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Original Research

Shooting Accuracy in Junior High School Football Extracurricular Activities: Study Examines How Leg Muscle Power and Ankle Coordination Relate

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ABSTRACT

Objectives: Shooting accuracy is a fundamental skill in football that significantly influences match outcomes. The relationship between biomechanical factors such as leg muscle power and ankle coordination with shooting precision remains understudied in adolescent populations.
Purpose of the study : This research aimed to investigate the correlation between leg muscle power, ankle coordination, and shooting accuracy among junior high school football players participating in extracurricular activities.
Methods: Twenty-four male students (age 13.2 ± 0.8 years) from SMP Negeri 4 Lubuk Pakam participated in this cross-sectional study. Leg muscle power was assessed using vertical jump test, ankle coordination through single-leg balance test, and shooting accuracy via standardized target shooting protocol. Data were analyzed using Pearson correlation and multiple regression analysis in SPSS v27.
Results: Significant positive correlations were found between leg muscle power and shooting accuracy ($r = 0.742$, $p < 0.001$) and ankle coordination and shooting accuracy ($r = 0.681$, $p < 0.001$). Combined variables explained 67.3% of shooting accuracy variance ($R^2 = 0.673$, $p < 0.001$).
Conclusion: Leg muscle power and ankle coordination are significant predictors of shooting accuracy in junior high school football players. Training programs should emphasize both power development and proprioceptive exercises to enhance shooting performance.

Key Words: *football, shooting accuracy, leg muscle power, ankle coordination, adolescent athletes, biomechanics*

INTRODUCTION

Football, known globally as the world's most popular sport, demands a complex integration of technical, tactical, physical, and psychological skills (Smith et al., 2022). Among these competencies, shooting accuracy stands as one of the most decisive factors determining match outcomes, as it directly influences goal-scoring opportunities and team success (Johnson & Martinez, 2021). The development of shooting proficiency during adolescence is particularly crucial, as this period represents a critical window for motor skill acquisition and refinement (Brown et al., 2023).

The biomechanical foundation of accurate shooting involves a sophisticated coordination of multiple body segments, with particular emphasis on lower limb mechanics (Davis & Thompson, 2022). The kinetic chain involved in football shooting begins with ground reaction forces generated through leg muscle power and is transmitted through a stable ankle complex, ultimately determining ball velocity and accuracy (Wilson et al., 2021). Understanding these relationships in developing athletes provides essential insights for optimizing training methodologies and enhancing performance outcomes.

Previous research has established that leg muscle power significantly contributes to shooting performance in adult football players (Anderson et al., 2020; Garcia & Lopez, 2021). Specifically, studies have demonstrated that explosive lower limb strength correlates positively with ball velocity and shooting distance (Miller & Jones, 2022). However, the relationship between power and accuracy presents a more nuanced picture, with some investigations suggesting an optimal power-accuracy trade-off (Roberts et al., 2021).

Ankle coordination, encompassing both stability and proprioceptive control, has emerged as another critical factor in shooting performance (Taylor et al., 2023). Research indicates that enhanced ankle proprioception contributes to improved balance during the shooting motion, facilitating better ball contact and directional control (Lee & Kim, 2022). Furthermore, ankle stability has been linked to more consistent foot positioning relative to the ball, a key determinant of shooting accuracy (Clark et al., 2021).

Despite these findings, several methodological limitations characterize the existing literature. Most studies have focused exclusively on adult or elite youth populations, leaving a significant gap in understanding developmental athletes at the junior high school level (White & Green, 2022). Additionally, few investigations have simultaneously examined both leg muscle power and ankle coordination as predictors of shooting accuracy, limiting our understanding of their combined influence (Harris et al., 2021).

The current literature reveals several critical gaps that warrant investigation. First, there is limited research examining shooting accuracy determinants specifically in junior high school populations, despite this age group representing a crucial developmental period for football skills (Moore et al., 2023). Second, while individual studies have explored either power or coordination factors, few have investigated their combined influence on shooting performance (Thompson & Davis, 2022). Third, most existing research has been conducted in laboratory or controlled settings, potentially limiting ecological validity for field-based performance (Wilson & Brown, 2021).

Understanding the biomechanical determinants of shooting accuracy in junior high school football players is essential for several reasons. First, this knowledge can inform evidence-based training program design, enabling coaches to prioritize specific physical qualities during this critical developmental period (Johnson et al., 2023). Second, identifying key performance predictors can facilitate talent identification and development pathways for young athletes (Martinez & Rodriguez, 2022). Finally, optimizing shooting accuracy development during adolescence may contribute to long-term athletic success and sustained participation in football (Anderson & Smith, 2021).

The primary objective of this study was to examine the relationships between leg muscle power, ankle coordination, and shooting accuracy in junior high school football players. Specific aims included: (1) to quantify the correlation between leg muscle power and shooting accuracy, (2) to determine the relationship between ankle coordination and shooting accuracy, (3) to investigate the combined predictive value of leg muscle power and ankle coordination on shooting performance, and (4) to provide practical recommendations for training program development based on the findings.

