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The Role Of Upper And Lower Body Strength Balance On Three-Point And Free-Throw Accuracy In Collegiate Basketball Players

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Abstract

Study purpose. This study aims to analyze the role of upper and lower body strength balance on three-point shooting accuracy and free throws in college basketball players. The balance of upper and lower body strength is one of the important factors in supporting the ability of shooting techniques, especially in static and dynamic situations.

Materials and methods. The research method used was quantitative correlational involving 17 purposively selected college basketball athletes. The instruments used included an upper body strength test using Bench Press 1 Repetition Maximum, a lower body strength testing Back Squat 1 Repetition Maximum, and a three-point throw accuracy test and free throw. The data were analyzed using simple regression and correlation techniques.

Result. The results showed that there was a significant relationship between the balance of upper and lower body strength (UB/LB ratio) and the accuracy of free throws ($R^2 = 0.362$; $p = 0.011$) and three-point throws ($R^2 = 0.485$; $p = 0.002$). The regression equation obtained for free throws is Free-Throw = 2.24 + 5.97 × UB/LB Ratio, while for three-point throws is Three-Point = -0.97 + 8.00 × UB/LB Ratio.

Conclusion. These results show that the more balanced the upper and lower body strength, the higher the level of shot accuracy achieved, with a greater contribution to the influence on the three-point shot. This study recommends the importance of an exercise program that emphasizes the balance of upper and lower body strength as an effort to improve the shooting performance of basketball players.

Keywords: Power Balance, Upper Body, Lower Body, Shooting Accuracy, Basketball

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Introduction

The game of basketball is a sport that demands a combination of technical skills, speed, precision, strength, and high physical endurance (Mancha-Triguero et al., 2019). One of the key elements in this game is the ability to make shots with high accuracy, especially in free-throw and three-point shot situations. Accuracy in shooting greatly determines a team's success in a match. Therefore, various factors that affect the accuracy of shots are important aspects to be studied scientifically, one of which is the player's muscle strength factor. In practice, basketball shots are not just the result of technical skill, but are also the result of cooperation between various body systems, including the musculoskeletal system that supports stability, strength, and coordination of movements. Upper body muscle strength plays a direct role in controlling the ball and generating momentum when shooting, while lower body strength is essential in creating stability, balance, and power from the bottom up that are integrated in a series of shooting movements (Cabarkapa et al., 2022; Cole & Panariello, 2015). However, what is often overlooked in training is the importance of strength balance between the upper and lower bodies as a unit that affects the efficiency and effectiveness of the shot.

Several previous studies have revealed that lower body strength has an important contribution to generating power when performing jump shots and provides the foundation for body stability (Cabarkapa et al., 2022). On the other hand, the upper body is responsible for the direction, speed, and control of the ball towards the basketball hoop (Arora et al., 2021). However, the imbalance of power between the two body segments has the potential to reduce coordination of movement, increase the risk of injury, and hinder technical performance, including shooting. Thus, studies that examine the role of upper and lower body strength balance in the context of shooting skills are very relevant to be carried out, especially at the level of collegiate athletes who are in the phase of performance development towards a higher level of competition. Facts on the court show that many basketball players have difficulty maintaining consistency in shooting accuracy, even though they have undergone various shooting technique exercises. This indicates that there are other factors underlying shooting ability, one of which is the foundation of muscle strength that supports the technique. In a three-point shot, for example, it takes lower body explosiveness to push the body up when making a jump shot, as well as upper body muscle control to direct the ball accurately (Li et al., 2025; Zhang et al., 2023). Similarly, in more static free-throw situations, posture stability and the ability to maintain balanced muscle tension between the upper and lower bodies remain determinants of shot accuracy (Delgado-Delgado et al., 2025).

However, until now, there have been no studies that specifically highlight the relationship between upper-lower body strength balance and shooting accuracy, both in the context of three-point and free-throw. Most previous studies have focused on only one part of the body or only looked at muscle strength separately without considering the balance aspect of its strength. In fact, in the perspective of sports biomechanics, a proportionate and balanced force between the two main segments of the body is essential in creating efficient and compensation-free movements, which ultimately impacts the accuracy of the Movement output (Association, 2021). Furthermore, in university-level athletes, muscle strength development is often more geared toward general goals such as increasing muscle mass or speed, without regard to the functional relationship between upper and lower body strength in game-specific skills, such as shooting. This opens up the need for a more integrated, evidence-based approach to training that takes into account the balance of body strength as an important determinant of basic technique performance, including shot accuracy. If the relationship proves to be significant, then it could have practical implications for trainers in crafting a more targeted exercise program, not only to increase total strength, but also to harmonize the work of the upper and lower body muscles.

