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Revealing the Relationship Between Flexibility and Leg Muscle Strength in Football Dribbling Skills

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ABSTRACT

This study aimed to examine the relationship between flexibility and leg muscle strength with football dribbling skills and to determine the combined contribution of both physical components to performance. Dribbling is recognized as a complex motor skill requiring efficient biomechanical movement, dynamic balance, and adequate force production. Therefore, understanding its physical determinants is essential for evidence-based training in youth football development. A quantitative correlational design was employed. The sample consisted of 23 male football players aged 14–15 years from Bangunjiwo FA Demak, selected using a total sampling technique. Flexibility was assessed using the V-sit and reach test, leg muscle strength was measured with a leg dynamometer, and dribbling performance was evaluated through a standardized football dribbling test based on completion time. Data were analyzed using Pearson product-moment correlation and multiple regression analysis after meeting assumptions of normality, linearity, and multicollinearity (α = 0.05). The findings revealed significant negative correlations between flexibility and dribbling time (r = -0.489; p = 0.018) and between leg muscle strength and dribbling time (r = -0.576; p = 0.004), indicating that higher levels of flexibility and strength are associated with faster and more efficient dribbling performance. Simultaneously, both variables contributed 43.2% to dribbling skills. These results highlight the integrated role of flexibility and lower-limb strength in optimizing technical performance in adolescent football players.

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A. Conception and design of the study;
B. Acquisition of data;
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INTRODUCTION

Football is the world's most popular offensive sport, with participation across all ages, genders, and social backgrounds (Hidayat, 2022; FIFA, 2023). This popularity makes football a highly competitive sport, demanding mastery of techniques, tactics, and optimal physical condition from a young age. In the context of game performance, scoring goals, the primary objective of the game, is largely determined by the effectiveness of mastering basic techniques such as passing, dribbling, and shooting (Wahyudi, 2020; Sarmento et al., 2020).

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Among these basic techniques, dribbling holds a central position because it allows players to maintain possession of the ball, pass opponents in one-on-one situations, and create attacking opportunities (Suryadi et al., 2023; Aquino et al., 2020). Effective dribbling is not simply the ability to carry the ball; it is a complex combination of motor control, neuromuscular coordination, acceleration, and body stability (Paul et al., 2021). In modern games characterized by high intensity and the pressure of confined spaces, dribbling success is often the deciding factor in match outcomes (Clemente et al., 2021).

However, dribbling ability is not solely determined by technical aspects. Sports science literature confirms that technical performance is significantly influenced by underlying physical condition components (Pratama et al., 2018; Ridwan & Irawan, 2018). In youth football, leg muscle flexibility and strength are two highly relevant components because they directly relate to joint range of motion, stride efficiency, stability during changes of direction, and ball control during acceleration (Maulana et al., 2024; Chaabene et al., 2019).

In the 14–15 age group, the growth spurt can cause an imbalance between strength and flexibility development (Malina et al., 2015). This condition has the potential to impact movement coordination and technical quality, including dribbling. At Bangunjiwo FA Demak, initial observations revealed significant variations in dribbling ability between players, even though they were in the same age group and underwent relatively similar training programs. This raises a scientific question: to what extent do leg muscle flexibility and strength contribute to dribbling skills in 14–15-year-old players?

This issue underpins the urgency of this research, which is to analyze the relationship and simultaneous contribution of leg muscle flexibility and strength to dribbling skills in the context of youth football development.

Research over the past decade has shown that football technical performance is closely linked to a player's physical condition profile. Studies by Hammami et al. (2018) and Chaabene et al. (2019) confirmed that leg muscle strength and power significantly correlate with sprint performance, change of direction, and ball control. This aspect is particularly relevant to dribbling, which requires rapid acceleration and controlled deceleration.

