



Contribution of Arm Muscle Strength to Chest Pass Results in Basketball Players: A Meta-Analysis Study

Review Article

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Abstract.

Background Objectives

Arm muscle strength plays a vital role in supporting the results of the chest pass in basketball. This study aims to analyze how much Arm muscle strength contributes to the chest pass results in basketball through a meta-analysis approach.

Methods

This study uses a meta-analysis method, a statistical analysis technique that combines the results of various similar studies to obtain a more comprehensive quantitative picture. The data analyzed were obtained from scientific articles published in Google Scholar with the keywords "hand muscle strength" AND "chest pass," "upper limb strength" AND "basketball pass," "grip strength" AND "basketball performance," "muscular strength" AND "passing accuracy," and "hand power" AND "chest pass" AND "basketball." The population in this study was 513 articles published from 2019 to 2025. The sampling technique used was purposive sampling with specific inclusion and exclusion criteria, namely: (1) discussing the relationship between hand muscle strength and chest pass results, (2) published in the period 2019–2025, (3) using a quantitative research design with a correlational approach (cross-sectional), and (4) not limited by the author's institution of origin. From the selection process, 17 articles met the requirements for further analysis. Data were analyzed using the effect size test with the help of JASP software.

Results

Analysis with the Random Effects model showed a significant positive relationship between arm muscle strength and chest pass results in basketball ($z = 5.626$; $p < 0.001$; 95% CI: 0.534–1.105). The Rank Correlation results showed a Kendall value of 0.00, and the Egger test produced a p-value of 0.748, indicating no publication bias. Forest plot analysis showed that the combined effect size was in the high category, with a value of 0.82 (0.15; 2.80).

Conclusion

Arm muscle strength plays a significant role in the results of a chest pass in basketball.

Keywords: Basketball, muscle strength, chest pass, meta-analysis

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INTRODUCTION

Sport is a physical activity that is carried out in a planned and systematic manner, which aims to improve a person's physical fitness, health, and quality of life (Atmaja et al., 2025; Islam et al., 2024). Sports activities carried out regularly, planned, and systematically in sports provide positive stimuli to an individual's physiological, psychological, and social aspects (Dewi et al., 2024). A person doing sports is not only limited to efforts to maintain physical health but also has a much broader meaning, especially for individuals actively involved in the world of sports (Islam et al., 2024). Sports have become an important medium for self-development, character-building, and achieving high achievements, especially for athletes (Islam et al., 2025; Setiadi et al., 2024). In competitive sports, sports are no longer seen as activities to maintain physical fitness but have become integral to developing self-potential to the maximum (Nubatonis et al., 2024).

Basketball is one of the most popular sports worldwide, including in Indonesia. In Indonesia, basketball is experiencing rapid development, as seen from the many basketball courts built in various cities and remote areas. This shows that basketball has become a favorite among the community, including students and college students. Regular matches between regions, provinces, and even

countries are also evidence of the great interest in basketball in Indonesia. In addition to finding superior athlete talents, these matches aim to test the players' abilities in basketball (Abadi et al., 2024; Hoffman, 2020).

Basketball is a type of sport categorized as *aerobic-based* and anaerobic because it requires players to perform high-intensity movements such as running, jumping, and moving quickly (Gholami et al., 2022; Wijaya et al., 2024). This sport is a team game that relies heavily on basic technical skills, game strategy, and teamwork. The combination of technical ability, physical condition, and tactical intelligence is the key to achieving optimal team performance during matches and training (Kristiono et al., 2024; Fernández et al., 2023).

One of basketball's most important fundamental skills is *passing* the ball (Firdausi et al., 2025; Hita et al., 2024). Effective passing allows for fast and accurate ball flow between players, creating better attacking opportunities and maintaining the rhythm of the game (Supola et al., 2023; Wang et al., 2024). Success in passing is greatly influenced by various physical and technical factors, one of which is the strength of the hand muscles. Strong hand muscles allow players to produce optimal speed, accuracy, and ball control when performing various types of passes, such as chest, bounce, and overhead passes.