By conducting this study, it is hoped that a more comprehensive picture can be obtained regarding the importance of balanced body strength in supporting basketball shooting skills. In addition, the results of this research are expected to contribute to the development of sports science, especially in the basketball branch, as well as become the basis for planning more specific and effective strength training programs. This research can also be a reference for coaches and sports practitioners to pay more attention to the balance of muscle strength in the athlete coaching process, not only in terms of performance but also in terms of preventing injuries due to chronic muscle imbalances..

Materials and Methods

Study participants

This study uses a quantitative approach with a correlational descriptive method, which aims to determine the relationship between the balance of upper and lower body strength and the accuracy of three-point and free-throw shots in college-level basketball athletes. The research design is cross-sectional, meaning that data collection is carried out at a certain time for all subjects involved. This study involved as many as 17 participants, all of whom were male students who were members of the basketball team of the Faculty Student Activity Agency (BKMF) FIKK State University of Makassar (UNM). The age range of participants ranged from 18 to 22 years old, which generally reflects the age group of university athletes (collegiate level) at the development phase of active physical performance and technical skills. All participants were selected purposively based on inclusion criteria, namely actively participating in basketball practices and competitions within the university and inter-university scope, having at least one year of experience playing in the team, and in good physical condition without injury

Study organization

In this study, the instruments used are divided into two main categories, namely strength tests to assess upper and lower body strength, and shot accuracy tests to measure players' shooting ability. Strength tests are designed to obtain quantitative data on muscle performance, while accuracy tests aim to reflect technical abilities in match situations. The following table 1 summarizes the types of instruments, objectives, implementation methods, and units of measurement used.

Table 1. Type of instrument

No.	Instruments	Purpose	Procedure
1.	Bench Press 1 Repetition Maximum (1RM)	Measures maximum upper body strength	The subject performs the maximum load force (1 time full force) with the bench press tool. The load is gradually increased until it cannot be lifted.
2.	Back Squat 1 Repetition Maximum (1RM)	Measure the maximum strength of the lower body	The subject performs maximum force using the back squat. The load is gradually increased until it is only able to do one repetition.
3.	Strength Balance Ratio (Upper:Lower)	Assess the balance of upper and lower body strength	Comparison of the value of a 1RM bench press with a 1RM back squat: (Bench Press / Back Squat) × 100%. The ideal value is close to the balanced strength ratio.
4.	Three-Point Shooting Test	Measuring three-point shooting accuracy	Subjects take 10 shots from each of the five standard points (right baseline, left baseline, top of key, right wing, left wing). A total of 50 shots.

5.	Free-Throw Shooting Test	Measuring free-throw accuracy	The subject made 20 free throws from the free-throw line. There are no distractions or defenses.

Statistical analysis

Data collected from upper and lower body strength as well as the accuracy of three-point and free-throw shots will be statistically analyzed. The first step is to check whether the data is spreading normally or not, using a normality test. Then, the ratio between upper and lower body strength will be calculated, as well as the percentage of success of the shot. After that, descriptive statistics will be used to see the average, highest, lowest, and distribution of data from each variable. To find out if there is a relationship between the balance of body strength and the accuracy of the shot, a correlation test will be performed. Then a regression analysis was carried out to see if body strength could affect the accuracy of the shot. All data will be analyzed with the help of programs such as SPSS. The results will help answer whether the balance of body strength affects the accuracy of the basketball player's shot.

Results

The table below presents descriptive statistics of the main variables analyzed in this study, which include participants' age, upper body strength (bench press), lower body strength (squat), upper to lower strength ratio (UB/LB), and performance in free-throw and three-point shooting accuracy. These statistics provide an overview of the distribution of data as well as the characteristics of the research subjects as a whole.

Table 2. Descriptive Statistic

Variabel	Mean	Std Dev	Min	Max
Age	20.06	1.39	18	22
Bench Press (kg)	78.53	10.86	60	95
Squat (kg)	98.53	7.24	85	110
Ratio UB/LB	0.80	0.11	0.65	1.00
Free-Throw (10x)	7.00	1.06	5	9
Three-Point (10x)	5.41	1.23	3	7

Based on the results table 2 of descriptive statistics, it is known that the average age of players is 20.06 years old with a standard deviation of 1.39 years. The average upper body strength, measured through the bench press, is 78.53 kg, while the lower body strength through squats is 98.53 kg. The ratio of upper to lower body strength (UB/LB) has an average value of 0.80 with a range between 0.65 to 1.00. In terms of performance, the average free-throw shooting accuracy is 7 out of 10, while three-point is 5.41 out of 10.

