

Relationship Between Leg Muscle Strength and Abdominal Muscles to Shooting Accuracy in Futsal Extracurricular Students of Indocement High School

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Abstract

Shooting accuracy is a technical skill in futsal, but field observations show that many school-level players fail to produce stable and powerful kicks due to low stability control and explosive power influenced by basic physical capacity. This study aims to analyze the partial and simultaneous relationship between leg muscle strength and abdominal muscle strength with shooting accuracy in futsal extracurricular students at SMA Indocement, Bogor Regency in 2026. Using a correlational quantitative design with a sample of 60 students, the instruments used included the Vertical Jump Test to measure leg muscle strength, the Timed Sit-Up Test for abdominal muscle strength, and the Target Shooting Test for shooting accuracy. The results of data analysis showed that leg muscle strength had a moderate correlation ($r = 0.528$), which indicates that the explosive propulsion ability of the legs determines the speed of the ball towards the target. Abdominal muscle strength was also significantly related ($r = 0.401$), which confirms the role of core stability in maintaining postural balance during kicking. Simultaneously, these two physical components contributed 35.4% to shooting accuracy ($r = 0.595$; $p < 0.05$), so it can be concluded that increasing the precision of a player's shot must be based on strengthening the explosive power of the legs and stability of the abdominal muscles in an integrated manner.

Keywords: leg muscles; abdominal muscles; shooting accuracy; futsal; extracurricular students

1. Introduction

The development of futsal sports in Indonesia has increased significantly since its introduction in the late 1990s (Yiannaki et al., 2020). Since that period, futsal began to be widely known and developed rapidly in the early 2000s, marked by the number of futsal schools and the organization of various competitions from the student to professional levels (Risyanto et al., 2020). Characteristically, futsal has fundamental differences from football, in terms of field size, number of players, duration of matches, and intensity of play (Ohmuro et al., 2020). The smaller field, the effective time duration of 2×20 minutes, and the fast tempo of the game require players to have excellent technique, tactics, and physical condition (Budiman et al., 2023). In this context, futsal under the auspices of FIFA has developed into a sport that demands physical performance and technical skills (Raibowo et al., 2021).

One of the basic techniques that greatly determines the success of a team in a futsal match is the ability to shoot or shoot at the goal (R. M. Yusuf et al., 2024). Shooting accuracy is an important indicator of attack effectiveness, because the higher the accuracy of the shot, the greater the chance of scoring goals (Ratri et al., 2024). However, shooting ability is not only determined by mastering technique, but also influenced by physical condition factors, especially the strength of the leg and

abdominal muscles (Jihad & Mugiyo Hartono, 2025) . The leg muscles play a role in producing explosive power and kicking power, while the core muscles function to maintain stability and balance when shooting (Rikardo, 2021).

Theoretically, the link between leg and abdominal muscle strength and shooting accuracy has been extensively discussed in the sports literature (Faozi et al., 2024). Previous studies have shown that improving shooting accuracy can be done through various training methods, such as the use of target media and game-based training approaches (Ardiansyah, 2020). However, most of these studies focused more on the effectiveness of exercise methods in improving shooting results, rather than on analyzing the direct relationship between certain components of physical conditions—specifically leg and abdominal muscle strength—and shooting accuracy (Saputra et al., 2024). This is where there is a research gap, namely there are still limited empirical studies that specifically test the simultaneous contribution of leg and abdominal muscle strength to shooting accuracy in the context of high school students (Alfarizi et al., 2024).

This gap becomes even more relevant when it is associated with factual conditions in the field. Based on initial observations on the futsal extracurricular activities of INDOCEMENT High School, it was found that students' basic technical skills, especially in shooting, are still relatively low. The coach said that the students' mastery of basic techniques was not optimal and required a more structured exercise improvement. In addition, there has never been a systematic measurement or physical condition test to determine the level of strength of students' leg and abdominal muscles. The training program that is running is not fully based on scientific principles of coaching and measurable evaluation.

This condition shows the urgency of research. Without data to find out the relationship between leg and abdominal muscle strength and shooting accuracy, coaches will have difficulty developing a targeted training program (Ardiansyah, 2020). Therefore, research is needed that can provide an objective picture of the extent to which leg and abdominal muscle strength contribute to shooting accuracy, so that the results can be used as a basis for planning a more targeted and evidence-based exercise program (Muhtarom et al., 2024).