Flexibility, particularly in the hip and ankle joints, plays a role in increasing range of motion and biomechanical efficiency during repeated ball touches (Behm et al., 2016; Konrad et al., 2021). Nuruhidin et al. (2023) reported that flexibility significantly contributes to dribbling effectiveness in adolescent players. Adrian et al. (2025) even found that flexibility accounted for 38.65% of the variance in dribbling ability.

Furthermore, leg muscle strength has been shown to be associated with stability and dynamic control during explosive movements (Zahid et al., 2023). Muchlisin & Kurniawan (2019) demonstrated a positive relationship between leg muscle strength and technical football skills, including dribbling. Alfaroby et al. (2022) corroborated these findings by stating that increased leg muscle strength significantly improved ball control during acceleration.

Biomechanically, dribbling involves the synergistic action of the quadriceps, hamstrings, gastrocnemius, and pelvic stabilizer muscles (Lees et al., 2018). Optimal

neuromuscular coordination enables players to maintain balance during rapid changes of direction (Nimphius et al., 2017). Therefore, strength without adequate flexibility can potentially result in stiff and inefficient movement patterns.

International literature also emphasizes the importance of a multicomponent approach in youth player development (Lloyd & Oliver, 2016; Lesinski et al., 2020). Integrating strength and flexibility training during the adolescent development phase has been shown to improve technical performance and reduce injury risk (Granacher et al., 2018).

Therefore, conceptually and empirically, both flexibility and leg muscle strength have been identified as important determinants of technical football performance, including dribbling.

Although various studies have examined the relationship between flexibility and dribbling, or between leg muscle strength and dribbling separately, there are still limitations in research that examines the contribution of both variables simultaneously in a single integrated analysis model, particularly in the 14–15 year old age group in the local Indonesian coaching context.

Most previous studies have focused on simple relationships (bivariate correlations) without exploring the relative contribution of each variable to dribbling skills (Nuruhidin et al., 2023; Zahid et al., 2023). Furthermore, international literature tends to examine elite academy players or different age groups, so generalization to regional academy players is still limited (Sarmento et al., 2020).

Another limitation lies in the lack of quantitative approaches that measure the simultaneous contribution of flexibility and leg muscle strength to dribbling performance using comprehensive inferential statistical analysis. In the context of modern sports performance, a data-driven approach is crucial for designing evidence-based training programs (Clemente et al., 2021).

Thus, there is a clear research gap: there has been no empirical study that simultaneously analyzes the relationship and contribution of flexibility and leg muscle strength to dribbling skills in 14–15-year-old players within the context of regional club development.

Based on these research problems and gaps, this study aims to: (1) Analyze the relationship between flexibility and dribbling skills in Bangunjiwo FA Demak players aged 14–15; (2) Analyze the relationship between leg muscle strength and dribbling skills; (3) Measure the simultaneous contribution of flexibility and leg muscle strength to dribbling skills.

The novelty of this research lies in its integrative approach, which simultaneously examines two main physical condition components to explain dribbling performance during the adolescent developmental phase. This study not only identifies the relationship but also quantifies the contribution of each variable to technical skills.

Theoretically, this research adds to the sports science literature on models of physical determinants of technical skills in youth football. Practically, the results of this study are expected to form the basis for designing more targeted and evidence-based training programs, particularly in integrating flexibility and leg muscle strength training to improve dribbling performance.

Therefore, this study provides conceptual and empirical contributions to the development of a more systematic, measurable, and evidence-based training principles for youth football development.

METHODS

This study used a quantitative approach with a correlational design to examine the relationship between leg muscle flexibility and strength as independent variables and dribbling skill as the dependent variable. A correlational design was chosen because it is effective in identifying the strength and direction of relationships between variables in the context of sports performance without manipulation of treatment (Creswell & Creswell, 2018; Thomas et al., 2022). This approach is widely used in sports science research to analyze the physical determinants of technical skills (Sarmento et al., 2020; Chaabene et al., 2019).