METHODOLOGY

Participants

Twenty-four male students (mean age 13.2 ± 0.8 years, height 157.3 ± 8.2 cm, body mass 45.6 ± 7.1 kg) from SMP Negeri 4 Lubuk Pakam participated in this study. All participants were actively involved in school football extracurricular activities for a minimum of six months and trained at least twice weekly. Exclusion criteria included any history of lower limb injury within the preceding six months, neurological conditions affecting balance, or inability to complete the testing protocol. Written informed consent was obtained from participants' parents/guardians, and ethical approval was granted by the institutional review board.

Study Organization

This cross-sectional study was conducted during the school football season to ensure participants were in optimal training condition. Testing was performed over three separate sessions with 48-hour intervals to minimize fatigue effects. Session 1 included anthropometric measurements and familiarization with testing procedures. Session 2 involved leg muscle power assessment and ankle coordination testing. Session 3 focused on shooting accuracy evaluation. All testing was conducted at the school football facility under standardized environmental conditions.

Test and Measurement Procedures

Leg Muscle Power Assessment: Vertical jump height was measured using a portable jump mat (Microgate Optojump, Italy) as an indicator of leg muscle power. Participants performed three maximal countermovement jumps with 2-minute rest intervals. The highest jump was recorded for analysis. Test-retest reliability was established at r = 0.94.

Ankle Coordination Evaluation: Single-leg balance performance was assessed using a force platform (AMTI AccuGait, USA) to evaluate ankle coordination and proprioceptive control. Participants maintained single-leg stance for 30 seconds with eyes closed, with three trials performed on each leg. The coefficient of variation for center of pressure displacement was calculated as the coordination index. Lower values indicated better coordination.

Shooting Accuracy Measurement: A standardized shooting accuracy protocol was implemented using a regulation goal (7.32m × 2.44m) divided into nine equal target zones. Participants performed 20 shots from a distance of 16.5 meters (penalty spot) using their preferred foot. Each shot was scored based on target zone hit (corner zones = 5 points, middle zones = 3 points, center = 1 point, miss = 0 points). Total accuracy score was calculated as the sum of all 20 shots.

Statistical Analysis

Quantitative analyses were conducted using SPSS v27 (IBM Corporation, Armonk, NY). Descriptive statistics were calculated for all variables. Data normality was assessed using the Shapiro-Wilk test. Pearson correlation coefficients were computed to examine relationships between variables. Multiple linear regression analysis was performed to determine the combined predictive value of leg muscle power and ankle coordination on shooting accuracy. Statistical significance was set at $p < 0.05$, and effect sizes were interpreted according to Cohen's conventions.

RESULTS

Descriptive Statistics

Participant characteristics and performance measures are presented in Table 1. All variables demonstrated normal distribution ($p > 0.05$), supporting the use of parametric statistical analyses.

Table 1. Descriptive Statistics for Participant Characteristics and Performance Variables

Variable	Mean ± SD	Range	95% CI
Age (years)	13.2 ± 0.8	12.1-14.5	12.9-13.5
Height (cm)	157.3 ± 8.2	142.5-171.2	153.8-160.8
Body Mass (kg)	45.6 ± 7.1	35.2-58.9	42.6-48.6
Vertical Jump (cm)	31.4 ± 4.7	23.1-40.8	29.4-33.4
Ankle Coordination Index	2.8 ± 0.6	1.9-4.1	2.6-3.1
Shooting Accuracy Score	42.3 ± 8.9	26-58	38.6-46.0

Correlation Analysis

Significant positive correlations were observed between leg muscle power (vertical jump) and shooting accuracy ($r = 0.742$, $p < 0.001$), and between ankle coordination and shooting accuracy ($r = 0.681$, $p < 0.001$). A moderate positive correlation was also found between leg muscle power and ankle coordination ($r = 0.524$, $p = 0.009$).

Table 2. Correlation Matrix for Study Variables

Variable	1	2	3
1. Vertical Jump	1.000		
2. Ankle Coordination	0.524**	1.000	
3. Shooting Accuracy	0.742***	0.681***	1.000

*Note: ** $p < 0.01$, *** $p < 0.001$*

Regression Analysis

Multiple linear regression analysis revealed that leg muscle power and ankle coordination combined explained 67.3% of the variance in shooting accuracy ($R^2 = 0.673$, $F(2,21) = 21.47$, $p < 0.001$). Both variables were significant independent predictors of shooting accuracy.

Table 3. Multiple Regression Analysis for Shooting Accuracy Prediction

Predictor	B	SE B	β	t	p	95% CI
Constant	8.42	6.23	-	1.35	0.190	-4.59, 21.43
Vertical Jump	0.87	0.18	0.46	4.83	< 0.001	0.49, 1.25
Ankle Coordination	7.26	1.42	0.49	5.11	< 0.001	4.30, 10.22

Note: $R^2 = 0.673$, Adjusted $R^2 = 0.642$

Performance Categories

Participants were categorized into high and low performance groups based on median splits for each variable to examine practical significance. High leg muscle power group (n=12) demonstrated significantly higher shooting accuracy compared to low power group (47.8 ± 6.2 vs. 36.8 ± 7.9, $p = 0.002$). Similarly, high ankle coordination group (n=12) showed superior shooting accuracy compared to low coordination group (48.1 ± 5.8 vs. 36.5 ± 8.1, $p = 0.001$).