Research conducted by Pradyta Sunur et al. (2023) shows that chest passes play an important role in basketball, allowing for quick and accurate ball movement over short distances (5–7 meters). This aligns with research conducted by Sunur et al. (2023). Chest pass ability is essential in basketball, significantly affecting scoring opportunities. Mastery of passing techniques, including Chest Pass, improves team performance and increases the likelihood of scoring more points during the game. Several factors affect the quality and effectiveness of the throw when performing a chest pass. One of the main factors is muscle strength, especially the arm and shoulder muscle groups. These muscles play an important role in producing the maximum muscle contractions needed to overcome or resist the ball's weight, either pulling or pushing. Movements such as pulling and throwing the ball require explosive strength from these muscles so the ball can slide with optimal speed and accuracy toward the target (Trinanda et al., 2024).

Several previous studies have investigated the relationship between arm muscle strength, or upper body muscle strength in general, and passing skills in basketball. However, these studies used different measurement methods to assess arm muscle strength and chest pass ability, resulting in varying findings. These results align with research conducted by McFadden et al. (2023), which shows that individual test instruments can produce variations in performance assessment depending on the type and characteristics of the measuring instrument. The inconsistency of the results in previous studies indicates the need for a more in-depth and systematic analysis to obtain more comprehensive and accurate data on the relationship between arm muscle strength and chest pass skills in basketball players.

Furthermore, until now, no meta-analysis has specifically highlighted the population of basketball players in Indonesia, especially in the adolescent to young adult age group. This age range is crucial in developing technical skills and physical capacity and achieving optimal sports achievements. Therefore, a meta-analysis study is needed to determine how much arm muscle strength contributes to chest pass results in basketball players.

METHOD

Research Design

The method used in this study is meta-analysis. Meta-analysis is a statistical analysis technique used to summarize the results of various studies, resulting in findings that attempt to integrate recent findings. Meta-analysis has an important role in research as an evaluation method for various previous studies that discuss similar themes but with a level of data validity that has not been fully verified (Husein et al., 2025; Reinebo et al., 2024).

In this analysis, the effect size value is used as a parameter to determine the significance of the research results (Maulana et al., 2025). Effect size can be expressed in raw form or standardized r values, representing the correlation and mean difference between the two variables analyzed (Cohen, 2013).

Procedures

The search strategy in this study was designed to identify relevant studies on the contribution of hand muscle strength to the ability to perform a chest pass in basketball. The literature search was conducted using Publish or Perish software by accessing Google Scholar.

The keywords used include a combination of terms related to the main variables of this study, such as: "hand muscle strength" AND "chest pass," "upper limb strength" AND "basketball pass," "grip strength" AND "basketball performance," "muscular strength" AND "passing accuracy," and "hand power" AND "chest pass" AND "basketball." All search terms are adjusted to the terminology commonly used in sports and kinesiology literature.

Inclusion and exclusion criteria

The studies analyzed in this meta-analysis were evaluated based on several strict inclusion criteria to ensure the relevance and quality of the data collected. First, the studies had to involve participants at least 13 years old to ensure the maturity of physical development relevant to measuring hand muscle strength. Second, the studies had to include correlation values or convertible effect sizes *between* hand muscle strength and *chest pass performance* in basketball. Third, the studies had to use standardized measurement instruments or procedures to assess hand muscle strength, such as handgrip dynamometers, and evaluate *chest pass performance*, such as accuracy tests or passing speed. Fourth, the accepted research designs included correlational studies and comparative studies between groups with different levels of hand muscle strength. Fifth, only quantitative studies published in peer-reviewed scientific journals and written in English were included. Finally, the selected studies had to originate from Indonesia and be published between 2019 and 2025.