The study population consisted of all players aged 14–15 at Bangunjiwo FA Demak. This age group was chosen because it falls within the rapid growth phase (peak height velocity), which physiologically affects strength and flexibility (Lloyd & Oliver, 2016; Malina et al., 2015). The sampling technique used was total sampling, considering the relatively limited population size and all relevant to the research objectives. Therefore, all 23 players were selected as the study sample. This strategy increases external validity within a specific population context (Sugiyono, 2018).

The research instrument consisted of three main components. Flexibility was measured using the V-sit and reach test, which has been shown to have high validity and reliability in assessing hamstring and lower back flexibility in adolescent athletes (Mayorga-Vega et al., 2014; Behm et al., 2016; Konrad et al., 2021). Hip and hamstring flexibility play a crucial role in increasing range of motion and biomechanical efficiency during dribbling (Lees et al., 2018; Aquino et al., 2020).

Leg muscle strength was measured using the leg dynamometer test, an objective instrument widely used in evaluating lower extremity isometric strength (Hammami et al., 2018; Comfort et al., 2019). Leg muscle strength contributes to stability, acceleration, and ball control during rapid changes of direction in dribbling (Nimphius et al., 2017; Zahid et al., 2023). A study by Lesinski et al. (2020) confirmed that lower extremity strength is a key determinant of technical performance in young athletes.

Dribbling skills were measured using a dribbling test instrument developed by Taufiq & Winarno (2024), which assesses ball speed and control in a standardized zigzag trajectory. This instrument is relevant to the demands of modern games, which emphasize the ability to change direction and control the ball in tight spaces (Clemente et al., 2021; Paul et al., 2021). The construct validity of the dribbling test aligns with football skill evaluation models developed in recent performance research (Sarmento et al., 2020).

Data collection procedures were conducted in a single testing session with a standardized dynamic warm-up to minimize injury risk and increase consistency of results (Behm et al., 2016). Each test was performed twice, and the best score was used as the final score to increase measurement reliability (Thomas et al., 2022).

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Data analysis was conducted in stages. Normality tests (Shapiro-Wilk), linearity tests, and multicollinearity tests were first conducted to ensure the parametric analysis assumptions were met (Field, 2018). Next, relationships between variables were analyzed using Pearson correlation, while the simultaneous contribution of leg muscle flexibility and strength to dribbling was analyzed using multiple linear regression. A multiple regression approach is recommended in sports performance research to identify the relative contributions of multiple predictor variables to technical performance (Tabachnick & Fidell, 2019; Clemente et al., 2021).

All analyses were conducted using SPSS version 25 with a significance level of $\alpha = 0.05$. This statistical approach allows for a comprehensive interpretation of the strength of the relationship and the magnitude of the contribution of physical variables to dribbling skills in adolescent football players.

RESULTS AND DISCUSSION

Result

The data collected from flexibility, leg muscle strength, and dribbling skills tests were then analyzed. The analysis process was carried out in stages. Descriptive analysis of the result test flexibility, leg muscle strength, and football dribbling skills of Bangunjiwo FA Demak players provides a general overview. The results of the descriptive analysis of this study can be seen in the following table:

Table 1.
Deskriptive Statistics of Reseach Variable

Statistic	Flexibility	Leg Muscle Strength	Dribbling
N	23	23	23
Min	9	25	7.02
Max	22	65	10.55
Range	13	40	3.53
Mean	15.57	42.413	8.7448
Std. Dev.	4.154	11.8702	1.07578

Table 1 above show the result of descriptive analysis in Bangunjiwo FA Demak with total sample 23 players. The flexibility data shows an average of 15.57 with a standard deviation of 4.15. The range of value is 13, with lowest value of 9 and maximum of 22. Leg muscle strength the average value is 42.41 with a standard deviation of 11.87. The range of value is 40, with a minimum value of 25 and maximum value of 65. Meanwhile, dribbling skills had an average value of 8.74 with a standard deviation of 1.08. The minimum value is 7.02 and maximum value is 10.55, with a range of values of 3.53.