The novelty of this study lies in the focus of analyzing the relationship between two components of physical condition—leg muscle strength and abdominal muscle strength—simultaneously to shooting accuracy in specific subjects, namely high school futsal extracurricular students (Karawang, 2020). This study not only assesses the improvement in outcomes due to certain exercise treatments, but examines the correlation and contribution of physical condition variables to the ability of shooting techniques (S. Yusuf et al., 2025). Thus, this research is expected to enrich the treasure of sports coaching science, especially in the development of school-age futsal coaching models (Ardiansyah, 2020).

Based on the identification of problems, research gaps, practical urgency, and novelty aspects, the purpose of this study is to find out and analyze the relationship between leg muscle strength and abdominal muscle strength to shooting accuracy in extracurricular futsal students of INDOCEMENT High School, both partially and simultaneously. The results of this research are expected to provide theoretical contributions in the field of sports science as well as practical contributions for extracurricular coaches and coaches in designing more effective and measurable training programs.

2. Method

This study used a quantitative correlational design to determine the relationship between leg muscle strength (X1), abdominal muscle strength (X2), and futsal shooting accuracy (Y). This study was conducted at Indocement High School, Bogor Regency, West Java, in January 2026. The study population was all students participating in the futsal extracurricular activity at Indocement High School. The sample size was 60 students from all futsal extracurricular activities. The instrument for measuring leg muscle strength was the vertical jump, for abdominal muscle strength, the timed sit-up, and for shooting accuracy, the target goal.

The instrument for measuring leg muscle strength was the height of the vertical jump, the abdominal muscle strength was the number of sit-ups performed during one minute, and the shooting accuracy was the numbered goal. Before analyzing the relationship, the data was first analyzed descriptively, followed by prerequisite tests: normality test, homogeneity test, linearity test and multicollinearity test using SPSS 25. After the assumptions were met, hypothesis tests: simple correlation, coefficient of determination and multiple correlation were used to test the direction, strength, and significance of the relationship between leg muscle strength and abdominal muscles on futsal shooting accuracy. This determination was based on the P value ($\alpha = 0.05$) to ensure that the results obtained from the study presented an accurate, measurable, and applicable situation regarding the relationship between leg muscle strength and abdominal muscles on extracurricular futsal shooting accuracy.

3. Result

Statistical data analysis on a sample of 60 students is presented in table 1 below:

Table 1. Descriptive statistics of research variables

Research Variables	N	Min	Max	Mean	Std. Deviation
Vertical Jump (X1)	60	22	58	39.53	9.802
Sit Up (X2)	60	20	56	36.65	9.001
Shooting (Y)	60	12	27	19.33	3.383

The test results on 60 samples showed an average vertical jump height of 39.53 (range 22–58), abdominal muscle strength through sit-up an average of 36.65 times (range 20–56), and shooting ability with an average score of 19.33 (range 12–27). Based on this data distribution, it can be concluded that there is a significant relationship between vertical jumps and sit-ups on shooting accuracy. This is because vertical jumps provide a wider viewing angle and shooting space, while strong abdominal muscles (sit-up) maintain body balance in the air, so that the coordination of the two directly increases the accuracy of the ball when released towards the target.

Table 2. Vertical jump assessment

No.	Jump	Category
1.	> 65 CM	Very good
2.	56 - 65 CM	Good
3.	46 – 55 CM	Enough
4.	36 – 45 CM	Less

No.	Jump	Category
5.	< 36 CM	Very Less

Leg muscle strength measurement was carried out using a vertical jump test that represents leg muscles through the difference between height and height (Gençoğlu et al., 2023).

Table 3. Sit up assessment

No.	Category	Presentation
1.	Very good	41 and above
2.	Good	30 - 40
3.	Enough	21 - 29
4.	Less	10 - 20
5.	Very Less	0 - 9

Abdominal muscle strength was measured using a sit-up test with a duration of one minute to describe the ability of the abdominal muscles to contract repeatedly (Nuraryati, 2025).

Table 4. Shooting accuracy assessment

No.	Category	Presentation
1.	Very good	25 - 30
2.	Good	19 - 24
3.	Enough	13 - 18
4.	Less	7 - 12
5.	Very Less	0 - 6

All measurements were conducted on the school field using uniform procedures to ensure consistency of results. Participants were given a briefing before the test and an opportunity to warm up to minimize the risk of injury and ensure optimal performance during data collection. Each test was performed alternately and repeated six times under the supervision of the researcher and an assistant to ensure objectivity in the scoring.

