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The Role of Foot-Eye Coordination and Leg Muscle Strength in Football Shooting Performance: A Correlational Analysis Among Youth Athletes

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A B S T R A C T

The purpose of the study. This study aimed to investigate the relationship between foot-eye coordination, leg muscle strength, and football shooting accuracy among youth football players, and to determine which factor contributes more significantly to shooting performance.

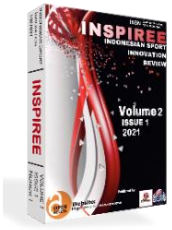
Materials and methods. Twenty-four male youth football players (aged 16-18 years) from Mabar Hilir Club, Medan City, participated in this cross-sectional correlational study. Participants underwent three assessment protocols: (1) foot-eye coordination using a modified ball control test, (2) leg muscle strength using isokinetic dynamometry, and (3) shooting accuracy using a standardized target shooting test. Data were analyzed using Pearson correlation coefficients and multiple regression analysis with SPSS v27.

Results. Significant positive correlations were found between shooting accuracy and foot-eye coordination ($r = 0.742$, $p < 0.001$) and leg muscle strength ($r = 0.628$, $p < 0.001$). Multiple regression analysis revealed that foot-eye coordination explained 55.1% of the variance in shooting accuracy, while leg muscle strength contributed an additional 16.3% ($R^2 = 0.714$, $p < 0.001$).

Conclusions. Foot-eye coordination demonstrates a stronger association with football shooting accuracy than leg muscle strength in youth athletes. Training programs should prioritize the development of coordinative abilities alongside strength training to optimize shooting performance.

Keywords: *football; shooting accuracy; foot-eye coordination; leg strength; youth athletes; motor skills.*

A R T I C L E I N F O



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INTRODUCTION

Football, known as soccer in some regions, represents the world's most popular sport, with success heavily dependent on technical skills execution under competitive pressure. Among the fundamental technical skills, shooting accuracy stands as perhaps the most decisive factor in determining match outcomes, as it directly translates

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possession and tactical advantage into scoring opportunities (Williams & Ford, 2008). The biomechanical complexity of football shooting involves a sophisticated interplay between visual perception, motor coordination, and muscular power generation, requiring athletes to integrate multiple physiological systems within milliseconds of decision-making (Bergmann et al., 2021). This intricate skill demands not only precise foot-eye coordination to orient the foot correctly relative to the ball and target but also substantial leg muscle strength to impart sufficient velocity and trajectory to the shot (Akmal et al., 2022). Therefore, understanding the underlying physiological and biomechanical determinants of shooting performance in youth athletes is crucial for effective talent identification, specialized training program development, and injury prevention strategies within football academies (Engler et al., 2023).

The development of shooting proficiency in youth athletes presents unique challenges, as their neuromuscular systems continue to mature throughout adolescence. Understanding the relative contributions of different physiological factors to shooting performance can inform evidence-based training methodologies and talent identification processes (Thompson & Hilliard, 2021). Furthermore, the optimization of training resources requires clarity regarding which physical attributes warrant prioritized development during critical learning periods (Dupuy et al., 2018; Lambert et al., 2008).

Previous research has established that football shooting involves complex motor patterns requiring precise timing, spatial accuracy, and force production (Engler et al., 2023; Ferede, 2021; Shan & Zhang, 2022). Studies examining the biomechanics of shooting have identified key kinematic variables, including approach angle, plant foot positioning, and follow-through trajectory, as determinants of ball velocity and accuracy (Apriantono et al., 2006). However, the literature reveals inconsistent findings regarding the relative importance of coordination versus strength in shooting performance.

Research investigating eye-foot coordination has demonstrated its significance in various football skills. Nascimento et al., (2021)reported strong correlations between

visual-motor coordination and technical skill proficiency in youth players. Similarly, Haaland & Hoff, (2003) found that coordination training improved shooting accuracy more effectively than strength training alone in adolescent players. These findings suggest that the integration of visual information with motor output represents a critical component of shooting proficiency.

Conversely, investigations of muscular strength have emphasized its role in ball velocity generation and shooting power. Čabarkapa et al., (2023) demonstrated significant relationships between quadriceps and hamstring strength and shooting velocity in professional players. More recent studies have confirmed that lower limb strength, particularly in the dominant leg, correlates with shooting performance across various age groups (len et al., 2005).