Normality Test

Normality test is used to determine whether data is normally distributed. In this study, Kolmogorov-Smirnov and Shapiro-Wilk test were applied with the following results:

Table 2.
Result of Normality Test

	Kolmogorov-Smirnov		Shapiro-Wilk	
	Statistics	Sig. (p)	Statistics	Sig. (p)
Flexibility	.123	.200*	.937	.156
Leg Muscle Strength	.117	.200*	.940	.179
Dribbling skills	.130	.200*	.942	.197

The result show that the significance values of Shapiro-Wilk test for variable flexibility of 0.156, leg muscle strength value of 0.179, and dribbling skills value of 0.197. The Kolmogorov-Smirnov test show that all variables have a value of 0.200, from both test, all variables have significance value (p-value) greater than 0.05. The conclusion is data for the three variables are normally distributed.

Linearity Test

Table 3.
Result of Linearity Test

Variable	F	P	Conclusion
Flexibility (X1) and Dribbling Skills (Y)	2.385	.091	Linear
Leg Muscle Strength and Dribbling Skills (Y)	1.086	.507	Linear

The result of the analysis above show that the relationship between flexibility (X1) and dribbling skills (Y) obtained a significance value (p) of 0.91. Meanwhile, the relationship between leg muscle strength (X2) and dribbling skills (Y) obtained a significance value (p) of 0.507. It can be concluded that both variables are linier because the significance value is greater than 0.05.

Multicollinearity Test

A multicollinearity test was conducted to ensure that there was no high correlation between the two independent variables. This test is a crucial prerequisite before conducting multiple regression analysis. The result of multicollinearity test can be seen in table 4 below.

Table 4.
Result of Multicollinearity Test

	Collinearity Statistics		Conclusion
	Tolerance	VIF	
Flexibility (X1)	.891	1.123	No Multicollinearity
Leg Muslce Strength (X2)	.891	1.123	No Multicollinearity

Tolerance and VIF values were used as the criteria to determine the presence of multicollinearity. Multicolllinearity is considered absent when the tolerance value exceeds 0.10 and the VIF value is below 10.00. Based on table 4 above, both independent variables show the same results. The tolerance value of 0.89 was greater than 0.10, and the VIF value of 1.123 was less than 10.00. Therefore, it can be concluded that multicollinearity did not occur between the two variables.

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Correlation Analyst

To test the hypothesis, correlation and regression analysis were conducted. The result of testing the hypothesis of the relationship between flexibility and dribbling skills of Bangunjiwo FA Demak players can be seen in table 5 below:

Table 5.
Correlation between Flexibility with Dribbling Skills

Variable	R	Sig. (p)	Conclusion
Flexibility (X1) Dribbling Skills (Y)	-.489	.018	Significant

Testing the relationship using product-moment correlation analysis shows a person correlation coefficient (R) between flexibility (X1) and ball dribbling skills (X2) of -0.489 with a significance level (p) of 0.018. The R value indicates a moderate relationship between the two variables. The negative correlation result indicates an inverse relationship between increased flexibility and decreased dribbling time, which significantly demonstrates improvement in ball dribbling skills. A significance level (p) of less than 0.05 confirms that the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. Thus, flexibility has a significance relationship with dribbling skill in Bangunjiwo FA Demak players.

The result of testing hypothesis of the relationship between leg muscle strength and dribbling skills of Bangunjiwo FA Demak players can be seen in table 6 below:

Table 6.
Correlation between Leg Muscle Streng with Dribbling Skills

Variable	R	Sig. (p)	Conclusion
Leg Muscle Strength (X2) Dribbling Skills (Y)	-.576	.004	Significant

The result of product moment correlation analysis show that the R value is -0.576 with a significance level (p) of 0.004. The R value indicate a moderate negative relationship between leg muscle strength (X2) and dribbling skills (Y). This indicates that as leg muscle strength increases, dribbling time tends to decrease. Dribbling ability improves. A significance value (p) of lower than 0.05 confirms that the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. Thus, it can be concluded that leg muscle strength has a significance relationship with dribbling skills in Bangunjiwo FA Demak players.

