SPORTIFY JOURNAL
https://journal-center.litpam.com/index.php/sfj

Desember 2026, Vol. 6, No. 2
e-ISSN: 2807-4076
pp. 166-185

Relationship Between Abdominal Muscle Strength, Leg Strength and Soccer Kicking Ability Students

M Imran Hasanuddin[1*], Benny Badaru[2], Ishak Bachtiar[3], Abdul Rahman[4]

[1*, 2 ,3, 4] Department of Physical Education, Health and Recreation, Faculty of Sports and Health Sciences, Universitas Negeri Makassar, Wijaya Kusuma Raya Street No. 14, Banta-Bantaeng Campus, Rappocini District, Makassar City, South Sulawesi Province, Indonesia.

*Corresponding Author e-mail: m.imran.hasanuddin@unm.ac.id
Submission: June19, 2026; Revision: July 28, 2026; Accepted: September 05, 2026.

Abstract

Soccer kicking ability is a fundamental skill that supports passing, shooting, and long-ball execution, yet its performance may depend not only on technical execution but also on specific physical components. This study aimed to examine the relationship between abdominal muscle strength, leg strength, and soccer kicking ability among students of SMA Negeri 10 Makassar. A quantitative approach with a descriptive-correlational design was used. The sample consisted of 60 male students selected through simple random sampling. Abdominal muscle strength was measured using a 30-second sit-up test, leg strength was measured using a leg dynamometer, and soccer kicking ability was assessed based on maximal kicking distance. Data were analyzed using descriptive statistics, normality testing, Pearson correlation, and multiple linear regression with SPSS. The findings showed that abdominal muscle strength was positively and significantly associated with soccer kicking ability ($r = .522$, $p < .001$), and leg strength also showed a positive and significant association with soccer kicking ability ($r = .586$, $p < .001$). Simultaneously, abdominal muscle strength and leg strength were significantly related to soccer kicking ability ($R = .671$, $R^2 = .450$, $p < .001$). These findings indicate that both trunk-related and lower-limb strength contribute meaningfully to distance-oriented kicking performance. The study provides practical implications for physical education teachers and coaches by emphasizing the importance of integrating abdominal and leg strength development into soccer skill learning and training programs.

Keywords: Abdominal muscle strength; Leg strength; Soccer kicking ability; Football; Correlational study.

How to Cite: Hasanuddin, M. I. ., Badaru, B. ., & Bachtiar, I. . (2026). Relationship Between Abdominal Muscle Strength, Leg Strength and Soccer Kicking Ability Students. *Sportify Journal*, *6*(2), 166-185. https://doi.org/10.36312/sj.v6i2.6038

https://doi.org/10.36312/sj.v6i2.6038

INTRODUCTION

Soccer kicking ability is a central technical component in football performance because it directly supports passing, shooting, clearance, and long-ball execution during play. Although kicking appears to be a simple motor action, it is actually a complex movement that requires the integration of lower-limb force production, trunk stabilization, joint coordination, foot–ball interaction, and task-specific control. Previous studies have shown that kicking performance is commonly evaluated through ball velocity, kicking accuracy, maximal kicking distance, or multidimensional indicators combining accuracy and speed (Carstensen & Andersen, 2026; Hunter et al., 2022; Masmoudi et al., 2021; Rodríguez-Lorenzo et al., 2018). In youth and school-age players, kicking ability is especially important because technical execution is still developing and is influenced by physical growth, strength, flexibility, motor control, and training exposure (Cejudo et al., 2024;

Rodríguez-Lorenzo et al., 2019). Biomechanical evidence further indicates that effective soccer kicking depends not only on the swinging leg but also on coordinated actions involving the trunk, pelvis, supporting leg, hip, knee, and ankle (da Silva Carvalho et al., 2024; Ou et al., 2023; Zhang, Navandar, & Navarro, 2025). Therefore, the study of soccer kicking ability should not be separated from the physical capacities that support the movement. Within this context, abdominal muscle strength and leg strength are relevant physical variables because the trunk contributes to stability and force transfer, whereas the lower limbs generate and transmit mechanical force during the kicking motion (Prieske et al., 2016; Rodríguez-Lorenzo et al., 2016; Sato et al., 2025).