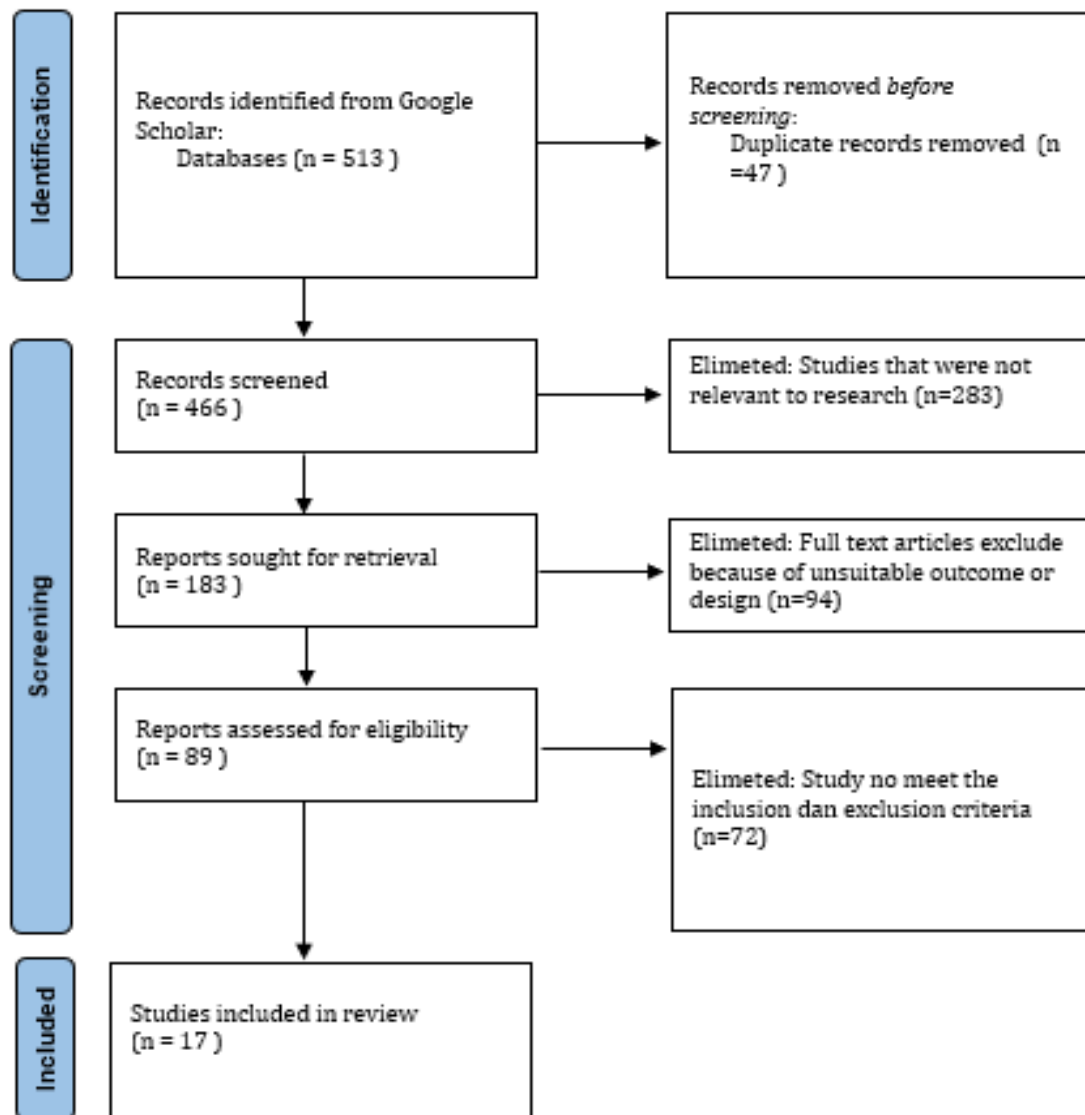


Figure1 Article Source Search Procedure

Quality study assessment

The methodological quality of the analyzed studies was evaluated using The Joanna Briggs Institute, 2017, emphasizing several criteria such as sampling methods, reliability of injury measurements, and accuracy of data analysis. Each study was assessed based on nine components, where low scores reflect a high risk of bias, while high scores indicate good methodological quality (Jun et al., 2021).