The data obtained were then analyzed to identify trends in the relationships between variables. The analysis focused on identifying the strength of the relationship between physical condition variables and shooting accuracy without presenting detailed statistical formulations. The results were used to interpret the extent to which leg and abdominal muscle strength contributes to the shooting accuracy of extracurricular futsal participants.

Prerequisite Test Normality

Table 5. Normality test

Research Variables	Sig. value (p-value)	Remarks
Vertical Jump (X1)	.058	Normally Distributed
Sit Up (X2)	.177	Normally Distributed
Shooting (Y)	.200	Normally Distributed

Based on the results of the statistical test, data from 60 participants for vertical jump, sit up, and shooting accuracy all had a significance value above 0.05. This proves that all the research data is

distributed normally, which means that the distribution of participant scores is evenly distributed and there is no data that is too extreme. Under these normal data conditions, it can be concluded that there is a consistent relationship between jumping ability and abdominal muscle strength to shot accuracy. A steady jump and strong abdominal muscles prove to be a normal and ideal foundation for an athlete to produce more accurate shots.

Table 6. Homogeneity Test

Research Variables	Sig. value (p-value)	Remarks
Vertical Jump (X1), Sit Up (X2) & Shooting Accuracy (Y)	.460	Homogeneous

Based on the results of the homogeneity test on the research data, a significance value (Sig.) of 0.460 was obtained. Since this value is much greater than the standard of at least 0.05, it can be concluded that the data of the variables Vertical Jump (X1) and Sit Up (X2) on Shooting Accuracy (Y) have a homogeneous variance. This means that the diversity of data on these variables is uniform or equivalent, so it is eligible to proceed to the next stage of statistical analysis.

Table 7. Linearity test

Variable Relationships	Sig. Value Deviation From Linearity	Remarks
Vertical Jump (X1) To Shooting (Y)	.722	Linear
Sit Up (X2) To Shoot (Y)	.542	Linear

Based on the results of the statistical test, the significance value of Deviation from Linearity for the relationship between Vertical Jump and shooting accuracy was 0.722, while for the relationship between Sit Up and shooting accuracy was 0.542. Since both values are much greater than 0.05, it can be concluded that there is a linear and consistent relationship between the explosive power of the limbs and the strength of the abdominal muscles to the accuracy of the shot. This means that any increase in physical ability on jumps and abdominal strength will be followed by an increase in shooting accuracy on a regular and stable basis.

Table 8. Multicollinearity test

Independent Variables	Tolerance	VIVID	Remarks
Vertical Jump	.934	1.070	Multicollinearity-free
Sit Up	.934	1.070	Multicollinearity-free

Based on the results of the multicollinearity test, the Tolerance value for the vertical jump and sit up variables was obtained of 0.934 (greater than 0.10) respectively. In addition, the VIF (Variance Inflation Factor) value for both variables is 1.070 (less than 10.00). Because the Tolerance value is > 0.10 and the VIF value is < 10.00 , it can be stated that there is no multicollinearity disturbance in this study model. This means that the vertical jump and sit up variables are two supporting factors that stand alone and do not overlap in predicting shooting accuracy.

Hypothesis Test

Table 9. Simple correlation test

Research Variables	Correlation Coefficient (r)	Remarks
Vertical Jump (X1) versus Shooting Accuracy (Y)	.528	Medium & Significant Relationships
Sit Up (X2) against Shooting Accuracy (Y)	.401	Medium & Significant Relationships

Overall, this data concludes that the better the vertical jump performance and sit up power, the higher the shooting accuracy rate. Although vertical jump has a more dominant influence (.528) than sit up (.401), both elements of physical condition remain crucial determining factors in the success of shooting technique. It can be concluded that in order to achieve the optimal level of shooting accuracy, one not only needs technical training, but also must be supported by excellent physical condition, especially in the aspects of the explosive power of the leg muscles and the strength of the core muscles of the body.

Table 10. Coefficient of determination test

Models	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.595	.354	.332	2.766

Based on the results of statistical analysis, it was found that the value of the determination coefficient (*R Square*) was 0.354. This means that the independent variables we studied were able to explain or contribute (0.354 x 100%) 35.4% to the changes that occurred in the bound variables. Meanwhile, the remaining 64.6% was explained by other factors outside the study.