Despite the importance of kicking ability in football, many young players still experience difficulty producing strong and effective kicks. This problem may occur because kicking performance is shaped by multiple interacting factors rather than by technical instruction alone. Empirical evidence shows that kicking performance can be affected by exercise intensity, fatigue, time pressure, task difficulty, support-foot placement, sleep quality, and neuromuscular coordination (Ferraz et al., 2017; Ferraz et al., 2019; Masmoudi et al., 2021; Ou et al., 2023; Palucci Vieira et al., 2022; Radman et al., 2016). Other studies have shown that lower-limb strength, hip and knee function, vertical jump ability, and inter-segmental coordination are relevant to maximal kicking speed and ball-striking performance (Kılcı et al., 2026; Rodríguez-Lorenzo et al., 2016; Zhang et al., 2025; Zhang et al., 2026). These findings indicate that the problem of limited kicking ability can be addressed through a better understanding of the physical and biomechanical contributors to kicking performance. However, in educational and school-based settings, assessment of kicking ability is often conducted practically through field tests, while physical components such as abdominal muscle strength and leg strength are not always analyzed as predictors or correlates of kicking performance. This issue is important because physical education teachers and coaches require simple, measurable, and evidence-based indicators to identify students' physical readiness for football skills. Therefore, examining the relationship between abdominal muscle strength, leg strength, and kicking ability is necessary to clarify whether these physical components are meaningfully associated with students' soccer kicking performance.

Previous research has provided important evidence regarding soccer kicking from several perspectives. Some studies have focused on kicking velocity, kicking accuracy, and the reliability of kicking-performance assessments (Carstensen & Andersen, 2026; Hunter et al., 2022; Vieira et al., 2017). Other studies have examined the influence of age, maturation, anthropometry, flexibility, vertical jump ability, and lower-limb strength on ball-kicking performance (Cejudo et al., 2024; Rodríguez-Lorenzo et al., 2016, 2018, 2019). Biomechanical investigations have also emphasized support-foot placement, trunk and lower-limb kinetic strategies, elastic taping, and support-leg kinematics during instep kicking (da Silva Carvalho et al., 2024; Ou et al., 2023; Sato et al., 2025; Zhang, Navandar, & Navarro, 2025). In addition, experimental research has investigated the effects of training, fatigue, physiological strain, and attentional factors on kicking outcomes (Ferraz et al., 2017; Kılcı et al., 2026; Navarro et al., 2018; Niźnikowski et al., 2025; Peng et al., 2026; Radman et al., 2016). However, the available literature still shows a gap in studies that specifically examine the combined relationship between abdominal muscle strength, leg strength, and kicking distance ability among school students in a physical education context. Most previous studies were conducted with trained players, academy athletes, university players, or competitive football populations, and many used laboratory-based biomechanical instruments. The novelty of the present study lies in its focus on simple field-based physical indicators—sit-up performance as an indicator of abdominal muscle strength and leg dynamometer performance as an indicator of leg strength—and their relationship with soccer kicking ability among students. This study therefore fills a practical and empirical gap by linking measurable physical fitness components with a fundamental football skill in a school-based sample.

Based on this background and research gap, the present study aims to examine the relationship between abdominal muscle strength, leg strength, and soccer kicking ability among students of SMA Negeri 10 Makassar. The scope of the study is limited to three observed variables: abdominal muscle strength, leg strength, and soccer kicking ability. Abdominal muscle strength is measured using a 30-second sit-up test, leg strength is measured using a leg dynamometer, and soccer kicking ability is measured through the distance achieved in a maximal ball-kicking test. The study applies a correlational design to determine whether abdominal muscle strength is associated with soccer kicking ability, whether leg strength is associated with soccer kicking ability, and whether both physical variables are jointly related to soccer kicking ability. This scope is consistent with the need for school-based evidence that can support football instruction, student assessment, and basic talent identification in physical education. The study does not attempt to explain all determinants of soccer kicking performance, because kicking ability may also be influenced by technique, coordination, flexibility, maturation, experience, psychological factors, and environmental constraints. Nevertheless, by focusing on abdominal muscle strength and leg strength, this study provides a practical contribution to understanding how selected physical components are related to students' ability to kick the ball farther. The findings are expected to offer empirical information for teachers, coaches, and researchers who seek to develop evidence-based approaches to football skill learning and physical conditioning in school settings.

