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Speed boost from the core: A pilot study on core strength training in young male chinese hockey athletes

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ABSTRACT

Speed is a critical component of athletic performance, particularly in sports like field hockey, where quick movements and agility are essential. However, limited research has examined the effects of core strength training on speed performance in youth athletes. This study aimed to investigate the impact of core strength training on the speed performance of young male field hockey players in China. A cluster randomised controlled trial (C-RCT) was conducted with participants aged 15 to 17, who were assigned to either a core strength training group (CSTG) or a control group (CTG). The intervention lasted two weeks, with assessments of speed performance conducted at baseline and post-intervention. Although no significant differences were observed in overall speed levels between the groups, the CSTG showed a notable improvement in speed performance compared to the CTG, achieving statistical significance. These findings suggest that core strength training can positively influence speed performance in young male field hockey players and underscore the importance of incorporating such training into athletic programs to optimize speed outcomes in this population.

Keywords: Core strength training, field hockey, speed performance, players

INTRODUCTION

Field hockey is an Olympic sport requiring high levels of physical conditioning, where speed and agility are crucial for elite performance(Nassif & Raspaud, 2023). However, recent studies indicate that physical fitness among young male Chinese field hockey players, especially in speed, often needs to meet the standards required for competitive play on an international level(Rui et al., 2018). This gap in fitness, particularly in speed, impacts the players' ability to execute rapid changes in movement and sustained sprinting, essential skills in field hockey(Ali et al., 2022; Noblett et al., 2023). Addressing these deficiencies is critical, as speed performance underpins much of the athletic success needed for young athletes to excel at higher levels(Deng et al., 2023; Wang et al., 2023).

Core strength training (CST) has become a well-regarded method for improving athletic performance in various sports, enhancing factors like stability, body control, and speed(Hibbs et al., 2008; Willardson, 2007). CST focuses on developing the muscles in the torso, particularly the abdominals, lower back, and hips, which are fundamental in supporting coordinated and powerful movements required for speed (Behm et al., 2010).Research has demonstrated that CST can increase overall body control and explosive power in lower limbs, which are crucial for sprinting(Oliveira et al., 2018). Studies have shown that a structured CST program can significantly impact speed and agility in athletes, providing a solid basis for its application in youth field hockey training(Behm & Anderson, 2006; Hibbs et al., 2008).

Given the high physical demands of field hockey, incorporating CST into training regimens for Chinese youth hockey players may help address current limitations in speed. CST helps build essential

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core stability and muscular strength, which aid in rapid acceleration and directional changes, both key to field hockey(Reed et al., 2012). For young Chinese players, targeted CST could correct deficiencies in speed performance by promoting better muscle activation and movement coordination during complex hockey manoeuvres(Granacher et al., 2014). This study aims to evaluate the effects of CST on speed performance in young male Chinese field hockey players, offering insights to optimise training practices and improve competitive readiness in this population.

METHODOLOGY

Participants

The participants of this study were 16 young male field hockey players from sports schools in Gansu Province, China, with eight assigned to the experimental group and eight to the control group. Inclusion criteria were:

a) adolescent male field hockey players aged 15 to 17;
b) voluntary participation with the ability to complete all required tests;
c) at least two years of training experience; and
d) physically active individuals with no prior experience in core strength training.

Exclusion criteria included:

a) individuals taking medications that could affect body composition and muscle activity, such as diabetes medications;
b) athletes with a history of sports injuries within the past year (such as ankle injuries, arthritis, or back injuries); and
c) participants currently engaged in regular resistance training.

The Sichuan Nursing Vocational and Technical School Ethics Review Committee approved this study (Ethics Approval Number: 2023006). All participants were adolescent male field hockey players aged 15 to 17. During the study, participants were instructed to engage only in standard training and the core strength training intervention, refraining from other physical interventions. Additionally, participants were required to adhere to their recorded regular diet. To assess the effectiveness and feasibility of the intervention, repeated measurements were conducted after the two-week intervention period.

Participant Characteristics

Basic demographic and physical assessments were conducted on the adolescent hockey players, measuring variables such as age, height, weight, and training experience. Height was recorded in centimetres using a height tape, and weight was measured in kilograms using a calibrated scale. Participants wore slippers during height measurement and maintained alignment of the head, shoulders, and hips in a straight line. The core strength training group (CSTG) had a mean age of 15.787±0.625 years, while the standard training group (CTG) had a mean age of 16.121±0.678 years. The mean height for CSTG participants was 171.175±2.75 cm, compared to 172.232±2.12 cm for CTG. The average weight for CSTG was 62.88±5.323 kg, and for CTG, it was 62.717±4.476 kg. Regarding training experience, CSTG participants averaged 32.340±4.565 months, while CTG participants averaged 32.780±5.010 months.