Analysis

Study selection was done by identifying references extracted into an Excel database to facilitate managing and deleting duplicate articles. Researchers reviewed the abstracts of the studies found using a search strategy to identify studies that fit the criteria for physical fitness and learning outcomes. Physical fitness is an important component that students must have in supporting the student learning process. The data obtained will go through a series of systematic analysis stages: Identifying research variables by entering the variables obtained into the appropriate columns and identifying correlation values in each article to be analyzed. If a research article only presents specific values, then these values must be converted using a predetermined formula.

$$F = t^2$$

$$t = \sqrt{Fr} = t / \sqrt{(t^2 + df)}$$

The risk of bias is analyzed to determine the effect size (Z) and standard error effect size (SEz) values, then the data is analyzed with the help of JASP software. The effect size and standard error effect size values are calculated using the following formula:

$$Z = 0,5 \times \ln \frac{1+r}{1-r}$$

Equation effect Size

$$V_2 = \frac{1}{n-3}$$

$$SE_2 = \sqrt{V_2}$$

Data from the Effect Size test results were interpreted using JASP software to obtain information about the presence or absence of publication bias. The results of publication data related to the relationship between physical fitness and student learning outcomes were categorized based on the correlation value: $r = 0.1$ (low), $r = 0.3$ (moderate), and $r = 0.5$ (high) (Cohen, 2013; Perwira Negara et al., 2021).

The data synthesis strategy of the research findings is presented in narrative form. Information on the research sample, effect size, standard error effect size, heterogeneity test, and publication bias test that have been conducted are displayed in tabular form. Meta-analysis in this study was conducted by calculating the level of heterogeneity using a random effect size model to estimate the average of variables that affect learning outcomes. The publication bias test was conducted based on the output of the rank correlation and regression methods. There is no publication bias if the p-value is more than 0.05. The funnel plot results explained through the Egger test also show a p-value of more than 0.05, which means there is no indication of publication bias. The forest plot results show the extent to which physical fitness influences learning outcomes based on the correlation categories $r = 0.1$ (low), $r = 0.3$ (moderate), and $r = 0.5$ (high). This meta-analysis can use JASP software, with effect size measurements calculated as standardized mean difference (Zhang et al., 2022).

Table 1. JBI checklist for cross-sectional study

Author	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured validly and reliably?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured validly and reliably?	Was appropriate statistical analysis used?	Total Score
Muzakky, (2025)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Andriansyah et al., (2025)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Juanda & Victorian, (2024)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Faisalani et al., (2024)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Santika & Sulastio, (2024)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Rosti, (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Literature, (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Pratiwi et al., (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Azhari et al., (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Sabilla, (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Sukarmin & Jumareng, (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Trisno et al., (2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Taaraungan et al., (2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Muslatubun et al., (2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Octavian, (2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Suhada, (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Saputra & Mahendra, (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8

RESULTS AND DISCUSSION

No	Author	Sample	N	Result			ES	SE
				F	T	R		
1	Muzakky, (2025)	Senior High School	20			0,527	0,586	0,243
2	Andriansyah et al., (2025)	Vocational School	13			0,975	2,185	0,316
3	Juanda & Victorian (2024)	Senior High School	30			0,870	1,333	0,192
4	Faisalani et al., (2024)	Junior High School	10	2,097	1,4481	0,145	0,146	0,378
5	Santika & Sulastio, (2024)	Senior High School	20			0,530	0,590	0,243
6	Rosti, (2023)	Junior High School	28			0,538	0,601	0,200
7	Sastra, (2023)	Junior High School	20			0,542	0,607	0,243
8	Pratiwi et al., (2023)	Senior High School	90			0,790	1,071	0,107
9	Azhari et al., (2023)	Senior High School	20		1,469	0,073	0,074	0,243
10	Sabilla, (2023)	Junior High School	20			0,672	0,814	0,243
11	Sukarmin & Jumareng, (2023)	Senior High School	33			0,414	0,440	0,183
12	Trisno et al., (2022)	Senior High School	20			0,444	0,477	0,243
13	Taaraungan et al., (2022)	Senior High School	18			0,734	0,937	0,258
14	Muslatubun et al., (2022)	Mahasiswa	27			0,977	2,227	0,204
15	Oktavyani, (2021)	Senior High School	28		5,01	0,179	0,181	0,200
16	Suhada, (2020)	Atlet	25			0,690	0,848	0,213
17	Saputra & Mahendra, (2019)	Junior High School	20			0,641	0,760	0,243