Despite extensive research on individual components of shooting performance, several gaps remain in the literature. First, most studies have examined coordination and strength as isolated variables, limiting understanding of their interactive effects on shooting accuracy. Second, the relative contributions of these factors have not been systematically quantified using standardized assessment protocols. Third, research focusing specifically on youth populations remains limited, despite the importance of this developmental period for skill acquisition.

Additionally, previous studies have often utilized subjective assessment methods or focused primarily on ball velocity rather than shooting accuracy. The lack of standardized, objective measurement protocols has hindered the development of evidence-based training guidelines and limited the generalizability of findings across different populations and contexts.

The present study addresses these limitations by employing a comprehensive correlational design to examine the relationships between foot-eye coordination, leg muscle strength, and shooting accuracy in youth football players. This research approach allows for the quantification of relative contributions while controlling for potential confounding variables. The findings will provide valuable insights for coaches, trainers, and sports scientists seeking to optimize training programs and enhance

player development strategies. Furthermore, understanding these relationships in youth populations is particularly relevant given the critical nature of adolescence for motor skill development and the long-term implications of training adaptations acquired during this period. The results may inform talent identification processes and guide resource allocation in youth development programs.

The main objective of this study is to test the relationship between eye-foot coordination, leg muscle strength, and shooting accuracy in football among young athletes, determine the relative contributions of eye-foot coordination and leg muscle strength to shooting performance, identify which factor serves as a stronger predictor of shooting accuracy, and provide evidence-based recommendations for the design and implementation of training programs.

MATERIALS AND METHODS

Study participants

A total of 24 male youth football players from Mabar Hilir Club, Medan City, North Sumatra, Indonesia, participated in this study. Participants ranged in age from 16 to 18 years (M = 17.2 ± 0.8 years), with a minimum of 3 years of organized football experience. All participants were free from musculoskeletal injuries and had maintained regular training schedules for at least 6 months prior to data collection. Written informed consent was obtained from participants and their legal guardians, and the study protocol was approved by the institutional ethics committee.

Inclusion criteria included: (1) age between 16-18 years, (2) minimum 3 years of competitive football experience, (3) current active participation in organized training, (4) absence of injury in the 6 months preceding the study, and (5) right-foot dominance for shooting. Exclusion criteria comprised: (1) history of serious lower limb injury, (2) neurological conditions affecting motor control, (3) visual impairments not corrected to normal acuity, and (4) failure to complete all assessment protocols.

Study Organization

The study employed a cross-sectional correlational design conducted over a 3-week period during the off-season training phase. Data collection was organized into three distinct sessions separated by 48-72 hours to minimize fatigue effects. Session 1

focused on anthropometric measurements and foot-eye coordination assessment, Session 2 involved leg muscle strength testing, and Session 3 consisted of shooting accuracy evaluation. All testing was conducted at consistent times (4:00-6:00 PM) to control for circadian rhythm effects.

Environmental conditions were standardized across all sessions, with temperature maintained at 23-25°C and humidity at 45-55%. Participants were instructed to maintain normal hydration and nutrition patterns while avoiding strenuous physical activity 24 hours prior to each testing session.

Test and Measurement Procedures

Table 1. Test and Measurement Procedures Overview

Test Component	Assessment Method	Equipment/Setup	Protocol Details	Scoring System	Duration
Foot-Eye Coordination	Modified ball control test (Rösch et al., 2000)	- Ball machine - Target zones (3m radius) - 20 footballs	- Ball delivery: 15 m/s velocity - Standardized trajectory - Dominant foot control - Direct to target zones	- Accuracy points (target achieved) - Control quality (touches required) - Higher scores = better coordination	15 minutes
Leg Muscle Strength	Isokinetic dynamometry	Biodex System 4 Pro (Biodex Medical Systems, NY, USA)	- Knee extension/flexion - Angular velocities: 60°/s & 180°/s - Maximal voluntary contractions - Dominant leg testing	- Peak torque (N·m) - Normalized to body weight - Recorded for both muscle groups	20 minutes
Shooting Accuracy	Standardized target shooting	- Regulation goal (7.32m × 2.44m) - 9 target zones - Distance: 16 meters	- 20 shots total - Maximum 3 touches per shot - 30 seconds between attempts	- Corner zones: 5 points - Edge zones: 3 points - Center zones: 1 point - Total: Sum of all attempts	25 minutes

Warm-up Protocol: All tests preceded by standardized 5-minute stationary cycling and submaximal familiarization contractions.