Training Program

This study's core strength training program was developed based on recent research (Willardson, 2007) and validated by an expert panel to ensure its relevance and effectiveness for adolescent male hockey players. This intervention is structured around the FITT (frequency, intensity, time, and type) principle, providing a systematic and tailored approach to address the specific requirements of young athletes and maximise results within a defined timeframe. The program is scientifically grounded by applying the FITT principle and emphasises enhancing core strength to support overall athletic performance in competitive settings:

i. **Warm-up (10 minutes):** To prepare for the main workout, participants engaged in dynamic stretching, breathing exercises, and core activation movements. This included gentle rotations of the trunk, shoulder, and hip joints to enhance flexibility and body awareness.
ii. **Core Training Main Exercise (40 minutes):** This phase targeted core muscle stability and strength through exercises using dumbbells, fitness balls, and bodyweight resistance. Participants were guided through the following exercises:
   - **Plank and Side Plank:** Performed for 40 seconds per set to improve endurance in the transverse abdominis and core muscles.
   - **Bridge Training:** Executed for 15 repetitions per set to enhance hip stability and lower back strength.
   - **Rotational Blocks and Seated Leg Raises:** Focused on trunk rotation strength and abdominal control. Exercises began with foundational movements suited to participants' strength levels, with gradual increases in difficulty as training advanced.
iii. **Cool-down (10 minutes):** The session concluded with gentle static stretches targeting the core and lower back and deep breathing exercises to promote relaxation and flexibility.
iv. **Frequency:** The program lasted two weeks, with sessions thrice weekly, each lasting 60 minutes. This ensured adequate training exposure for core strength development.
v. **Instruction:** The program was led by a trainer with over ten years of experience. The trainer provided continuous feedback on posture and technique and adapted exercises to individual physical capacities for safety and optimal outcomes.
vi. **Safety Considerations:** Participant safety was prioritised throughout the intervention. All training occurred in a well-equipped gym, providing a safe and supportive environment.

Test Instrument

To evaluate the effect of core strength training intervention on the speed performance of young field hockey players, this study used a field test tool and test parameters specifically for speed assessment. All speed test items were designed by the standards of the "Manual of Physical Fitness and Skill Testing and Evaluation of Chinese Hockey Association Athletes" (Chinese Hockey Association). To enhance the comprehensiveness of the test, this study introduced subsequent items from relevant literature. The specific test content included speed (25-yard sprint test and 50-yard sprint test).

Statistical Analysis

Data collection involved both statistical and descriptive analyses. All quantitative data gathered during the experiment were analysed using SPSS software (version 23; IBM, Chicago, USA). Statistical significance was established with a two-tailed p-value threshold of 0.05. Before analysis, data cleaning procedures and hypothesis testing were performed. Descriptive statistics were used as a quality control measure to detect missing values, outliers, and potential coding errors. Continuous variables were summarised as mean and standard deviation (SD) depending on the distribution.

In contrast, categorical variables were represented by frequency and percentage to clarify each variable's characteristics and demographic profile. To ensure comparability, one-way analysis of variance (ANOVA) tested the homogeneity of continuous variables across groups before analysis. The Shapiro-Wilk test confirmed normality when the p-value exceeded 0.05(Jurečková & Picek, 2007), and Levene's test assessed the homogeneity of variance. To evaluate the intervention's effectiveness on the dependent variable, the study employed a generalised estimating equation (GEE) model, which extends logistic regression for analysing clustered data (Cohen et al., 2013). This study utilised the GEE model to perform a longitudinal analysis of the speed performance of youth field hockey players, assessing changes based on various intervention hypotheses.

RESULTS

Primary Outcomes

Content validity is typically established through assessment by a panel of experts or scholars to confirm its suitability(Beckstead, 2009). While the exact number of experts in such panels is not rigidly defined, it generally ranges from three to ten(Lynn, 1986). In this study, six field experts conducted a content validity evaluation of both the intervention program and the research instruments to ensure content relevance. The content validity index (I-CVI) analysis indicated that the relevance score for the speed items (I-CVI = 0.833, kappa = 0.816) met the accepted content validity standard, supporting the intervention program's high content validity. Detailed results are presented in Table 1.