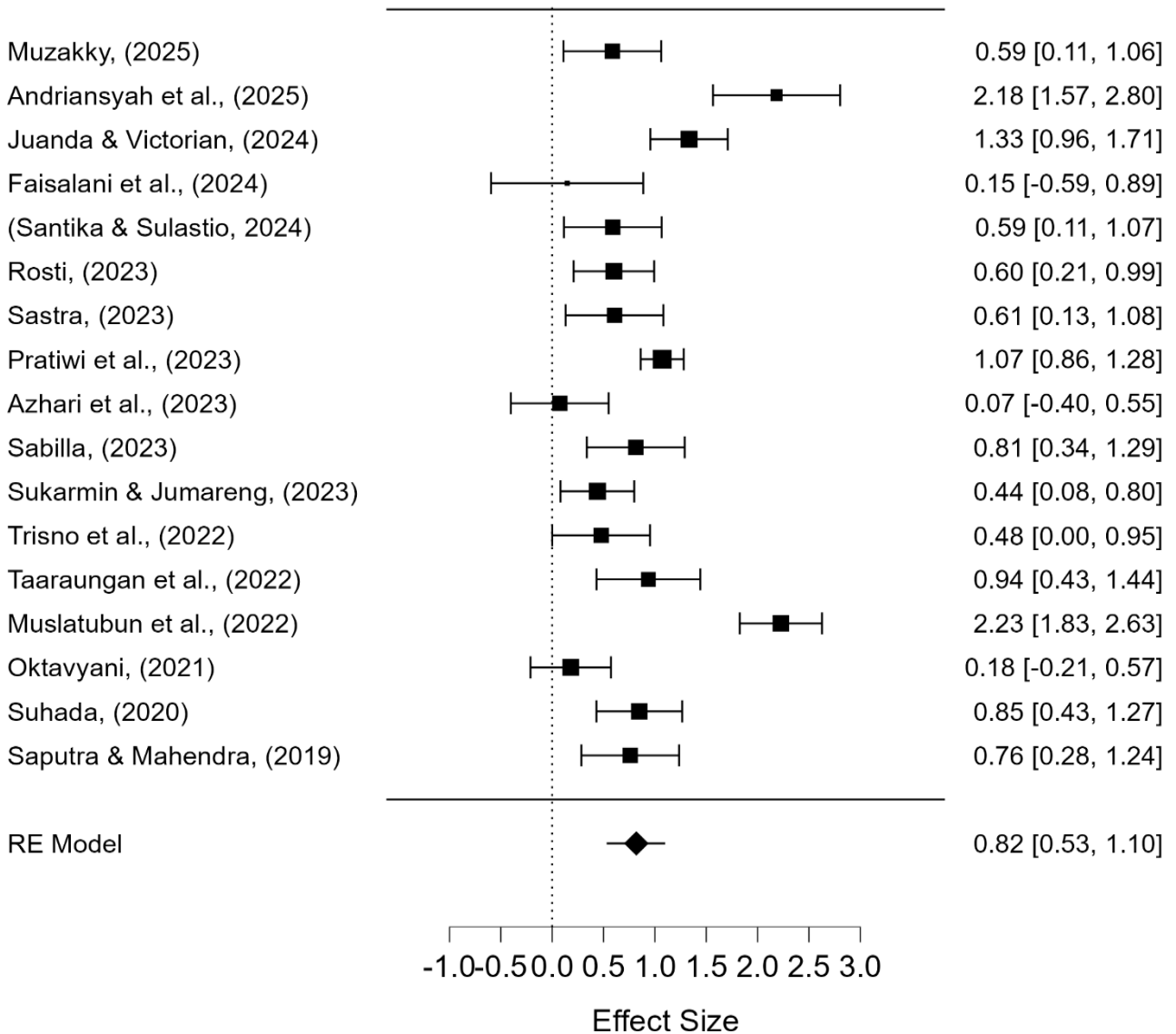


Figure 2. Forest Plot

Based on the results of the forest plot, it can be observed that the studies analyzed showed variations in influence values ranging from 0.15 to 2.80. In addition, an average effect value (summary effect) of 0.82 was obtained.