Statistical Analysis

Statistical analyses were conducted using SPSS version 27.0 (IBM Corporation, Armonk, NY, USA). Descriptive statistics including means, standard deviations, and ranges were calculated for all variables.

Pearson product-moment correlation coefficients were computed to examine relationships between foot-eye coordination, leg muscle strength, and shooting accuracy. The strength of correlations was interpreted according to Cohen's guidelines: small (r = 0.10-0.29), medium (r = 0.30-0.49), and large (r ≥ 0.50). Multiple regression

analysis was performed to determine the relative contributions of predictor variables to shooting accuracy, with assumptions of linearity, independence, homoscedasticity, and normality of residuals verified prior to analysis. Statistical significance was set at α = 0.05 for all analyses. Effect sizes were calculated and interpreted using Cohen's conventions to assess practical significance of findings.

RESULTS

Table 2 presents descriptive statistics for all measured variables. Participants demonstrated moderate to high levels of performance across all assessments, with shooting accuracy scores ranging from 34 to 78 points out of a possible 100 points (M = 58.7 ± 12.4). Foot-eye coordination scores exhibited a normal distribution (M = 16.3 ± 2.8, range: 11-21), while leg muscle strength values showed typical patterns for this age group (Peak Torque = 187.4 ± 23.6 N·m).

Table 2. Descriptive Statistics for All Variables

Variable	Mean	SD	Minimum	Maximum	Skewness	Kurtosis
Age (years)	17.2	0.8	16.0	18.0	-0.12	-1.18
Height (cm)	171.3	6.7	160.0	185.0	0.28	-0.42
Weight (kg)	64.8	8.2	52.0	82.0	0.35	-0.18
Foot-Eye Coordination	16.3	2.8	11.0	21.0	-0.15	-0.67
Leg Strength (N·m)	187.4	23.6	145.0	235.0	0.22	-0.58
Shooting Accuracy	58.7	12.4	34.0	78.0	-0.08	-0.92

Correlational Analysis

Pearson correlation analysis revealed significant positive relationships between shooting accuracy and both predictor variables. The correlation between foot-eye coordination and shooting accuracy was large and statistically significant ($r = 0.742$, $p < 0.001$, 95% CI [0.521, 0.872]), indicating that 55.1% of the variance in shooting accuracy was associated with coordination abilities.

The relationship between leg muscle strength and shooting accuracy was also statistically significant but demonstrated a medium to large effect size ($r = 0.628$, $p < 0.001$, 95% CI [0.364, 0.801]), accounting for 39.4% of the variance in shooting performance. Additionally, a moderate positive correlation was observed between foot-eye coordination and leg muscle strength ($r = 0.485$, $p = 0.016$), suggesting some degree of shared variance between these physical attributes.

Table 3. Correlation Matrix for All Variables

	1	2	3
1. Foot-Eye Coordination	-		
2. Leg Muscle Strength	0.485*	-	
3. Shooting Accuracy	0.742**	0.628**	-

p < 0.05, *p < 0.001

Correlational Analysis

Multiple regression analysis was conducted to determine the unique contributions of foot-eye coordination and leg muscle strength to shooting accuracy. The overall model was statistically significant ($F(2,21) = 26.18$, $p < 0.001$) and explained 71.4% of the variance in shooting accuracy ($R^2 = 0.714$, adjusted $R^2 = 0.687$).

Examination of individual predictors revealed that foot-eye coordination made a significant unique contribution to the model ($\beta = 0.598$, $t = 3.87$, $p = 0.001$), while leg muscle strength also contributed significantly but to a lesser degree ($\beta = 0.347$, $t = 2.25$, $p = 0.035$). The standardized beta coefficients indicate that foot-eye coordination had approximately 1.7 times greater influence on shooting accuracy compared to leg muscle strength.