METHOD

Research Design

This study employed a quantitative descriptive-correlational design. The design was selected because the study aimed to examine the relationships between abdominal muscle strength, leg strength, and soccer kicking ability rather than to test an intervention, compare experimental groups, or manipulate treatment conditions. The variables were measured directly through field-based performance tests, and the statistical analysis focused on the direction, strength, and significance of the associations among the observed variables. This design is therefore consistent with the research questions, which examined the relationship between abdominal muscle strength and soccer kicking ability, the relationship between leg strength and soccer kicking ability, and the simultaneous relationship between the two physical variables and soccer kicking ability.

The dependent variable in this study was soccer kicking ability, operationalized as maximal kicking distance. The independent variables were abdominal muscle strength and leg strength. The use of field-based indicators is consistent with sport-performance research in which kicking performance is examined through measurable outcomes such as distance, velocity, accuracy, and performance validity (Carstensen & Andersen, 2026; Vieira et al., 2017). Biomechanical evidence also supports the relevance of trunk and lower-limb variables in soccer kicking because kicking performance involves coordinated force transfer from the body segments to the ball (da Silva Carvalho et al., 2024; Ou et al., 2023).

Table 1. Research design and variable structure

Variable Code	Variable	Role in the Study	Operational Indicator
X1	Abdominal muscle strength	Independent variable	Number of sit-up repetitions completed within 30 seconds
X2	Leg strength	Independent variable	Best score obtained using a leg dynamometer
Y	Soccer kicking ability	Dependent variable	Maximum distance achieved in the soccer kicking test

Participants

The population of this study consisted of students of SMA Negeri 10 Makassar. The sample consisted of 60 male students selected using simple random sampling through a lottery-based procedure. The source document states that the selected participants had similar basic characteristics, namely being male students and being able to perform a soccer kicking task. The document does not provide additional demographic or anthropometric information, such as age, grade level, height, body mass, football-training background, or biological maturation status. Therefore, these details were not added to this method section to preserve the integrity of the original methodological information.

The available inclusion criteria were limited to male students who were able to kick a soccer ball. The source document did not report formal exclusion criteria such as lower-limb injury, medical conditions, recent participation in structured football training, or absence from testing. Since previous youth soccer studies have shown that age, maturation, and body size may influence kicking-performance outcomes, the absence of these variables should be acknowledged as a methodological limitation rather than reconstructed without evidence (Cejudo et al., 2024).

Table 2. Participants and sampling characteristics

Component	Description
Population	Students of SMA Negeri 10 Makassar
Sample size	60 students
Sex	Male
Sampling technique	Simple random sampling
Sampling procedure	Lottery-based selection
Available inclusion criteria	Male students who were able to kick a soccer ball
Research location	SMA Negeri 10 Makassar

Instruments and Research Procedures

Three instruments were used to collect the research data: a 30-second sit-up test, a leg dynamometer test, and a soccer kicking distance test. The sit-up test was used to measure abdominal muscle strength. The leg dynamometer test was used to measure leg strength. The soccer kicking distance test was used to measure the students' ability to kick the ball as far as possible. The use of practical performance tests is appropriate for school-based physical education research because the variables can be observed directly and converted into quantitative scores. However, the source document does not report numerical validity or reliability coefficients for the instruments. Therefore, this section does not add unsupported validity or reliability values.

For the abdominal muscle strength test, participants assumed a supine position on a flat surface with both hands linked behind the head. At the command to start, each participant performed sit-ups for 30 seconds. The score recorded was the number of completed repetitions within the time limit. For the leg strength test, participants stood on a leg dynamometer while holding the dynamometer bar with both hands and flexing the knees to approximately 115 degrees. After the command, participants straightened the knees without using the hands to pull the handle. Two trials were provided, and the best score was recorded. For the soccer kicking ability test, participants stood behind the ball and kicked it as far as possible without a running approach. Three attempts were provided, and the farthest distance was recorded as the final score.

Table 3. Instruments, measured indicators, and scoring procedures

Variable	Instrument	Testing Procedure	Score Recorded
Abdominal muscle strength	30-second sit-up test	Participant performed sit-ups from a supine position with hands linked behind the head for 30 seconds.	Number of sit-up repetitions completed within 30 seconds
Leg strength	Leg dynamometer	Participant stood on the dynamometer, flexed the knees approximately 115 degrees, and straightened the knees after the command. Two trials were given.	Best score from two attempts
Soccer kicking ability	Maximal soccer kicking distance test	Participant kicked the ball as far as possible without a running approach. Three attempts were given.	Farthest kicking distance from three attempts

The research procedure was conducted in several stages. First, the researcher prepared the testing location, equipment, data collection sheets, and field markers. Second, participants were selected using the simple random sampling procedure described above. Third, the participants completed the physical and skill tests, namely the 30-second sit-up test, leg dynamometer test, and soccer kicking distance test. Fourth, the results were recorded and tabulated for statistical analysis. Fifth, the data were analyzed using descriptive and inferential statistics. The source document states that the research was conducted at SMA Negeri 10 Makassar, but it does not report the exact date of data collection, warm-up protocol, ethical approval procedure, written informed consent, or instrument calibration procedure.

