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The Relationship of Agility, Reaction Speed, and Eye-Hand Coordination to Volleyball Forearm Passing Ability

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Abstract

Volleyball, a dynamic team sport, relies heavily on mastering fundamental techniques such as forearm passing to ensure seamless gameplay and effective team strategies. The proficiency in forearm passing is influenced not only by technical skills but also by physical components, including agility, reaction time, and eye-hand coordination. This study aims to analyze the relationship between these three physical factors and forearm passing ability among volleyball players. Conducted at the Tunas Brilliant Volleyball Club, vocational high school Ma'arif NU 01 Limpung, Batang, Central Java, in December 2024, the research employed a quantitative correlational approach. A purposive sampling technique was used to select 30 active players aged 15–18 years. Data were collected through standardized tests: the Illinois Agility Run Test for agility, the Whole Body Reaction Test for reaction time, the ball throw-catch test for eye-hand coordination, and the volleyball forearm passing test for passing ability. Pearson correlation analysis revealed significant relationships: agility showed a strong negative correlation (r = -0,553, p = 0,002), reaction time a moderate negative correlation (r = -0,378, p = 0,039), and eye-hand coordination a strong positive correlation (r = 0,564, p = 0,001) with passing ability. These findings underscore the critical role of integrated physical training in enhancing passing skills. Coaches are recommended to design holistic training programs incorporating agility drills, reaction exercises, and coordination activities to optimize player performance and support long-term volleyball development.

How to Cite

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INTRODUCTION

Volleyball is a team sport that is popular and growing rapidly at various levels, including school, regional, national and international levels (Azis, 2021). Volleyball demands solid teamwork, mature game strategies, and good mastery of basic technical skills by each player. One of the basic techniques that has a vital role in the smooth running of the game is the lower pass. This technique is used mainly to receive the opponent›s serve or smash and direct the ball to the feeder so that an attack can be built (Vinsensius et al., 2022). Good passing quality will determine the stability of attack transitions and the overall efficiency of team play.

The ability to perform effective forearm passing does not only depend on technical aspects alone, but is also greatly influenced by various physical factors of the player. Three physical components that are believed to have a major contribution to forearm passing skills are agility, reaction speed, and eye-hand coordination (Akhmady & Firda, 2022; Johari et al., 2022). These three factors are interrelated and form an essential motor base in supporting volleyball game performance.

Agility is the body›s ability to move quickly and change direction suddenly in a short time without losing balance (Hapsoro, 2023). In the context of volleyball, agility is indispensable when players have to adjust their body position quickly to the direction the ball is coming from, especially in defensive situations and receiving serves. Without adequate agility, players will find it difficult to catch up or adjust position when the ball moves out of reach. Reaction speed, on the other hand, is the player›s ability to respond as quickly as possible to stimuli, such as ball movement, opponent movement, or changes in the game situation (Pratiwi & Prayoga, 2019). Players with good reaction speed will be better prepared to anticipate the opponent›s attack and more quickly make the initial movement for passing.

Eye-hand coordination is the ability to synchronize visual information with hand movements in a precise and accurate time (Fadli et al., 2025). In a volleyball game, this is very important especially when receiving a fast ball and adjusting the position of the hand so that contact with the ball produces a direction that matches the target. Players who have good eye-hand coordination will be able to make precise movements and avoid ball control errors.

The three components complement each other. Agility helps players move into the right position, reaction speed allows players to initiate movement quickly, and eye-hand coordination helps produce accurate passing. However, in practice, not all players are able to develop all three simultaneously. There are players who are agile but slow to react, or who have fast reactions but poor coordination. These limitations will have an impact on the effectiveness of forearm passing and lead to a decrease in the quality of team play (Nurmaida et al., 2024).

Various previous studies have examined the relationship between each of these physical abilities and forearm passing ability, but they are still partial. For example, Alwi et al (2024) examined the contribution of eye-hand coordination to passing ability and found a significant relationship of 15.6%. Nasriani & Mardela (2024) examined the relationship of reaction speed partially to passing skills, while Alfian (2023) evaluated the effect of agility on passing techniques using the shuttle run test. Although the results support the role of each factor, research that combines the three variables simultaneously is still very limited.

Research gaps that need to be bridged. There are still not many studies that examine holistically the relationship between agility, reaction speed, and eye-hand coordination simultaneously on forearm passing ability. In fact, volleyball games on the real field require all three abilities to work in an integrated manner. Therefore, this study aims to analyze the three factors simultaneously and thoroughly, in order to provide a more comprehensive picture of the physical factors that contribute to basic technical skills in volleyball.