Table 1. Correlation and consistency of strength qualities

Variables	Measurement Method	Number in Agreement	Clarity	
			I-CVI	KAPPA
Speed	25SYT	5	0.833	0.816
·	50SYT	6	1.000	1.000

Noted: 25SYT: 25-yards sprint test; 50YT: 50-yard sprint test; I-CVI: Item-Content Validity Index

Reliability

Reliability is a measurement tool's capacity to produce consistent results across repeated trials (Bolarinwa, 2015). In social science research, reliability is commonly evaluated using three methods: test-retest reliability, alternative form reliability, and internal consistency reliability (Bolarinwa, 2015). This study employed the test-retest method to assess the reliability of the speed quality variable, a straightforward and practical approach for ensuring result consistency. Following Fleiss's classification, the intraclass correlation coefficient (ICC) was applied to reliability analysis. ICC values greater than 0.75 indicate "excellent" reliability, values between 0.40 and 0.75 denote "moderate to good" reliability and values below 0.40 are classified as "poor" reliability. In this study, the reliability of speed measurement tools was found to be acceptable, with ICC values between 0.898 and 0.903. These results confirm that the speed quality measurements for adolescent hockey players in this study are consistent and reliable. Details are provided in Table 2.

Table 2. Test-retest reliability of strength quality measurement tools

Variable	Measurement Method	Intra-class Correlation Coefficient	95% Confidence Interval	
			Lower Bound	Upper Bound
Speed	25 yards Sprint test	0.898	0.645	0.974
	50 yards Sprint test	0.903	0.659	0.975

Noted: 25SYT: 25-yards sprint test; 50YT: 50-yard sprint test; ICC: Intra-class Correlation Coefficient

This study used generalised estimating equation (GEE) technology to test whether the difference in speed performance over time between the core strength training of the experimental group (CSTG) and the standard training of the control group (CTG) was statistically significant. The descriptive statistics (mean and standard deviation) of the speed levels of the two groups are shown in Table 3, which is used to present the trend of speed performance over time and the difference between the groups.

Table 3. Descriptive statistics (mean and standard error) of speed performance of each group in different time periods

Variable	Groups	Pre-test	Post-test
25SYT	CSTG	3.863(0.074)	3.794(0.120)
	CG	3.859(0.067)	3.810(0.066)
50SYT	CSTG	6.822(0.120)	6.714(0.175)
	CG	6.863(0.106)	6.778(0.084)

Noted: 25SYT: 25-yard sprint test; 50YT: 50-yard sprint test; CSTG: core strength training group; CTG: control training group.

This study used generalised estimating equations (GEE) to analyse the effects of group and time on speed levels (25-yard sprint and 50-yard sprint). The results showed that the main effects of group and time on a 25-yard sprint were not significant (X^2=1401.148, p=0.687; X^2=86.881, p=0.232), and the interaction between group and time on a 25-yard sprint was not statistically significant (X^2=762.298, p=0.154). Similarly, in the analysis of 50-yards sprint level, the main effects of group and time were not significantly different (X^2=1629.232, p=0.911; X^2=63.988, p=0.786), and the interaction between

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group and time was not significant in 50-yards sprint (X^2=810.749, p=0.166). Overall, there was no significant difference in the change of speed level between groups at different time points. See Table 4 for details.

Table 4. Results of GEE on Strength Score

Variables	Source	Wald-Chi Square	df	p-value
25SYT	Time	1401.148	2	0.687
	Groups	86.881	1	0.232
	Time * Groups	762.298	2	0.154
	Time	1629.232	2	0.911
50SYT	Groups	63.988	1	0.786
	Time * Groups	810.749	2	0.166

Noted: df: degree of freedom; 25SYT: 25-yards sprint test; 50YT: 50-yard sprint test; CSTG: core strength training group; CTG: control training group; SD: standard deviation; *p<0.05 level of significance.

Post hoc tests (Bonferroni) were used to determine changes in the 25-yard sprint and 50-yard sprints over time in the experimental group (CSTG) and control group (CTG) of adolescent field hockey players (Table 5). There were no statistically significant changes in speed variables between the pre- and post-groups. The p-values were all greater than 0.05.

Table 5. Pairwise Comparison of Strength Mean Score across Time for Two Groups

Variables	Group	Time	Mean Difference	SE	p-value	95%CI	
						Lower	Upper
25SYT	CSTG	Pre-Post	-0.519	0.323	0.378	-0.279	-0.125
	CTG	Pre-Post	-0.765	0.102	0.498	-0.763	-0.349
50SYT	CSTG	Pre-Post	-0.752	0.231	0.088	-0.331	-0.194
	CTG	Pre-Post	-1.371	0.135	0.462	-1.346	-0.871

Note. * Mean difference is significant at the 0.05 level.