The value explains that the average influence of hand muscle strength on the chest pass results is 82%, which is included in the strong category. Based on the effect size classification, namely $r = 0.1$ (low), $r = 0.3$ (moderate), and $r = 0.5$ (high) (Cohen, 2013). Meanwhile, other factors that influence are 28%.

1. Heterogeneity tes

Table 2. Fixed and Random Effects

	Q_e	Df	P
Omnibus test of Model Coefficients	31.653	1	< .001
Test of Residual Heterogeneity	111.309	16	< .001

Note. p -values are approximate.

Note. The model was estimated using Restricted ML method.

Table 2 fixed and random effects table analysis results show that the results of the 33 effect sizes of the studies analyzed are heterogeneous ($Q = 111.309$; $0.01 < 0.05$). Thus, the random effect model is more suitable for estimating the average effect size of the 17 studies to be analyzed.

Table 3. Residual Heterogeneity Estimates

	Estimate	95% Confidence Interval	
		Lower	Upper
τ^2	0.305	0.147	0.811
T	0.553	0.383	0.901
I^2 (%)	87.151	76.493	94.741
H^2	7.782	4.254	19.014

The Tabel 3 Residual Heterogeneity Estimates table analysis results show a statistical relationship between physical fitness and student learning outcomes, with a contribution of 13% and a relatively high level of study heterogeneity ($I^2 = 87\%$). These findings suggest that although arm muscle strength is essential in supporting chest pass results, other factors also influence it.

2. Hypothesis test

Table 4. Effect measuring model test

Estimate	Standard Error	Z	P	95% Confidence Interval	
				Lower	Upper
Intercept	0.819	0.146	5.626	< .001	0.534 1.105

Table 4 of the effect measuring model test shows a significant positive correlation between hand muscle strength and chest pass ($z = 5.626$; $p < 0.001$, 95% CI (0.534; 1.105).

3. Publication bias test

A publication bias test is conducted to review whether the publication data used in this study represents the population as a whole. The existence of publication bias can be known by looking at the values generated through the Rank Correlation output and Regression methods.

Table 5. Rank correlation test for Funnel plot asymmetry

	Kendall's τ	P
Rank test	0.00	1.000

Based on Table 5 Rank correlation test for Funnel plot asymmetry, it can be seen that the Kendall value of 0.00 indicates that the correlation coefficient between effect size and variance is not equal to 0. The p-value of 1.000 is greater than 0.05, which means there is no publication bias