Table 11. Multiple correlation test

Variable Relationships	Correlation Value (R)	Contributions (R ²)	Significance (Sig.)
Vertical Jump (X1) & Sit Up (X2) Against Shooting Accuracy	.595	.354	.000

The results of this study prove that vertical jump (leg muscle strength) and sit up (abdominal muscle strength) have a very close relationship in determining shooting accuracy or shooting accuracy. The combination of these two physical activities contributes 35.4% to a person's shot success. This means that if a person has a powerful jump and strong abdominal muscles to maintain balance, then the chances of his shot going in or hitting the target will increase drastically. So, to become an accurate shooter, it is not enough to just train the hands, but also to train the strength of the legs and core muscles of the body at the same time.

4. Discussion

The results of this study revealed that leg and abdominal muscle strength had a very close significant relationship with shooting accuracy in Indocement High School futsal extracurricular participants, where the significance of the ($p < 0.05$) confirms that physical fitness is a fundamental determinant for technical success. In terms of movement mechanics, leg muscle strength plays a

role not only in generating propulsion (power), but also determines the stability of the supporting leg and the speed of the leg swing which are the main variables in transferring energy to the ball; this is in line with the theory of (Zemková et al., 2022). Regarding the importance of explosive contraction of the lower extremities for directional accuracy. On the other hand, the significant role of abdominal muscles as part of the core muscle unit provides proximal stability that allows for more precise distal (leg) movements; without strong abdominal muscles, the body overcompensates when kicking which often causes the ball to go astray (Hassan et al., 2023). Simultaneously, the combined contribution of these two variables indicates that shooting is a complex kinetic synergy process; Abdominal muscle strength acts as a balance anchor when the leg muscles execute a maximal swing, thus creating more effective neuromuscular coordination than if the two muscles worked in isolation. This finding supports the literature from (Mitrousis et al., 2023) that optimizing kicking accuracy at the school player level is highly dependent on the player's physical maturity in maintaining body control and motor control during dynamic situations on the field.

The significant relationship found in this study confirms that shooting accuracy in Indocement High School futsal players is not simply a result of mastery of motor skills, but rather a manifestation of functional integration between leg muscle strength and abdominal muscle strength. Statistically, the strong correlation ($p < 0.05$) indicates that a player's ability to consistently direct the ball toward the target is highly dependent on the physical capacity that supports these movement mechanics. This finding demonstrates that physical factors are the foundational determinants that enable higher-quality shooting techniques.

Biomechanically, leg muscle strength acts as the prime mover, generating explosive contractions. This strength determines the speed of the leg swing and the amount of propulsion transferred to the ball. Leg muscle stability and strength are also crucial in creating a solid foundation for the other leg to swing. Without adequate leg muscle strength, players will struggle to generate the necessary power, which often results in decreased control of the ball's direction due to unnecessary compensatory movements.

However, lower extremity strength will not achieve optimal precision without the support of abdominal muscle strength, which functions as core stability. Abdominal stability plays a role in maintaining postural balance and efficient proximal-to-distal energy transfer (from the center of the body to the toes) upon contact with the ball. Strong abdominal muscles minimize torso shock, thus maintaining neuromuscular coordination and minimizing movement deviations. This synergy between explosive leg power and core muscle control ultimately results in shots that are not only powerful, but also accurate and controlled.

5. Conclusion and Recommendation

Based on these findings, the extracurricular futsal training program at Indocement High School in Bogor should be designed more comprehensively by integrating technical training and physical conditioning. Practically, coaches need to develop a training curriculum that incorporates leg muscle strengthening through structured squats, lunges, and plyometric methods. These exercises should be combined with core strengthening exercises such as planks and their variations to ensure students have adequate body stability during dynamic movements on the field. Consistent, gradual

weight training is crucial for optimal and sustainable physical adaptation and technical performance improvement.

For further scientific development, future researchers are advised to expand the scope of research variables by adding other physical aspects such as foot-eye coordination, flexibility, and dynamic balance to obtain a more comprehensive picture of accuracy factors. Furthermore, the use of an experimental research design is highly recommended to directly test the effectiveness of an integrated strength training program (a combination of leg and core) in improving shooting accuracy compared to conventional training methods that focus solely on technique.

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