The novelty of this study lies in the integrative approach used in analyzing the three physical variables against one key technical skill in volleyball. By knowing the extent to which the three factors affect the ability to pass down, the results of this study are expected to make a practical contribution in the preparation of a more specific, targeted, and evidence-based training program. In addition, the findings can assist coaches in identifying players› individual physical weaknesses, so that training can be personalized and more efficient. More broadly, this research is expected to be a reference in the development of optimal volleyball training models at various levels, as well as enrich the academic literature in the field of volleyball sports training.

METHOD

This study uses a quantitative approach with a correlational type that aims to analyze the relationship between agility, reaction speed, and eye-hand coordination on forearm passing ability in volleyball games. The research was conducted in December 2024 at the Tunas Brilliant Volleyball Club vocational high school Ma'arif NU 01 LIMPUNG, Batang, Central Java, which is the center of coaching young athletes in the region. The time and location were chosen because the team was in the tournament preparation period, thus reflecting the optimal player performance conditions.

The population in this study were 35 active players in the club. The sample was taken purposively with the criteria of age 15-18 years and actively practicing regularly, so that 30 respondents were obtained. The independent variables consist of agility, reaction speed, and eye-hand coordination, while the dependent variable is the ability to pass down. Data collection was done through observation, literature study, and physical measurement tests. The agility test used the Illinois Agility Run Test (Ilham et al., 2025), reaction speed was measured with the Whole Body Reaction Test (Sukamti et al., 2020), eye-hand coordination used the ball throw-catch test (Utama et al., 2022), and the forearm passing ability was measured through the volleyball forearm passing test (Putro & Anwar, 2022).

Each test was conducted following standardized protocols with tools such as stopwatches, sensors, and balls. The data were analyzed descriptively to see the general description of each variable, as well as the Pearson correlation test to determine the relationship between variables. The results of the analysis are expected to provide an empirical picture of the contribution of physical aspects to the basic technical skills of volleyball, as well as input in the preparation of a more effective training program.

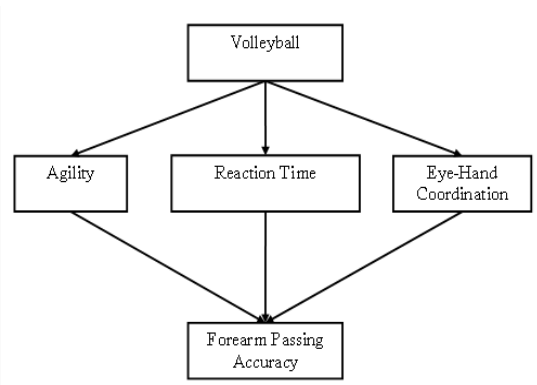

Figure 1. research thinking framework.

RESULTS AND DISCUSSION

Before testing the relationship between variables, descriptive analysis was conducted to describe the characteristics of the data on the variables of agility, reaction speed, eye-hand coordination, and volleyball forearm passing ability. This analysis includes the mean, standard deviation, minimum, and maximum values, and is used to group the results into certain norm categories. The goal is to provide an initial picture of the distribution of respondents' abilities and map the potential and weaknesses as a basis for developing volleyball training programs.

Table 1. Descriptive Statistical Analysis

	N	Mean	Std. Deviation	Range	Min	Max
Agility	30	15,94	2,261	6,98	12,88	19,86
Reaction Time	30	0,275	0,078	0,33	0,05	0,37
Eye-Hand Coodrination	30	19,633	5,034	20,00	10,00	30,00
Forearm Passing Accuracy	30	51,700	12,484	41,00	36,00	77,00

Based on the results **Table 1** of descriptive analysis of 30 respondents, an overview of the data characteristics of the four research variables was obtained. The agility variable has an average of 15.94 seconds with a range of values of 6.98, showing moderate variation in ability. Reaction speed has an average of 0.275 seconds with a range of 0.33, reflecting a fairly significant difference between respondents. Eye-hand coordination showed an average of 19.63 with a range of 20.00, indicating a high level of coordination variation. Volleyball forearm passing ability had an average of 51.70 with a range of 41.00, indicating a fairly wide spread of values. Overall, the data shows the diversity of physical abilities and basic techniques that are the basis for analyzing the relationship between variables in coaching volleyball achievements.