Figure 3. Funnel Plot

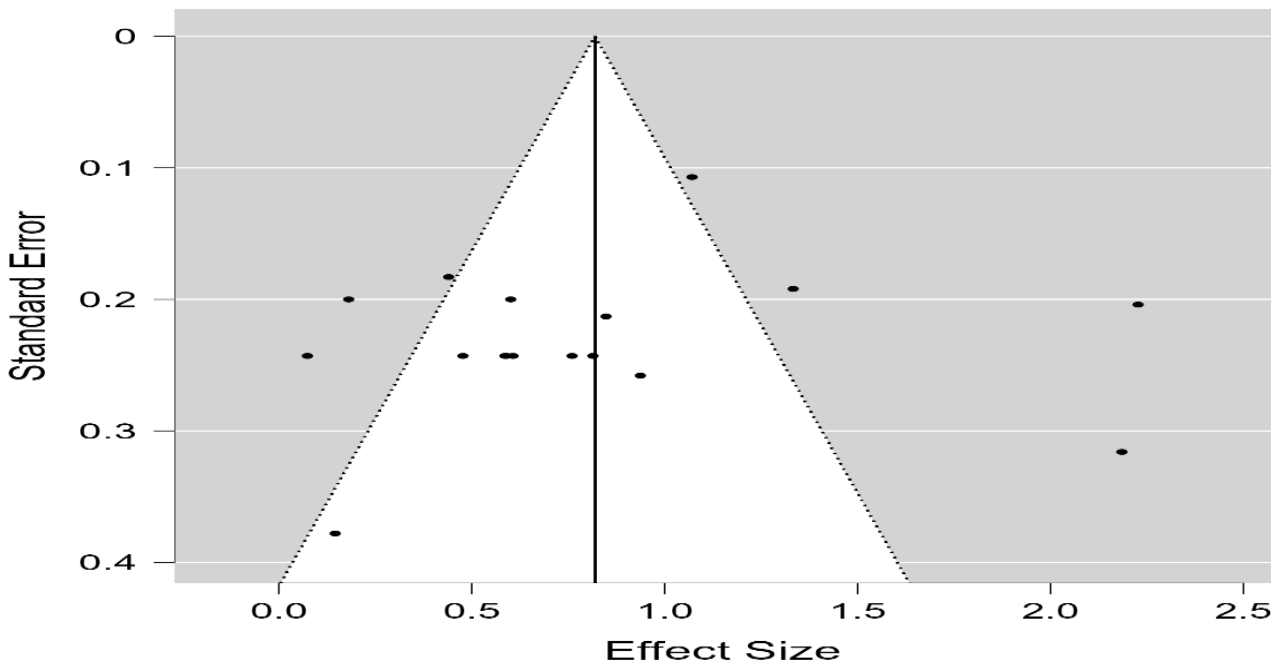


Figure 3 presents the regression test for the funnel plot, which shows an imbalance in the data distribution, thus not providing strong evidence of symmetry in the results. This result requires further analysis using Egger's test to evaluate the degree of symmetry and ensure the validity of the findings related to potential publication bias. The results of Egger's test analysis, which provide a more in-depth picture of this possible bias, are presented in Table 5 below.

Table 6. Regression Test for Funnel Plot Asymmetry ("Egger's test")

	Z	P
Sei	321	0.748

The results in Table 5 show that the Egger test results show a p-value of 0.748, which is far above the threshold of 0.05. This indicates that the meta-analysis conducted is free from publication bias. The data distribution tendency was further analyzed using the Drawer Record Test analysis, better known as Fail-safe N, as shown in Table 7 below, to improve the results' accuracy and validity.

Table 7. Record Drawer Test

	Fail-safe N	Target Significance	Observed Significance
Rosenthal	1554.000	0.050	< .001

Record drawer test analysis was used to estimate the number of articles with insignificant results that have not been published (Marks-Anglin & Chen, 2020). The results in the Table show a fail-safe value of 1554,000. The analysis formula used is $5k + 10$, where the k value represents the amount of data analyzed. $K = 17$, so $5k + 10 = 5(17) + 10 = 95$. There is no publication bias in meta-analysis research if the record drawer test value is greater (Azzahrah et al., 2021). Thus, it can be concluded that the fail-safe N value of $1554.000 > 95$ indicates no publication bias in this study.

The data were analyzed using the effect size test with the help of JASP software. Analysis with the Random Effects model showed a significant positive relationship between arm muscle strength and chest pass results in basketball ($z = 5.626$; $p < 0.001$; 95% CI: 0.534–1.105). The Rank Correlation results

showed a Kendall value of 0.00, and the Egger test produced a p-value of 0.748, indicating no publication bias. Forest plot analysis showed that the combined effect size was in the high category, with a value of 0.82 (0.15; 2.80). A significant relationship exists between hand muscles that contribute to basketball's chest pass results. Based on a systematic analysis of 17 scientific articles published between 2019 and 2025, consistent and significant evidence suggests a positive correlation between the contribution of arm muscles to chest pass results in basketball.

