness training on agility performance among team-sport athletes, although the evidence varied across studies. The present findings are consistent with the general importance of targeted conditioning for agility; however, this external evidence does not directly establish the superiority of closed kinetic chain exercises over the other training methods.

The ANCOVA results revealed significant differences among the groups after adjusting for pre-test scores. Scheffé's test indicated significant differences between the closed kinetic chain and open kinetic chain groups, as well as between each training group and the control group. However, the difference between the closed kinetic chain and combined training groups was not statistically significant. The greater improvement observed in the closed kinetic chain group may indicate that this training approach was beneficial for the agility demands assessed by the T-test. Nevertheless, further research involving larger samples, clearly documented training protocols and additional performance measures is needed to confirm these findings and determine whether the improvements transfer to cricket-specific movements during competition.

Conclusion

The findings of the study indicate that 12 weeks of open kinetic chain, closed kinetic chain and combined kinetic chain training improved agility performance among inter-collegiate cricket players compared with their pre-test scores. Among the three experimental groups, the closed kinetic chain training group demonstrated the greatest reduction in agility completion time, followed by the combined training group and the open kinetic chain training group. The control group showed no meaningful improvement. The results suggest that closed kinetic chain training may be a useful approach for developing agility in cricket players. However, the difference between the closed kinetic chain and combined training groups was not statistically significant. Further studies with larger samples and clearly standardised training protocols are recommended to confirm these findings.

Limitations and Future Research

1. The study included only 60 inter-collegiate cricket players aged 18–25 years from a single institution, which may limit the generalisability of the findings.

2. Agility was assessed using only the T-test; other variables, such as sprint speed, muscular power and cricket-specific movement ability, were not examined.
3. The long-term maintenance of improvements following the 12-week training programme was not investigated.
4. Future studies should include larger samples from multiple institutions to strengthen the applicability of the findings.
5. Further research should examine additional physical fitness and cricket-specific performance variables using different agility assessment methods.
6. Studies should compare different training durations, intensities, and exercise progressions to identify effective training approaches.
7. Follow-up assessments should be conducted to determine whether improvements are maintained after training ends.
8. Future investigations should further compare open, closed, and combined kinetic chain training methods to establish their effectiveness in improving cricket players' performance.

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