Table 2. Description of Agility

Criteria	Frequency	Percentage	Description
<15,2	11	36,67%	Very Good
15,2-16,1	5	16,67%	Good
16,2-18,1	7	23,33%	Moderate
18,2-19,3	3	10,00%	Poor
>19,3	4	13,33%	Very Poor
Total	30	100%	

The results **Table 2** of descriptive analysis of agility variables show that there are variations in the level of ability among 30 respondents. A total of 11 respondents (36.6%) were in the very good category, and 5 respondents (16.67%) were in the good category. Thus, more than half of the respondents (56.66%) had high agility. Meanwhile, 7 respondents (23.33%) were in the moderate category, 3 respondents (10%) in the less category, and 4 respondents (13.33%) in the very less category. This finding indicates that in general, respondents have good agility skills, which play an important role in supporting volleyball game performance.

Figure 2. Agility Categories

Table 3. Description of Reaction Time

Criteria	Frequency	%	Description
0,001-0,100	3	10,00%	Excellent
0,101-0,200	4	13,30%	Very Good
0,201-0,300	12	40,00%	Good
0,301-0,400	11	36,70%	Moderate
0,401-0,500	0	0,00%	Poor
>501	0	0,00%	Very Poor
Total	30	100%	

The results **Table 3** of the descriptive analysis of the reaction speed variable show that the majority of respondents are in the moderate to good category. Of the 30 respondents, 3 people (10%) were in the excellent category, 4 people (13.3%) in the good category, and 12 people (36.7%) in the fair category. No respondents fell into the poor or very poor categories. This finding indicates that in general, respondents have responsive motor reaction skills, which are very important in volleyball games to respond quickly and appropriately to ball movements.

The results **Table 4** of descriptive analysis of eye-hand coordination variables show that the majority of respondents have good to very good coordination skills. A total of 15 respondents (50%) were in the very good category, 9 respondents (30%) in the good category, and 6 respondents (20%) in the moderate category. There were no respondents in the poor or very poor categories. This finding shows that all respondents have an adequate level of hand-eye coordination, which is very instrumental in technical volleyball skills such as catching, directing, and controlling the ball.

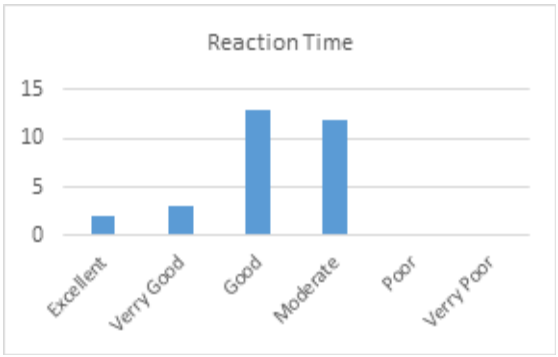

Figure 3. Reaction Time Categories

Table 4. Description of Eye-Hand Coordination

Norm	Frequency	%	Description
≥22	15	50,00%	Very Good
16-21	9	30,00%	Good
10-15	6	30,00%	Moderate
4-9	0	0,00%	Poor
≤3	0	0,00%	Very Poor
Total	30	100%	

The results **Table 5** of descriptive analysis of volleyball forearm passing ability variables show that most respondents have good basic technical skills. Of the 30 respondents, 14 people (46.7%) were in the good category, 8 people (26.7%) in the medium category, and 7 people (23.3%) in the less category. Only 1 respondent (3.3%) was in the very poor category. This finding shows that the majority of respondents had adequate to good forearm passing skills, which reflects their mastery of important basic techniques in volleyball, especially in receiving serves and controlling the first ball.

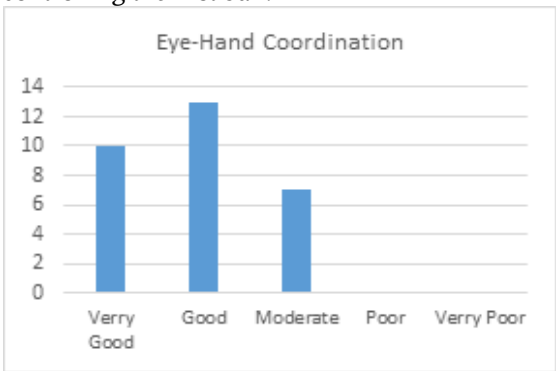

Figure 4. Eye-Hand Coordination Categories

Table 5. Description of Forearm Passing Accuracy

Norm	Frequency	%	Description
>88	0	0,00%	Very Good
73-87	14	46,70%	Good
58-72	8	26,70%	Moderate
44-57	7	23,30%	Poor
<43	1	3,30%	Very Poor
Total	30	100%	