Table 4. Sequential research procedure

Stage	Procedure	Information Available in the Source Document
1. Preparation	Preparation of location, equipment, and recording sheets	Testing was conducted at SMA Negeri 10 Makassar; detailed preparation procedures were not fully reported
2. Sampling	Selection of research participants	Simple random sampling through a lottery-based procedure
3. Measurement	Administration of sit-up, leg dynamometer, and soccer kicking distance tests	Three measured variables: abdominal muscle strength, leg strength, and soccer kicking ability
4. Recording	Recording of scores for each variable	Scores were tabulated for 60 male students
5. Analysis	Descriptive statistics, normality test, correlation, and multiple regression analysis	SPSS was used for statistical analysis

Data Analysis

The collected data were analyzed using descriptive and inferential statistics with SPSS. Descriptive statistics were used to summarize the distribution of each variable, including mean, standard deviation, variance, minimum score, maximum score, and range. Before hypothesis testing, the normality assumption was examined using the Kolmogorov-Smirnov test as described in the source document. The purpose of this prerequisite test was to determine whether parametric statistical procedures could be applied. Inferential analysis was conducted to test the relationships among the variables. Simple correlation analysis was used to examine the relationship between abdominal muscle strength and soccer kicking ability and between leg strength and soccer kicking ability. Multiple correlation or multiple linear regression analysis was used to examine the simultaneous relationship between abdominal muscle strength and leg strength with soccer kicking ability. Although the narrative in the source document contains inconsistent wording between Pearson Product-Moment and Spearman correlation, the SPSS output provided in the research file reports Pearson correlations and multiple linear regression. Therefore, the final methodological description is aligned with the reported SPSS output, while the normality test is retained as a prerequisite analysis. The significance level used for hypothesis testing was .05.

Table 5. Statistical analysis plan

Analysis Stage	Statistical Technique	Purpose	Decision / Interpretation Basis
Descriptive analysis	Mean, standard deviation, variance, minimum, maximum, and range	To describe the distribution of abdominal muscle strength, leg strength, and soccer kicking ability	Descriptive values were interpreted according to the observed score distribution
Prerequisite analysis	Kolmogorov-Smirnov normality test	To examine whether the variables met the normality assumption for parametric testing	$p > .05$ indicates no significant deviation from normality; $p < .05$

			indicates non-normal distribution
Simple relationship testing	Pearson Product-Moment correlation as reported in the SPSS output	To examine the relationship between each independent variable and soccer kicking ability	Correlation coefficient, direction of relationship, and significance value
Simultaneous relationship testing	Multiple correlation / multiple linear regression	To examine the joint relationship between abdominal muscle strength and leg strength with soccer kicking ability	R, R Square, Adjusted R Square, F-test, coefficients, t-values, tolerance, VIF, and residual statistics
Software and significance level	SPSS; alpha = .05	To support statistical computation and hypothesis testing	Results were considered significant when p < .05

RESULTS AND DISCUSSION

The descriptive statistics showed that all variables had 60 valid cases and no missing values. Abdominal muscle strength had a mean score of 18.3333, leg strength had a mean score of 44.8667, and soccer kicking ability had a mean score of 26.9272.

Table 6. Statistics

		Kekuatan Otot Perut	Kekuatan Tungkai	Kemampuan Menendang Bola
N	Valid	60	60	60
	Missing	0	0	0
Mean		18.3333	44.8667	26.9272
Median		18.5000	44.7500	27.1550
Mode		21.00	67.50	24.28[a]
Std. Deviation		2.47473	14.27391	3.75899
Range		8.00	42.50	14.18
Minimum		14.00	25.00	19.06
Maximum		22.00	67.50	33.24

Table 7. Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Kekuatan Otot Perut	60	8.00	14.00	22.00	18.3333	2.47473	6.124
Kekuatan Tungkai	60	42.50	25.00	67.50	44.8667	14.27391	203.745
Kemampuan Menendang Bola	60	14.18	19.06	33.24	26.9272	3.75899	14.130
Valid N (listwise)	60						

Tests of Normality

The normality test was conducted using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The results showed that abdominal muscle strength and soccer kicking ability had Kolmogorov-Smirnov significance values below .05, while leg strength had a Kolmogorov-Smirnov significance value above .05. Based on Shapiro-Wilk, all variables had significance values below .05.