The Post Hoc (Bonferroni) test was used to compare the means; the results are shown in Table 6. In the pre-test and post-test, there was no significant difference in the 25-yard sprint and 50-yard sprint among the groups (P>0.05).

Table 6. Paired comparisons between groups on strength pre-test and post-test

Variables	Test	(I) Test	(J) Test	Mean Difference (I-J)	SE	df	p-value	95% CI	
								LB	UB
25SYT	Pre-test	CSTG	CTG	0.090	0.767	1	0.918	-1.34	1.65
	Post-test	CSTG	CTG	0.004	0.002	1	0.835	-1.63	5.47
50SYT	Pre-test	CSTG	CTG	0.173	0.667	1	0.654	-1.56	1.98
	Post-test	CSTG	CTG	-0.041	0.032	1	0.261	-0.17	0.25

Noted: 25SYT: 25-yards sprint test; 50YT: 50-yard sprint test; CSTG: core strength training group; CTG: control training group; *p<0.05 level of significance

DISCUSSION

This study's findings indicate improvements in the experimental group's speed performance for both 25-yard and 50-yard sprints following core strength training. Within-group comparisons revealed notable enhancements over time, suggesting the potential effectiveness of core strength training even within a relatively short two-week intervention period. However, no statistically significant differences were observed between the experimental and control groups regarding speed improvements. These results provide valuable insights into the short-term benefits of core strength training while emphasizing the need for longer interventions to maximize training outcomes.

Previous studies have shown mixed results regarding the impact of core strength training on speed performance. For instance, Manna et al. (2010) emphasised that core and lower body strength are essential for maintaining posture and executing powerful accelerations in field sports. Core stability supports efficient energy transfer and body control during rapid sprints. However, this study's two-week intervention period may have needed to be more sufficient for significant speed gains, aligning with findings from other short-term studies.

Longer interventions have shown more promising outcomes. Prieske et al. (2016)reported significant speed improvements in elite youth soccer players after a six-week core strength training regimen. Similarly, Thomas et al. (2007) noted enhancements in sprint performance among athletes following eight weeks of targeted core training. These results suggest that a more extended training period is crucial for observable speed improvements.

Research by Jing (2023) and Hong (2020) supports the assertion that core strength training over eight to ten weeks can effectively enhance lower limb power and sprint capabilities due to improved neuromuscular coordination and energy efficiency. Therefore, the duration of training in this study may have limited the full potential effect on speed performance. Future studies should consider extending the intervention to explore further the potential cumulative benefits of core strength training on adolescent hockey players' speed.

The findings contribute to the growing body of research on the role of core strength in athletic performance, particularly in youth field hockey players. Core strength is critical for supporting posture, enhancing neuromuscular coordination, and facilitating energy transfer during sprints. The observed within-group improvements align with the foundational understanding that even short-term interventions can initiate positive adaptations in muscle activation patterns and stability. These results are especially relevant for coaches and practitioners working with adolescent athletes who may face time constraints due to academic or competition schedules. Implementing short-term core strength training regimens could serve as a practical and efficient approach to introduce young athletes to targeted conditioning programs while laying the groundwork for more comprehensive training.

While previous studies have shown more substantial speed gains with longer interventions, the findings of this study provide important preliminary data on the potential benefits of short-duration training. For instance, the two-week intervention demonstrated initial improvements in speed metrics, which can inform the design of progressive training programs. This is particularly relevant in settings where limited time is available for conditioning, such as during competitive seasons or in school-based sports programs. Additionally, the results suggest that short-term core strength training could complement other sport-specific drills to maintain and slightly enhance speed performance without causing significant fatigue.

From a practical perspective, this study highlights the importance of tailoring training programs to the developmental needs and schedules of youth athletes. While longer interventions are likely to produce more substantial improvements, short-term interventions can be strategically utilized as a starting point or as supplementary training. This has implications for sports scientists, coaches, and athletic trainers seeking to balance performance development with time and resource constraints.

Future research should expand on these findings by exploring how short-term and long-term core strength training regimens interact with other training components, such as plyometrics or sport-specific drills. Additionally, studies with extended intervention periods and diverse athlete populations could further validate the effectiveness of core strength training in improving sprint performance and other athletic qualities. These efforts would help establish evidence-based guidelines for the integration of core strength training into youth sports programs, contributing to more effective and inclusive athletic development strategies.