Basketball is a team game played by two teams, each consisting of five players. In this game, players must master the basic techniques to move the ball effectively. This sport has three main basic techniques: dribbling, passing, and shooting (Pradyta Sunur et al., 2023). Of the three basic techniques, passing is one of the most frequently used movement components in a match, especially in forming and organizing the team's attack pattern. Types of passing in basketball include *chest passes*, *bounce passes*, *one-handed bounce passes*, *baseball passes*, *overhead passes*, *hand-off passes*, and *lob passes*. Among these types of passing, *chest pass* is the most common and widely used passing technique in basketball (Putra, 2020). The study's results showed a strong and significant relationship between hand muscle strength and *chest pass results* in basketball. This finding indicates that the higher the level of hand muscle strength of a player, the better their ability to perform *chest passes* effectively.

According to Cronin & Owen (2004), To master the *chest pass technique* optimally, a basketball player must have a supportive physical condition, especially in muscle strength, especially hand muscles. The *chest pass technique* requires mastery of the mechanical aspects of the movement and physical strength to produce fast, straight, and accurate passes to teammates. Hand muscle strength plays an important role in the ball-pushing phase from the chest toward the target, where muscles such as *the flexors* and *extensors* in the lower arms help create thrust and wrist stabilization when the ball is released (Izzo & Russo, 2011).

Passing technique movement in basketball is a motor activity that involves integrated coordination between the muscles of the upper arm, lower arm, and hand (Maimón et al., 2020). Although the entire series of movements requires a synergy of the upper body muscles, the most crucial phase is when the ball is released from the hand. At this stage, the success of the *passing execution* is primarily determined by the strength and stability of the hand muscles. The strength of the hand muscles plays a role in producing sufficient thrust, while their stability maintains the direction of the ball release so that it remains accurate (Cronin & Owen, 2004).

For the basic chest pass technique to be optimized, it must be supported by good physical condition, including strength, speed, balance, flexibility, agility, and well-developed coordination. One of the most important components of physical condition in performing a chest pass is the strength of the triceps arm muscles because it is necessary to produce an effective chest pass (Cahyadi & Saputra, 2023). Arm muscle strength can be increased through a planned and structured strength training program (Indayani & Fenanlampir, 2023). Syahrudin et al. (2023) state that implementing a *chest pass* requires high accuracy and precision. Achieving this requires intensive training specifically aimed at increasing arm muscle strength.

This is in line with research conducted by Kusuma et al. (2025), which shows that accurate chest pass ability must contribute from arm muscle strength; arm strength is the ability of a group of arm and shoulder muscles to perform maximum contractions to overcome or resist loads, such as pulling and throwing a ball. In the Chest Pass movement, arm muscle strength greatly influences throwing the ball. The most specific muscle used in this movement is the triceps muscle.

Weight training is a standard method to develop muscle strength and improve *chest pass ability*. The training load can be internal, such as one's body weight, or external, such as using aids such as barbells, resistance bands, or *medicine balls* (Burhan & Herlina, 2022; Hadjarati & Haryanto, 2022; Miftahul'izza et al., 2024). Training intensity must be adjusted to the athlete's maximum physical ability and skill level to achieve optimal physiological adaptation (Bompa & Buzzichelli, 2019).

Hand muscle strength is significant in the results of *chest passes* in basketball games. Therefore,

developing hand muscle strength through structured and specific training must be an integral part of the basic technique development program for basketball players to increase passing effectiveness and improve team performance.

CONCLUSION

It can be concluded that arm muscle strength has a strong and significant relationship to chest pass results in basketball games. Therefore, a targeted and structured training program is needed to increase arm muscle strength and optimize passing technique skills.

For further research, it is recommended to analyze other variables affecting chest pass ability, such as motor coordination, reaction speed, and psychological aspects, such as concentration and self-confidence. The limitation of this study is that it only uses data sources from national journals, so the generalization of the findings is still limited. Future research is expected to involve references from reputable international journals to enrich the perspective and validity of the study more broadly.

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AUTHOR CONTRIBUTION STATEMENT

The Author Contributions Statement can be up to several sentences long and should briefly describe the tasks of individual authors. Please list only two initials for each author, without full stops, but separated by commas (e.g., JC, JS). For two authors with the same initials, please use their middle initial to differentiate between them (e.g., REW, RSW). The Author Contributions Statement should be included at the end of the manuscript before the References.

CONFLICT OF INTEREST AND FUNDING

There is no conflict of interest

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