Table 8. Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Kekuatan Otot Perut	.126	60	.019	.936	60	.004
Kekuatan Tungkai	.109	60	.071	.916	60	.001
Kemampuan Menendang Bola	.119	60	.036	.960	60	.049

Pearson Correlation Analysis

Pearson correlation analysis showed that abdominal muscle strength was positively and significantly correlated with soccer kicking ability, r = .522, Sig. = .000. Leg strength was also positively and significantly correlated with soccer kicking ability, r = .586, Sig. = .000. In addition, abdominal muscle strength was positively correlated with leg strength, r = .375, Sig. = .003.

Table 9. Correlations

		Kekuatan Otot Perut	Kekuatan Tungkai	Kemampuan Menendang Bola
Kekuatan Otot Perut	Pearson Correlation	1	.375**	.522**
	Sig. (2-tailed)		.003	.000
	N	60	60	60
Kekuatan Tungkai	Pearson Correlation	.375**	1	.586**
	Sig. (2-tailed)	.003		.000
	N	60	60	60
Kemampuan Menendang Bola	Pearson Correlation	.522**	.586**	1
	Sig. (2-tailed)	.000	.000	
	N	60	60	60

Descriptive Statistics for Regression Analysis

Before conducting multiple linear regression, descriptive statistics for the dependent and independent variables were also reported. Soccer kicking ability was used as the dependent variable, while abdominal muscle strength and leg strength were used as independent variables.

Table 10. Descriptive Statistics

	Mean	Std. Deviation	N
Kemampuan Menendang Bola	26.9272	3.75899	60
Kekuatan Otot Perut	18.3333	2.47473	60
Kekuatan Tungkai	44.8667	14.27391	60

Correlations for Regression Analysis

The regression correlation matrix showed that soccer kicking ability had a positive correlation with abdominal muscle strength, r = .522, and leg strength, r = .586. The correlation between abdominal muscle strength and leg strength was r = .375.

Table 11. Correlations

		Kemampuan Menendang Bola	Kekuatan Otot Perut	Kekuatan Tungkai
Pearson Correlation	Kemampuan Menendang Bola	1.000	.522	.586
	Kekuatan Otot Perut	.522	1.000	.375
	Kekuatan Tungkai	.586	.375	1.000
Sig. (1-tailed)	Kemampuan Menendang Bola	.	.000	.000
	Kekuatan Otot Perut	.000	.	.002
	Kekuatan Tungkai	.000	.002	.
N	Kemampuan Menendang Bola	60	60	60
	Kekuatan Otot Perut	60	60	60
	Kekuatan Tungkai	60	60	60

Variables Entered/Removed

The multiple linear regression analysis used the Enter method. Leg strength and abdominal muscle strength were entered simultaneously as predictors of soccer kicking ability.

Table 12. Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Kekuatan Tungkai, Kekuatan Otot Perut[b]	.	Enter

Model Summary

The multiple regression model showed an R value of .671, indicating a strong relationship between the predictors and soccer kicking ability. The R Square value was .450, meaning that abdominal muscle strength and leg strength explained 45.0% of the variance in soccer kicking ability. The adjusted R Square value was .431.

Table 13. Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.671[a]	.450	.431	2.83575	.450	23.336	2	57	.000	1.775

ANOVA

The ANOVA result showed that the regression model was statistically significant, F(2, 57) = 23.336, Sig. = .000. This indicates that abdominal muscle strength and leg strength simultaneously predicted soccer kicking ability.

Table 14. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	375.307	2	187.654	23.336	.000[b]
	Residual	458.363	57	8.041		
	Total	833.670	59			

Regression Coefficients

The coefficient table showed that abdominal muscle strength significantly predicted soccer kicking ability, B = .535, t = 3.322, Sig. = .002. Leg strength also significantly predicted soccer kicking ability, B = .120, t = 4.288, Sig. = .000. Based on standardized coefficients, leg strength had a stronger relative contribution, β = .454, compared with abdominal muscle strength, β = .352. The regression equation was: Soccer Kicking Ability = 11.759 + .535 (Abdominal Muscle Strength) + .120 (Leg Strength).