Tabel 3. Normality Test

Variabel	Statistics Shapiro-Wilk	p-value	Interpretasi
Free-Throw	0.922	0.159	Normally distributed data
Three-Point	0.915	0.123	Normally distributed data
Ratio UB/LB	0.937	0.282	Normally distributed data

Since all p-values > 0.05, there is not enough evidence to reject the null hypothesis. This means that all of these variables **are normally distributed**, and are suitable for use in parametric analyses such as Pearson correlation and linear regression.

Table 3. Correlation Test

Model	Regression equations	R^2	p-value	Interpretasi
Ratio UB/LB → Free-Throw	Free-Throw = 2.24 + 5.97 × Ratio UB/LB	0.362	0.011	The UB/LB ratio explains the 36.2% variability of the free-throw score.
Ratio UB/LB → Three-Point	Three-Point = -0.97 + 8.00 × Ratio UB/LB	0.485	0.002	The UB/LB ratio explains the 48.5% variability of three-point scores.

Based on the results table 3 of regression analysis, it was found that the ratio of upper and lower body strength (UB/LB) had a significant influence on the accuracy of free throws and three-pointers in college basketball players. In the free throw, the regression equation obtained was Free-Throw = 2.24 + 5.97 × UB/LB Ratio with a determination coefficient value (R^2) of 0.362 and a significance value (p) of 0.011. This showed that the UB/LB strength ratio was able to explain the 36.2% variability of the free throw score, with a statistically significant influence ($p < 0.05$). Meanwhile, for the three-point throw, the Three-Point regression equation = -0.97 + 8.00 × UB/LB Ratio, with an R^2 value of 0.485 and p of 0.002. This indicates that the UB/LB strength ratio can explain the 48.5% variability of three-point throw scores, also with a significant influence ($p < 0.01$). Thus, it can be concluded that the balance of upper and lower body strength plays a fairly important role in supporting the accuracy of shots, especially in three-pointers which show a greater contribution of influence than free throws.

UB/LB Ratio to Free Throw and Three-Point Shooting Accuracy Chart

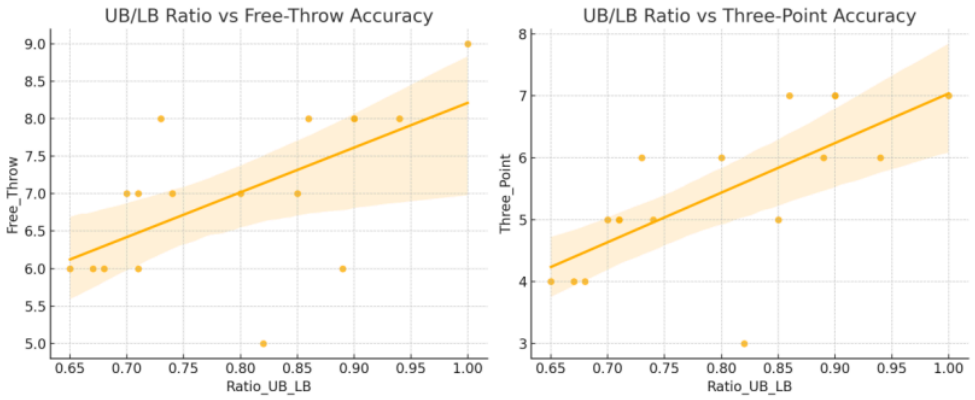

Figure 1. UB/LB Ratio to Free Throw and Three-Point Shooting Accuracy Chart

The figure 1 on the left graph, there is a positive relationship between the ratio of upper and lower body strength (UB/LB Ratio) and free-throw accuracy. The higher the UB/LB ratio value (the more balanced or dominant the top), the higher the free throw score achieved by the player. The regression line shows a consistent upward trend, with the distribution of the data fairly evenly around the line. The confidence interval shows that the model's predictions have a fairly good level of confidence, although there are some outliers at the bottom that are slightly away from the regression line.

On the chart on the right, a similar relationship pattern can also be seen between the UB/LB Ratio and the Three-Point Accuracy. The regression line shows a sharper upward trend

than the free-throw chart, which indicates that the balance of upper and lower body strength has a greater contribution to the accuracy of the three-point shot. The distribution of data follows a relatively linear pattern, with a fixed area of confidence interval indicating a good level of confidence in the established regression model. This supports the results of the previous regression analysis, where the R^2 value of 0.485 on three-pointers is higher than 0.362 on free throws, which means that balance of body strength plays a greater role in three-point shooting. Visually, both graphs show that the better the balance of upper and lower body strength, the better the shooting accuracy for both free throws and three-pointers, with a stronger influence seen on three-point shots.