The results **Table 6** of the correlation analysis showed a variation in the strength of the relationship between each independent variable and volleyball forearm passing ability. Agility has a strong and significant negative relationship with forearm passing ability (r = -0.553; p = 0.002), which means the better the player's agility, the higher the forearm passing ability. Reaction speed also showed a significant negative relationship (r = -0.378; p = 0.039), although with a weaker correlation strength. Meanwhile, eye-hand coordination had a highly significant positive relationship (r = 0.741; p = 0.001), indicating that the better the eye-hand coordination, the higher the forearm passing ability. Thus, agility and hand-eye coordination play an important role in supporting the skill of basic forearm passing techniques in volleyball games, while reaction speed also contributes albeit to a lesser extent.

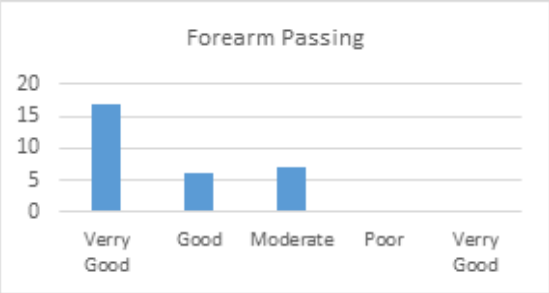

Figure 5. Forearm Passing Accuracy Categories

Table 6. Description of Analisis Correlation

Relationship	Correlation	Sig.
Agility ↔ Forearm Passing Accuracy	-0,553	0,002
Reaction Time ↔ Forearm Passing Accuracy	-0,378	0,039
Eye-Hand Coordination tangan ↔ Forearm Passing Accuracy	0,564	0,001

The game of volleyball demands mastery of basic techniques such as forearm passing, which is the foundation in building strategy and smooth team play. This ability not only depends on technical aspects alone, but is also influenced by various components of physical condition and motor skills, including agility, reaction speed, and eye-hand coordination. These three components have a complementary role in supporting the accuracy, precision, and consistency of the execution of lower passes. In this study, the relationship between the three independent variables on the ability to pass down is analyzed to determine their respective contributions and their implications in the process of coaching basic volleyball techniques.

Agility is an essential physical ability in volleyball, particularly in the context of forearm passing. Agility is defined as an individual's ability to change the direction or position of the body quickly and in a controlled manner. In the execution of forearm passing, agility plays a crucial role in helping players adjust their body position to match the direction and speed of the ball, especially when receiving serves or the first ball from the opponent's attack. The findings of this study indicate a significant negative relationship between agility and forearm passing ability (r = -0,553, p = 0,002), suggesting that the faster the agility response time (indicating better agility), the higher the quality of the forearm pass produced. This can be explained by the need for players to move quickly to an ideal position beneath the ball, maintain balance, and ensure the accuracy of the pass.

The role of agility becomes increasingly vital in the dynamic nature of volleyball, which demands rapid responses to constantly changing game situations. For instance, when receiving a fast serve or a ball with an unpredictable trajectory, players must be able to move laterally, diagonally, or even backward quickly to position their bodies optimally. Agility also supports players' ability to promptly return to the ready position after executing a pass, which is important for maintaining the team's continuity of play (Zwierko et al., 2023) . The data from this study show that most respondents possessed a high level of agility, which was strongly associated with good to excellent forearm passing ability. This underscores that agility is not merely a physical skill but also a fundamental basis for the precise execution of technical movements.

These findings are consistent with the study by Iqram et al (2025) , which revealed a significant correlation between agility and forearm passing ability among junior volleyball players. That study concluded that agility training, such as shuttle runs and agility ladder drills, effectively

enhances players' ability to adjust body position, thereby supporting passing accuracy. Similarly, the study by (Chuang et al., 2022) involving elite volleyball athletes identified agility as a key predictor of defensive performance, including the ability to receive the first ball, aligning with the present study's findings.

As a practical implication, coaches are encouraged to incorporate agility exercises such as shuttle runs, ladder drills, zig-zag sprints, and sudden directional change drills with the ball into training programs. These exercises not only improve quick directional change ability but also strengthen balance and body coordination, which are essential for performing effective forearm passes in actual match situations.

Reaction time, defined as the duration required to respond to a specific stimulus, plays a critical role in the execution of effective forearm passing. The significant negative correlation between reaction time and forearm passing ability ($r = -0.378$, $p = 0.039$) indicates that players with faster reaction times tend to demonstrate better passing performance. In volleyball, quick reaction time is essential for anticipating the direction and speed of the ball, particularly when dealing with powerful serves, spikes, or tips from opponents. Players must be able to detect visual stimuli (ball trajectory) and immediately make decisions to move into the appropriate position and adjust their passing technique accordingly.