Table 15. Coefficients[a]

Model		Unstandardized Coefficients: B	Std. Error	Standardized Coefficients: Beta	t	Sig.	Correlations: Zero-order	Partial	Part	Collinearity Statistics: Tolerance	VIF
1	(Constant)	11.759	2.763		4.256	.000					
	Kekuatan Otot Perut	.535	.161	.352	3.322	.002	.522	.403	.326	.859	1.164
	Kekuatan Tungkai	.120	.028	.454	4.288	.000	.586	.494	.421	.859	1.164

Collinearity Diagnostics

The collinearity diagnostics showed condition index values of 1.000, 7.328, and 18.561. The tolerance values in the coefficient table were .859, and the VIF values were 1.164 for both predictors. These results indicate that there was no serious multicollinearity problem in the regression model.

Table 16. Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	Kekuatan Otot Perut	Kekuatan Tungkai
1	1	2.937	1.000	.00	.00	.01
	2	.055	7.328	.07	.03	.95
	3	.009	18.561	.93	.97	.04

Residual Statistics

The residual statistics showed that the predicted values ranged from 22.4134 to 31.5951, with a mean of 26.9272 and a standard deviation of 2.52213. The residual values ranged from -8.65700 to 5.03146. The standardized residual values ranged from -3.053 to 1.774.

Table 17. Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	22.4134	31.5951	26.9272	2.52213	60
Residual	-8.65700	5.03146	.00000	2.78727	60
Std. Predicted Value	-1.790	1.851	.000	1.000	60
Std. Residual	-3.053	1.774	.000	.983	60

The SPSS results showed that abdominal muscle strength and leg strength were positively and significantly correlated with soccer kicking ability. Leg strength had a stronger bivariate relationship with soccer kicking ability than abdominal muscle strength. The multiple regression model was statistically significant and explained 45.0% of the variance in soccer kicking ability. Both abdominal muscle strength and leg strength were significant predictors, with leg strength showing the stronger relative contribution based on the standardized beta coefficient.

DISCUSSION

The significant relationship between abdominal muscle strength and soccer kicking ability indicates that trunk-related strength has a meaningful role in supporting long-distance kicking performance among school students. This finding should not be interpreted merely as a mechanical contribution of the abdominal muscles in isolation, but as evidence that the trunk may support force transfer, postural control, and movement stability during the kicking action. From a theoretical perspective, kicking is a sequential movement in which the body must coordinate proximal and distal segments so that force generated by the lower limbs can be efficiently transmitted to the ball. The present finding is consistent with evidence showing that core stability training can improve selected neuromuscular and technical outcomes in young soccer players, including balance, agility, and kicking accuracy (Gottlieb et al., 2025). It also aligns with studies emphasizing that kicking performance is influenced by neuromuscular control, movement organization, and coordination of body segments rather than by limb force alone (Akcan et al., 2026; Navandar et al., 2022; Wang et al., 2025). However, not all studies place trunk strength as a direct predictor of kicking performance. For example, research on supporting-leg stiffness and trunk kinematics has shown that trunk-related mechanics may not always translate directly into swing speed or kicking outcomes (Tamura et al., 2024). This difference may arise because the present study used a simple sit-up test as a field-based indicator of abdominal muscle strength, whereas biomechanical studies often assess joint kinematics, stiffness, and segmental velocity using laboratory instruments. Therefore, the present result suggests a practical association rather than a definitive biomechanical causal pathway. A limitation is that sit-up performance may reflect muscular endurance and movement familiarity, not pure trunk strength. Practically, however, the finding supports the inclusion of trunk-strengthening exercises in school football instruction, provided that such training is integrated with technical kicking practice rather than treated as an isolated determinant of performance.