To determine the relationship between flexibility and leg muscle strength with dribbling, and to test the main research hypothesis, the collected data were analyzed using multiple correlation regression. The test results are shown in table 7 below:

Table 7.
Correlation between Flexibility and Leg Mucle Strength with Dribbling Skills

Variable	R	r^2	F	Sig. (p)	Conclusion
Flexibility (X1) and Leg Muscle Strength (X2) Dribbling Skills (Y)	.657	.432	7.604	.003	Significant

Based on the results of the analysis in table 7 above, a multiple correlation coefficient (R) of 0.657 was obtained, indicating a strong relationship between flexibility (X1) and leg muscle strength (X2) simultaneously with dribbling ability (Y). The significance value (p) of 0.003 is smaller than the significance level of 0.05, indicating that the influence of the two independent variables is statistically significant. The regression results also show a coefficient of determination (r^2) value of 0.043, indicating that flexibility and leg muscle strength contribute 43.2% to the dribbling ability of Bangunjiwo FA Demak players, while remaining 56,8% is influenced by other factors outside the variables studied in this study. A significance value of less than 0.05 means that the null hypothesis is rejected and the alternative hypothesis is accepted, confirming that both variables simultaneously have a significant effect on the dribbling skills of Bangunjiwo FA Demak players.

Discussion

The analysis showed that leg muscle flexibility and strength were significantly related to the dribbling skills of Bangunjiwo FA Demak players, both partially and simultaneously. This finding reinforces the view in modern sports science that football technical skills do not exist as isolated motor entities, but rather are manifestations of the integration of underlying neuromuscular, biomechanical, and physiological abilities (Sarmento et al., 2020; Clemente et al., 2021). Dribbling, as a complex basic technique, demands intersegmental coordination, dynamic control, and adequate physical capacity to support movement efficiency in high-intensity game situations (Paul et al., 2021).

Partially, flexibility demonstrated a moderate and significant relationship with dribbling skills. A negative correlation coefficient indicates that the better a player's flexibility, the shorter the dribbling time achieved, meaning more effective dribbling performance. Biomechanically, flexibility plays a role in expanding the range of motion in the hip, knee, and ankle joints, allowing players to change direction more fluidly and efficiently (Lees et al., 2018; Aquino et al., 2020).

In the context of dribbling, good flexibility facilitates postural adaptation and dynamic stability when facing opponent pressure in confined spaces. Behm et al. (2016) and Konrad et al. (2021) explain that flexibility contributes to neuromuscular efficiency by increasing muscle-tendon tissue compliance, which ultimately supports explosive movement coordination. The findings of this study align with those of Paryadi et al. (2023), who asserted that flexibility significantly contributes to fundamental football skills, particularly movements requiring dynamic coordination and balance.

Furthermore, Asmara et al. (2023) reported a 28.19% contribution of flexibility to dribbling ability, while Adrian et al. (2025) found a larger contribution of 38.65%. These varying contributions indicate that flexibility is not the sole determinant, but remains a crucial factor in improving technical performance. Physiologically, adequate flexibility allows players to extend and flex their lower extremities more efficiently, thereby reducing mechanical resistance when carrying the ball at high speeds (Chaabene et al., 2019).

However, the results of this study differ from those of Fakhriza & Permono (2025), who stated that flexibility did not show a significant relationship with dribbling. This

difference may be influenced by variations in sample characteristics, flexibility measurement methods, and the dribbling test instruments used. Lloyd & Oliver (2016) emphasized that in early adolescence, variations in biological maturation can influence the relationship between physical components and technical performance. Therefore, the age context of 14–15 years in this study is likely an important factor explaining the difference in results.