Discussion

The results of this study show that there is a significant relationship between upper and lower body strength balance and free-throw and three-point shooting accuracy in college basketball players. In general, these findings indicate that players who have a more balanced or near-ideal upper-to-bottom body strength ratio tend to have better shooting accuracy. This reinforces the understanding that shooting performance in basketball is not only determined by technical skill alone, but also by the physical conditions that support the stability and efficiency of movement.

The balance of power between the upper and lower bodies is essential in the biomechanical movement of shooting (Izzo et al., 2015; Zhen et al., 2015). The shooting movement in basketball is not an activity that involves one part of the body in isolation, but is the result of the synergy of the entire kinetic chain. The movement starts from the legs, continues through the hips and torso (core), and ends in the arms and wrists as the final executor (Matsunaga & Oshikawa, 2022). When there is an imbalance of strength, for example, the lower body is much stronger than the upper part there is an imbalance of force contribution during the movement of the shot. This can lead to overcompensation by certain parts of the body, impaired stability when jumping, or even impaired in the accuracy of the direction of the ball due to unbalanced power distribution. In contrast, a more harmonious power ratio allows for more efficient distribution of load and power, strengthens postural stability when shooting, and improves the consistency of the ball's trajectory. In the context of free-throws that are performed in a static state, stability and muscle control are more dominant, whereas in three-points that are usually done with vertical thrusts, the strength of the lower body plays an important role in generating jump power, while the upper body ensures the accuracy of the ball direction (Delgado-Delgado et al., 2025; Pan et al., 2021; Spiteri et al., 2014). Thus, the balance of power not only supports performance but also minimizes the risk of injury due to biomechanical imbalances.

These findings are supported by various previous studies showing that leg muscle strength and dynamic balance make a real contribution to the success of jump shots (Boonsom & Bungmark, 2024; Hassan et al., 2023). The study emphasizes that players with good leg muscle strength tend to have a more stable posture when performing jump shots, which is crucial for maintaining accuracy. Similar results were found in another study that stated that arm muscle strength and balance correlated with the ability to make lay-ups, indicating that the upper strength aspect is also vital for the final coordination of shooting movements (Gözaçik, 2023; Saputra et al., 2022). These studies reinforce the argument that shooting performance in basketball is not only influenced by the individual strength of the upper or lower body, but by the harmonious integration of the two. In addition, other studies state that optimal transfer of power from the legs to the arms through the midbody is key in high-accuracy shooting (Tong, 2022). They suggest that integrative training that targets the full kinetic chain would be more beneficial than segmental training that focuses only on specific parts of the body.

Practically, these results have important implications for coaches and athletes. Physical exercise programs should be designed not only to increase strength in general, but also to maintain a balance between upper and lower body strength. Exercises such as squats, lunges, bench presses, and push presses can be combined with proprioceptive activities and core training to ensure that strength and stability develop in a balanced manner (Boyce & Schoenfeld, 2022). Thus, athletes are not only stronger individually, but also more stable and efficient when performing shooting movements. Additionally, it's important to consider that in the context of high-performance training, technical and physical improvements must go hand in hand. Shooting technique training done in conjunction with proper strength training can result in synergies that improve the consistency and accuracy of the shot (VanKouwenberg, 2024). Coaches can evaluate the athlete's body strength ratio as part of a periodic assessment, then adjust the training program to close the strength gaps found.

For further research, it is recommended that longitudinal studies be conducted that observe changes in shooting performance in line with strength training interventions that target body balance. In addition, observation in real-world match conditions or using more advanced biomechanical measurements such as motion capture and force plate will enrich our understanding of how muscle strength affects shot accuracy in dynamic situations. Research with a larger sample count and including players of different skill levels will also help expand the generalization of these findings. Overall, the results of this study provide evidence that supports the importance of balance of body strength in sports performance, especially in shooting skills in basketball. By seriously considering this factor in training planning, it is hoped that improving player performance can be achieved in a more targeted and sustainable manner.

Conclusions

This study aims to determine the role of the balance of upper and lower body strength on free-throw and three-point shooting accuracy in college basketball players. Based on the results of data analysis, it can be concluded that there is a significant relationship between the ratio of upper and lower body strength to shooting accuracy. The more balanced the power between the upper and lower bodies, the better the accuracy of the shots achieved by the player**.** The data analyzed showed that the balance of body strength had a fairly strong contribution in explaining the variation in shot accuracy, especially in three-point shots. This confirms that muscle strength, when proportionally distributed between the upper and lower parts of the body, supports the coordination and stability of movement required in shooting techniques.

Thus, the results of this study confirm the importance of developing balanced muscle strength in basketball training programs. Coaches and athletes need to consider this balance as part of a performance-enhancing strategy, not only for general fitness purposes, but also as a determining factor in the successful execution of shooting techniques in the game..

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Conflict of interest

All authors declare no internal conflicts in the completion of this research.

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