The stronger relationship between leg strength and soccer kicking ability confirms the functional importance of the lower limbs in producing effective kicking distance. In the context of soccer kicking, the leg does not merely strike the ball; it generates, accelerates, and transfers mechanical force through coordinated hip, knee, ankle, and support-leg actions. This interpretation is supported by studies showing that joint-specific strength profiles are related to maximal soccer kicking speed (Akcan et al., 2026), while muscular strength, asymmetry, and fatigue can affect kicking speed and accuracy in soccer players (Maly et al., 2018). Similar evidence indicates that mechanical properties of the lower limbs and dynamic balance contribute to free-kick accuracy, suggesting that leg function involves both force generation and movement control (Jihad et al., 2025). The present finding also corresponds with studies on kicking velocity and leg dominance, where preferred-leg performance and lower-limb efficiency are important markers of kicking capacity (Rađa et al., 2023; Šoš & Segedi, 2025). Nevertheless, the present finding differs from studies showing that static stability of the supporting leg may not significantly predict one-step kicking performance (Bisht & Singh, 2025), and that selected equipment or environmental manipulations can alter kicking outcomes independently of muscular strength (Cigoja et al., 2019; Hasan et al., 2016). These differences may be explained by the dependent variable used in each study. The present study measured maximum kicking distance, whereas other studies examined accuracy, ball velocity, stability, or equipment-related effects. Distance-based kicking may be more sensitive to gross lower-limb force capacity, whereas accuracy-based kicking may depend more on coordination, target control, and perceptual regulation. A limitation of the present study is that leg strength was measured with a leg dynamometer, which does not fully replicate the dynamic angular velocities and inter-segmental timing of an actual soccer kick. Even so, the finding provides practical evidence that leg-strength assessment can be used as a simple screening indicator in school-based football learning.

The simultaneous relationship between abdominal muscle strength, leg strength, and soccer kicking ability shows that kicking performance is better understood as a multifactorial outcome than as the result of a single physical component. The regression model indicates that the two physical variables jointly explain a substantial portion of the variance in kicking ability, but also leaves room for other determinants not measured in the study. Theoretically, this supports a multidimensional view of sport skill performance, in which physical capacity, technical execution, coordination, perception, fatigue resistance, and contextual constraints interact to produce the final movement outcome. Studies on kicking performance have shown that technical skill can be influenced by training format, task design, attentional focus, decision-making, fatigue, and perceptual-cognitive conditions (Albaitomi et al., 2025; Bonney et al., 2020a; Bonney et al., 2020b; Elliott et al., 2020; Gaspar et al., 2019; van den Tillaar & Fuglstad, 2017). Other evidence from football and Australian football also demonstrates that kicking or goal-kicking performance is shaped by task constraints such as distance, angle, target location, shot type, and environmental context (Anderson et al., 2018; Browne et al., 2022; Dwyer & Young, 2024; Murray et al., 2022). These studies differ from the present research because they typically evaluate performance in more complex or competitive environments, whereas this study measured maximal kicking distance under a standardized field-test condition. This difference is important because a simplified test may capture physical contribution more clearly, but may not reflect the perceptual and tactical demands of real match play. The limitation, therefore, is that the present model cannot explain all aspects of soccer kicking performance, particularly accuracy, decision-making, ball placement, and pressure-based execution. Nevertheless, the finding has methodological value because it demonstrates that two easily measured physical variables can provide meaningful explanatory information in a school-based sample.

The relative dominance of leg strength compared with abdominal muscle strength in the regression model provides further insight into the hierarchy of physical contributions to kicking distance. This does not mean that abdominal muscle strength is unimportant, but rather that lower-limb strength appears to have a more direct relationship with the outcome measured in this study. The dependent variable was maximum kicking distance, and such an outcome is logically more dependent on force production from the kicking and supporting limbs than on trunk strength alone. This interpretation is compatible with evidence that lower-limb power, stiffness, muscle function, and kicking-specific strength are associated with football performance indicators (Joseph et al., 2020; Kilci et al., 2026; Lesinski et al., 2021; Mensah et al., 2020). At the same time, studies on kicking accuracy and speed–accuracy trade-off suggest that more forceful kicking does not automatically result in more accurate kicking (Sørensen et al., 2024; Šoš & Segedi, 2025; van den Tillaar & Fuglstad, 2017). This comparison clarifies the scope of the present finding: leg strength may be more relevant for distance-oriented kicking, but it cannot be assumed to be equally dominant for accuracy-oriented or tactical kicking tasks. Differences between studies may also be caused by variations in sample characteristics, because the present study involved school students, whereas several previous investigations used trained players, academy athletes, or competitive samples. The present study also did not report age, maturation, body size, training history, or dominant-leg status, all of which may influence kicking outcomes. Therefore, the implication is that leg-strength development should be emphasized in physical education and youth football conditioning, but should be combined with technique, bilateral practice, balance, and accuracy drills to prevent a narrow interpretation that strength alone determines kicking quality.