Table 4. Multiple Regression Analysis Results

Variable	B	SE B	β	t	p	sr^2
Constant	-12.84	8.92	-	-1.44	0.165	-
Foot-Eye Coordination	2.65	0.68	0.598	3.87	0.001	0.263
Leg Muscle Strength	0.18	0.08	0.347	2.25	0.035	0.089

Note: $R^2 = 0.714$, $F(2,21) = 26.18$, $p < 0.001$

Performance Distribution Analysis

Analysis of performance distributions revealed that participants with high foot-eye coordination scores (top tertile) achieved significantly higher shooting accuracy compared to those in the middle and lower tertiles ($F(2,21) = 18.45$, $p < 0.001$). Post-hoc comparisons using Tukey's HSD indicated significant differences between all groups ($p < 0.05$), with effect sizes ranging from large to very large (Cohen's d = 1.2-2.1). Similarly, participants with greater leg muscle strength demonstrated superior shooting accuracy, though the differences were less pronounced than those observed for coordination ($F(2,21) = 8.92$, $p = 0.002$). The magnitude of differences between strength tertiles was moderate to large (Cohen's d = 0.8-1.4).

DISCUSSION

The present findings provide compelling evidence for the significant roles of both foot-eye coordination and leg muscle strength in football shooting accuracy among youth athletes. The large correlation coefficient observed between foot-eye coordination and shooting accuracy ($r = 0.742$) represents one of the strongest

relationships reported in the youth football literature, highlighting the critical importance of coordinative abilities in technical skill execution. This strong association underscores the necessity for targeted training interventions that specifically enhance visuomotor integration and proprioception in aspiring young footballers (Eraslan et al., 2025; Juliarta et al., 2023; Knöllner et al., 2022). This aligns with previous research emphasizing the multifaceted nature of shooting performance, where precise control over limb movements, guided by visual feedback, is paramount for successful outcomes (Badarin et al., 2023; Engler et al., 2023).

The multiple regression analysis results offer particularly valuable insights into the relative contributions of these factors. The finding that foot-eye coordination uniquely explains 26.3% of shooting accuracy variance, while leg muscle strength contributes an additional 8.9%, suggests that training programs emphasizing coordination development may yield greater performance benefits than those focusing solely on strength enhancement. This differential impact underscores the complex interplay of biomechanical and neurological factors in sports performance, where fine motor control often supersedes raw power in skill-based tasks (Jeong et al., 2024). Despite the observed hierarchy of influence, the significant contribution of leg muscle strength to shooting accuracy cannot be overlooked, as it provides the foundational power for ball propulsion (Saleh & Martiani, 2020).

These results align with motor learning theory, which emphasizes the primacy of coordinative patterns in skill acquisition and execution. The complex spatiotemporal demands of football shooting require precise integration of visual information with motor output, a process that appears more critical for accuracy than pure force production capabilities. Furthermore, the findings suggest that while strength is a necessary component, particularly for ball velocity (Andrade et al., 2015), it is the refined coordination that dictates the precision required for accurate targeting (Akmal et al., 2022). This interpretation is consistent with the observation that professional footballers often demonstrate superior shooting accuracy despite not necessarily possessing exceptional leg strength compared to other athletes.

The current findings both confirm and extend previous research examining factors influencing football shooting performance. The strong relationship between coordination and shooting accuracy corroborates the work of Rahmadhani et al., (2019), who reported similar correlations in slightly older populations. However, this study further delineates the independent contributions of foot-eye coordination and leg muscle strength, providing a more nuanced understanding of their respective roles in youth athlete performance, a distinction not always explicitly addressed in prior literature (Marzuki & Sukoco, 2018; Purnomo & Yendrizal, 2020). Specifically, the ability of the non-dominant leg to provide stable support during the rapid swing of the kicking leg is critical for maintaining balance and achieving accurate ball contact, a factor often enhanced through coordinated movements rather than brute force (Balcells et al., 2016).