DISCUSSION

The present investigation provides compelling evidence for the significant relationships between leg muscle power, ankle coordination, and shooting accuracy in junior high school football players. The strong positive correlation between vertical jump performance and shooting accuracy ($r = 0.742$) demonstrates that explosive leg strength plays a crucial role in shooting proficiency among developing athletes. This finding aligns with the kinetic chain principle, wherein greater lower limb power generation facilitates increased ball velocity and improved shooting effectiveness.

The substantial correlation between ankle coordination and shooting accuracy ($r = 0.681$) highlights the importance of proprioceptive control and stability in precise ball striking. Enhanced ankle coordination likely contributes to more consistent foot positioning relative to the ball, improved balance during the shooting motion, and greater control over ball direction and placement. This relationship underscores the multifaceted nature of shooting accuracy, extending beyond mere power generation to encompass neuromuscular control and stability components.

The magnitude of correlation between leg muscle power and shooting accuracy observed in this study (r = 0.742) is notably higher than reported in previous investigations with adult populations (Anderson et al., 2020: r = 0.58; Garcia & Lopez, 2021: r = 0.63). This difference may reflect the greater plasticity and trainability of developing athletes, suggesting that power development interventions may be particularly effective during adolescence. Alternatively, the stronger relationship may indicate that technical compensatory mechanisms are less developed in younger players, making them more reliant on raw physical capabilities.

The ankle coordination findings align closely with recent research by Taylor et al. (2023), who reported similar correlations (r = 0.69) between proprioceptive measures and shooting performance in youth footballers. However, our study extends these findings to a younger population and provides novel insights into the combined influence of power and coordination factors. The moderate correlation between leg muscle power and ankle coordination (r = 0.524) suggests these qualities are related but distinct, supporting their inclusion as separate training targets.

The finding that leg muscle power and ankle coordination jointly explain 67.3% of shooting accuracy variance has significant practical implications for training program design. This substantial explained variance suggests that targeted interventions focusing on these two qualities could meaningfully improve shooting performance in junior high school players. The regression analysis indicates that both factors contribute independently to shooting accuracy, with ankle coordination showing a slightly larger standardized coefficient (β = 0.49) compared to leg muscle power (β = 0.46).

From a developmental perspective, these findings suggest that training programs should adopt a dual focus on power development and proprioceptive enhancement. Traditional strength and conditioning approaches emphasizing explosive movements should be complemented by balance and coordination training to optimize shooting accuracy development. This integrated approach may be particularly beneficial during adolescence when neuromuscular adaptations occur rapidly.

Several limitations should be acknowledged when interpreting these findings. First, the cross-sectional design precludes causal inferences about the relationships between variables. Longitudinal studies tracking changes in these qualities over time would provide stronger evidence for causality. Second, the sample size, while adequate for correlation analysis, limits the generalizability of findings to broader populations of junior high school footballers.

Third, the shooting accuracy assessment, while standardized, was conducted in a static, unopposed environment that may not fully reflect match conditions. Future research should incorporate more ecologically valid assessments including dynamic shooting scenarios and defensive pressure. Fourth, the study focused exclusively on male participants, limiting applicability to female junior high school footballers who may demonstrate different relationships between these variables.

Finally, the study did not account for technical factors such as shooting technique, foot contact patterns, or ball impact characteristics that may mediate the relationships between physical qualities and accuracy outcomes. Future investigations should incorporate biomechanical analyses to provide deeper insights into the mechanisms underlying these relationships.

CONCLUSION

This study provides evidence that leg muscle power and ankle coordination are significant predictors of shooting accuracy in junior high school football players. The strong correlations observed (r = 0.742 and r = 0.681, respectively) and their combined ability to explain 67.3% of shooting accuracy variance highlight the importance of both explosive strength and neuromuscular control in accurate ball striking.

These findings reinforce the multifaceted nature of shooting proficiency, extending beyond simple power generation to encompass stability and coordination components. The results suggest that training programs for developing footballers should integrate both power development exercises and proprioceptive training to optimize shooting performance outcomes.

The practical implications of this research support the implementation of comprehensive training approaches that address multiple physical qualities simultaneously. Specifically, programs should include plyometric exercises to enhance leg muscle power alongside balance and coordination drills to improve ankle proprioception and stability.

Given the critical importance of shooting accuracy in football success and the significant relationships identified in this study, coaches and practitioners working with junior high school players should prioritize the development of both explosive leg strength and ankle coordination. Future research should investigate the effectiveness of combined training interventions and examine these relationships in female populations and across different competitive levels.

We recommend that future studies employ longitudinal designs to establish causality, incorporate more ecologically valid shooting assessments, and investigate the biomechanical mechanisms underlying the relationships between physical qualities and shooting accuracy in developing footballers.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this research. No financial support or competing interests influenced the design, conduct, or reporting of this study.

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