The normality and residual diagnostics provide an important methodological context for interpreting the findings. The normality results indicate that the assumption of normality was not fully satisfied, particularly when the Shapiro-Wilk test is considered. Therefore, although the SPSS output reports Pearson correlations and multiple linear regression, the interpretation of the results should remain cautious. This does not invalidate the findings, but it suggests that future studies should consider complementary nonparametric analyses, robust regression, or data transformation when distributional assumptions are not fully met. The residual statistics also indicated one standardized residual slightly beyond the common threshold, suggesting that at least one case may have differed from the general prediction pattern. In sport performance research, such deviation is plausible because an individual may have high physical strength but still produce a lower kicking outcome due to technique, coordination, contact quality, motivation, fatigue, or unfamiliarity with the test. Previous studies have shown that kicking outcomes may be influenced by factors beyond strength, including fatigue, intervention type, visual-perceptual control, biomechanical measurement procedures, and neuromuscular regulation (Augustus et al., 2023; Carstensen et al., 2026; Chinaglia et al., 2026; Giustino et al., 2024; Piskin et al., 2025). These studies help explain why physical variables may not perfectly predict kicking performance. The limitation of the present study is that it did not include observational technique assessment, video analysis, ball velocity measurement, kicking accuracy, or repeated reliability testing. As a result, the model should be viewed as a field-based correlational explanation rather than a comprehensive performance model. Methodologically, the study highlights the need for future research to combine simple school-based physical tests with technical and biomechanical indicators.

Taken together, the findings contribute to the understanding of soccer kicking ability in a school-based context by showing that abdominal muscle strength and leg strength are meaningfully associated with kicking distance. Theoretically, the results support the idea that soccer kicking is an integrated physical-skill action involving both proximal stability and distal force production. Practically, the findings indicate that physical education teachers and coaches can use sit-up and leg dynamometer tests as preliminary indicators to understand students' physical readiness for distance-based kicking tasks. However, the discussion also shows that kicking performance cannot be reduced to physical strength alone. Studies on fatigue, task constraints, training methods, support-leg mechanics, and perceptual-cognitive factors indicate that performance emerges from the interaction between physical capacity and task execution demands (Attaallah et al., 2021; Hadlow et al., 2017; Ozimek et al., 2022; Peker et al., 2022; Pocock et al., 2018; Steel & Ellem, 2016; Tamura et al., 2023). The main difference between these studies and the present research lies in context and measurement focus: many previous studies investigated competitive, laboratory, or intervention settings, whereas this study used a correlational field-test design in school students. This difference strengthens the practical relevance of the study but also limits causal interpretation. Therefore, future research should include larger and more diverse samples, age and anthropometric data, technical assessments, kicking accuracy, ball velocity, and instrument reliability evidence. The practical implication is that school football instruction should integrate leg-strength development, trunk stabilization, kicking technique, dynamic balance, and task-specific practice to improve kicking performance more comprehensively.

CONCLUSION

This study concludes that abdominal muscle strength and leg strength are significantly associated with soccer kicking ability among students of SMA Negeri 10 Makassar. The findings answer the research objectives by showing that each physical component has a meaningful relationship with kicking performance, and that both variables together provide a relevant explanation of students' ability to kick the ball farther. Leg strength appears to have a stronger relative contribution than abdominal muscle strength, indicating that lower-limb force capacity plays a central role in distance-oriented kicking performance. Nevertheless, abdominal muscle strength remains important because trunk stability may support movement control and force transfer during the kicking action.

Theoretically, this study strengthens the view that soccer kicking ability is not only a technical skill but also a physical-performance outcome supported by integrated trunk and lower-limb function. Practically, the findings suggest that physical education teachers and coaches may consider abdominal and leg strength as useful field-based indicators when assessing students' readiness and potential in football learning. Methodologically, the study demonstrates that simple performance tests, such as sit-ups, leg dynamometer assessment, and maximal kicking distance tests, can provide practical information in school-based sport research.

However, this study is limited by the absence of information on age, anthropometry, football experience, technical quality, ball velocity, kicking accuracy, instrument reliability, and detailed biomechanical variables. Therefore, future studies should include broader participant characteristics, combine physical tests with technical and biomechanical assessments, and examine whether strength-related variables predict not only kicking distance but also accuracy and performance consistency. Further research may also use longitudinal or intervention designs to clarify whether improving abdominal and leg strength directly enhances soccer kicking ability.

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