Regarding muscle strength, the moderate correlation observed (r = 0.628) is consistent with previous research by Vieira et al., (2016) and Ien et al., (2005), though these earlier studies focused primarily on ball velocity rather than accuracy. The present findings suggest that while strength contributes to shooting performance, its influence may be more pronounced for power generation than precision, which aligns with biomechanical analyses indicating that accuracy demands differ qualitatively from velocity requirements. Furthermore, the observed contributions of leg muscle strength to shooting accuracy, although secondary to foot-eye coordination, resonate with the understanding that robust lower limb musculature provides the necessary force generation for effective ball propulsion and stability during the dynamic kicking motion (Hart et al., 2014; Zago et al., 2014). This foundational strength also contributes to maintaining proper body mechanics throughout the shooting sequence, which is essential for consistent accuracy and injury prevention (Chen et al., 2024).

The observed relationship between foot-eye coordination and leg strength (r = 0.485) represents a novel finding that may reflect the integrated nature of motor development during adolescence. This moderate correlation suggests that these attributes develop somewhat independently, supporting the rationale for targeted

training approaches that address both components while recognizing their distinct contributions to performance.

These findings carry significant implications for youth football development programs and training methodology. The demonstrated superiority of coordination over strength in predicting shooting accuracy suggests that coaches and trainers should prioritize technical skill development and visual-motor integration during critical learning periods. This recommendation is particularly relevant given the limited training time available in most youth programs and the need for efficient resource allocation.

From a practical perspective, the results support the implementation of coordination-focused training methods such as small-sided games, juggling exercises, and reaction-based drills that challenge visual-motor integration under varying conditions. While strength training should not be neglected, particularly for injury prevention and overall athletic development, the findings suggest that excessive emphasis on strength gains at the expense of coordinative development may not optimally enhance shooting performance.

The research also has implications for talent identification processes, as foot-eye coordination appears more predictive of shooting ability than easily observable physical attributes such as leg strength. This finding may encourage talent scouts and youth coaches to place greater emphasis on technical assessments that evaluate coordinative abilities rather than relying primarily on anthropometric or strength measures.

Several limitations must be acknowledged when interpreting these findings. First, the relatively small sample size (n = 24) and homogeneous participant characteristics (male youth players from a single club) limit the generalizability of results to broader populations. Future research should include larger, more diverse samples encompassing different age groups, skill levels, and cultural contexts. Second, the cross-sectional design precludes causal inferences regarding the relationships between variables. Longitudinal studies tracking the development of coordination, strength, and

shooting accuracy over time would provide more definitive evidence regarding causality and the optimal timing of different training interventions. Third, the study focused exclusively on shooting accuracy rather than other aspects of shooting performance such as velocity, consistency, or performance under defensive pressure. These additional dimensions may show different relationships with the predictor variables and warrant investigation in future research. Finally, the assessment protocols, while standardized and reliable, represent laboratory-based measures that may not fully capture the complexity of shooting performance in actual match conditions. Field-based assessments incorporating factors such as fatigue, time pressure, and defensive interference would enhance the ecological validity of findings.

CONCLUSION

This study provides robust evidence for the significant relationships between foot-eye coordination, leg muscle strength, and football shooting accuracy in youth athletes. The findings demonstrate that foot-eye coordination serves as a stronger predictor of shooting performance than leg muscle strength, with coordination abilities uniquely explaining over 26% of accuracy variance compared to less than 9% for strength measures.

These results reinforce theoretical frameworks emphasizing the primacy of coordinative abilities in technical skill execution and provide practical guidance for training program design. Youth development programs should prioritize activities that challenge visual-motor integration and coordinative abilities while maintaining appropriate strength development to support overall athletic growth and injury prevention.

The research highlights the importance and potential impact of understanding the multifactorial nature of football skills, moving beyond simplistic strength-focused approaches to embrace the complexity of motor performance. These findings correlate evidence for the hypothesis that coordinative abilities represent critical determinants of technical skill proficiency, supporting the theoretical framework established in the introduction through empirical investigation.

Future research should examine these relationships across broader populations, investigate the longitudinal development of these attributes, and explore the effectiveness of targeted training interventions designed to optimize both coordination and strength development. Additionally, investigations of these relationships in female athletes and across different skill levels would enhance the comprehensiveness of our understanding.

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CONFLICT OF INTERESTS

The authors declare no competing financial, professional, or personal interests that could have influenced the conduct or reporting of this research. No external funding was received for this study, and all authors contributed to the research design, data collection, analysis, and manuscript preparation without external influence or compensation.

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APPENDIX

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