Reaction time is also closely related to perceptual-motor ability, which involves the integration of visual information processing and motor responses. In this study, the majority of respondents exhibited reaction times within the "adequate" to "excellent" categories, with no respondents classified as having poor reaction times. This suggests that the player population possesses a solid baseline ability to respond to the fast-paced and dynamic situations typical in volleyball. Good reaction time allows players to minimize passing errors, such as failing to reach the ball or producing inaccurate passes, thereby enhancing team play fluidity (Kanatschnig et al., 2025).

Mancini et al (2024) reported that reaction time showed a positive correlation with defensive performance in volleyball, including forearm passing ability, with a correlation coefficient. This study highlighted the importance of rapid reactions in competitive play situations, where players must make decisions within a very short time frame. Furthermore, research by Bean (2021) found that specific reaction training, such as reaction ball drills, improved players' ability to respond quickly to the ball, positively impacting passing accuracy.

To enhance reaction time, coaches are encouraged to implement exercises such as reaction ball drills, where players are required to catch balls that bounce unpredictably, as well as high-speed catch-and-throw exercises. The use of visual cues in training, such as light signals or coach movements, can also help develop players' anticipatory skills. These exercises should be conducted consistently to sharpen reaction speed and improve adaptability in unpredictable game situations.

Hand-eye coordination, which refers to the ability to integrate visual information with precise hand movements, is a key factor in the successful execution of forearm passing. The significant positive correlation between hand-eye coordination and forearm passing ability ($r = 0.564$, $p = 0.001$) indicates that players with good visual-motor coordination tend to direct the ball more accurately during passing. In forearm passing, players must be able to visually track the ball's trajectory, estimate the contact point, and coordinate arm and hand movements to deliver a controlled pass. Good coordination ensures that the ball can be directed toward the intended target with high accuracy, which is essential for building effective team attacks.

The study data showed that all respondents demonstrated hand-eye coordination within the moderate to high category, reflecting adequate sensorimotor readiness to perform fundamental volleyball techniques. Hand-eye coordination enables players to adjust the strength and angle of their passing according to the ball's speed and direction, thereby minimizing the likelihood of misdirected or improperly powered passes (Mahmudin et al., 2025). This ability is particularly relevant in match situations that require quick responses to unpredictable ball trajectories, such as when receiving float serves or powerful spikes.

A study by Mahmudin et al (2025) found a strong positive correlation between hand-eye coordination and forearm passing accuracy among volleyball players, with a correlation coefficient. This study emphasized that hand-eye coordination training, such as target passing drills, enhances players' ability to control the direction of the ball. In addition, research by (Ottoboni et al., 2021) identified visual-motor coordination as a key predictor of technical skills in racket and ball sports, including volleyball, supporting the findings of the present study.

To improve hand-eye coordination, coaches are advised to incorporate exercises such as target passing drills, where players must direct the ball accurately to designated zones. Catch-and-

throw exercises with varied speed and direction, as well as the use of patterned balls to sharpen visual focus, are also highly effective. These drills can be combined with game simulations, such as passing under time pressure, to enhance players' adaptability and precision in real match conditions.

CONCLUSION

Overall, the findings of this study demonstrate that agility, reaction time, and hand-eye coordination play significant roles and have meaningful correlations with forearm passing ability in volleyball. Agility facilitates rapid and controlled movement to achieve the optimal position when receiving the ball. Reaction time ensures that players can respond instantly to dynamic game stimuli, such as unpredictable ball direction or speed. Hand-eye coordination is essential for achieving precision in ball control, enabling players to deliver accurate passes that support the team's offensive flow. These results are consistent with prior studies, which have highlighted the crucial contribution of these physical components to technical performance in volleyball, particularly in first-line defense. Accordingly, coaches are encouraged to design comprehensive and structured training programs that integrate agility exercises (such as shuttle runs and ladder drills), reaction time drills (including reaction ball exercises and visual cue training), and hand-eye coordination training (such as target passing drills and catch-throw activities with varying speeds and directions). Such programs should be implemented consistently and progressively, taking into account the specific needs and skill levels of each player. This integrated approach is expected not only to enhance forearm passing performance but also to strengthen the physical and motor foundations necessary for overall volleyball excellence, thereby contributing to the development of competitive and sustainable athletes.

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