Meanwhile, leg muscle strength in this study showed a strong and significant relationship with dribbling skills. This finding is consistent with the literature stating that lower extremity strength is the mechanical foundation for generating force during acceleration, deceleration, and changes of direction (Nimphius et al., 2017; Comfort et al., 2019). Effective dribbling requires the ability to generate rapid horizontal force while maintaining ball control, which relies heavily on the strength capacity of the quadriceps, hamstring, and gastrocnemius muscles (Lees et al., 2018).

Adrian et al. (2025) and Habibulloh & Permono (2025) also reported that leg muscle strength significantly correlated with dribbling performance. Lesinski et al. (2020) added that increased strength in young athletes directly impacts technical performance through increased neuromuscular capacity and joint stability. From a sports physiology perspective, leg muscle strength enables optimal ground reaction force production, thus supporting rapid acceleration when dribbling (Hammami et al., 2018).

Furthermore, leg muscle strength plays a role in maintaining the stability of the body's center of mass when players perform lateral movements or body rotations to avoid opponents (Granacher et al., 2018). This stability is crucial for maintaining ball control in dynamic match situations. Thus, the results of this study confirm that leg muscle strength is a significant determinant of dribbling performance.

When analyzed simultaneously, leg muscle flexibility and strength contribute substantially to dribbling skills. These findings support the multicomponent approach to youth player development, as recommended by Lloyd & Oliver (2016) and Lesinski et al. (2020). The combination of flexibility and strength creates a synergy between movement efficiency and force production capacity. Flexibility enables more economical and adaptive movements, while strength provides the mechanical energy necessary to maintain speed and control the ball.

Theoretically, these results reinforce the integrative model of technical performance, which places physical conditioning as the foundation of sport-specific skills (Sarmento et al., 2020). Dribbling is not simply the result of repetitive technical practice but also represents physical readiness that supports optimal technical execution. In a coaching context, training programs that focus solely on technical aspects without strengthening the physical components have the potential to result in less than optimal performance development.

The practical implication of this study is the need to integrate dynamic flexibility training and progressive strength training into the training programs of players aged 14–15. Chaabene et al. (2019) suggest that strength development during adolescence should be systematically implemented to support improved technical performance while

minimizing the risk of injury. Meanwhile, dynamic stretching-based flexibility training can improve neuromuscular readiness prior to technical training (Behm et al., 2016).

Overall, this study confirms that leg muscle flexibility and strength are important, complementary factors in improving dribbling skills. The combination of these two components forms a physical foundation that enables players to dribble quickly, stably, and efficiently in competitive match situations. These findings provide a conceptual contribution to the literature on the physical determinants of football technical skills and a practical contribution to the design of evidence-based training programs.

CONCLUSION

This study concluded that leg muscle flexibility and strength significantly contributed to the dribbling skills of Bangunjiwo FA Demak players aged 14–15, both partially and simultaneously. Flexibility showed a moderately significant relationship, indicating its role in improving biomechanical efficiency, fluidity, and the ability to change direction while dribbling. Meanwhile, leg muscle strength showed a stronger relationship, confirming that force production capacity, dynamic stability, and acceleration are the main foundations of effective dribbling performance.

These findings reinforce the perspective that dribbling is a complex motor skill resulting from the interaction of various components of physical condition, not solely a matter of technical mastery. Therefore, training programs during the adolescent phase need to be designed in an integrative manner, combining the development of leg muscle flexibility and strength proportionally and based on the principle of periodization for optimal and sustainable performance improvement.

Further research is recommended to include additional variables such as speed, agility, and psychological aspects to build a more comprehensive contribution model. Furthermore, using a larger and more diverse sample will increase the generalizability of the findings and strengthen the development of evidence-based training strategies for athletes.

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