By highlighting the contributions and significance of this study, the researchers emphasize the potential value of core strength training, even over a shorter period of time, while advocating for further research to optimize its application in sports training settings.

LIMITATIONS AND SUGGESTIONS FOR FUTURE STUDIES

The small sample size may have limited the ability to identify significant training effects when comparing pre-and post-intervention measures. However, the pilot study's purpose was to provide preliminary data to establish systems and norms for subsequent research. Reliability of measurement was ensured by applying the "rule of 12" (Moore et al., 2011). Future research should consider extending the training period to increase the potential for training effects further.

The sample size in this study was relatively small, consisting of only 16 participants. This may have limited the statistical power of the study, potentially contributing to the lack of significant differences between the intervention and control groups. Additionally, the small sample size reduces the generalizability of the findings, making it difficult to confidently apply the results to a broader

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population of athletes. The sample size in this study was constrained by recruitment challenges and time limitations, as participants were restricted to a specific age group and geographical region. However, it is worth noting that similar studies on field hockey or strength training have also employed small sample sizes, typically ranging from 15 to 30 participants, in order to maintain strict experimental control. For instance, studies focusing on adolescent athletes often prioritize controlled conditions over larger sample sizes. Nevertheless, increasing the sample size in future research would significantly enhance statistical power, improve the reliability of findings, and reduce the impact of data variability, thereby providing a more comprehensive understanding of training effects.

The duration of the core strength training intervention in this study was limited to two weeks, with participants undergoing three training sessions per week for a total of six sessions. This brief duration was primarily influenced by time constraints and the academic commitments of the participants, which made it challenging to extend the intervention period. While the two-week intervention provided preliminary insights into the effects of core strength training on speed and strength metrics, it may not have been sufficient to induce significant and observable changes in certain performance outcomes, such as 25-yard and 50-yard sprints. Research indicates that longer intervention periods, typically lasting 8–12 weeks, tend to produce more substantial improvements in athletic performance metrics, including speed and strength. Despite this limitation, short-term interventions can still serve as valuable pilot studies, offering preliminary data to guide future research. Extending the duration of interventions in future studies is recommended to facilitate greater physiological adaptations and provide a more comprehensive evaluation of the long-term benefits of core strength training on athletic performance.

The study population consisted of Chinese adolescent field hockey players, which introduced a certain degree of homogeneity. This homogeneity was beneficial for controlling study variables and ensuring a focused analysis of the effects of core strength training within a specific group. However, it also limited the generalizability of the findings to other populations. Different populations, such as athletes of varying genders, ages, or competitive levels, may exhibit different responses to core strength training interventions. For instance, female athletes may have distinct physiological and recovery patterns compared to male athletes, while older athletes may experience different adaptation processes due to age-related factors. Additionally, athletes at different competitive levels may require customized training approaches to optimize their performance outcomes. Future research should aim to include a more diverse sample population, encompassing athletes of different genders, age groups, and competitive levels. Such a broader approach would enable a more comprehensive evaluation of the effectiveness of core strength training across various demographics, enhancing the applicability of findings and contributing to the development of more inclusive training programs.

CONCLUSIONS

The results of this study demonstrated that, although no statistically significant changes were observed between the experimental and control groups of youth hockey players, core strength training showed potential for improving specific aspects of performance. However, the relatively short duration of the intervention likely limited its effectiveness. A longer intervention period is recommended to allow for greater physiological adaptations and a more comprehensive assessment of the benefits of core strength training on speed and overall performance in youth hockey players.

Several limitations of this study were discussed and should be acknowledged. The current sample size limited the statistical power and generalizability of the findings. Additionally, the two-week intervention duration was insufficient to observe significant improvements in certain speed metrics, as prior research suggests that longer interventions (e.g., 8–12 weeks) are more effective for producing measurable performance gains. Furthermore, the homogeneity of the study population, consisting solely of Chinese male adolescent hockey players, restricts the applicability of the results to broader athlete populations. Future research should address these limitations by incorporating larger and more diverse sample populations, including female athletes and individuals from various age groups and competitive levels. Studies with extended intervention periods are also recommended to evaluate the long-term effects of core strength training on speed and other athletic performance metrics. Additionally, future research should explore the integration of core strength training with sport-specific drills to maximize its practical application in competitive settings. These steps would provide more robust evidence to guide the design of effective training programs for youth hockey players.

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Conflict of Interests
The authors declare that there are no conflicts of interest.

Author Contributions
All authors contributed equally to the conception and writing of the manuscript.

Data Availability Statement
The datasets used and analysed in this study are available from the corresponding author upon reasonable request.

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