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The Effect of Arm Muscle Strength And Hand-Eye Coordination On Under Passing Ability Through Motivation In Female Volleyball Athletes

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ABSTRACT

This study aims to examine the effect of arm muscle strength and hand-eye coordination on under passing ability through motivation as a mediating variable in female volleyball athletes. Volleyball performance, particularly under passing, is influenced not only by physical factors but also by psychological aspects such as motivation, making an integrated analysis essential. This research employed a quantitative approach using a path analysis design. The sample consisted of 25 active female athletes from the Sparta FIKK UNM volleyball club, selected through purposive sampling. Data were collected using standardized instruments: Pull and Push Dynamometer for arm muscle strength, a wall throw-and-catch test for hand-eye coordination, a 33-item Likert-scale questionnaire for motivation, and the Brumbach forearm pass wall-volley test for under passing ability. Data analysis was conducted using SPSS Statistics version 25, including descriptive statistics and inferential analysis with prerequisite tests (normality, linearity, and multicollinearity) at a significance level of $\alpha = 0.05$. The results showed that arm muscle strength significantly affected motivation ($\beta = 0.293$; $p = 0.001$) and under passing ability ($\beta = 0.282$; $p = 0.001$). Hand-eye coordination had a stronger effect on motivation ($\beta = 0.681$; $p = 0.000$) and also significantly influenced under passing ability ($\beta = 0.274$; $p = 0.000$). Motivation emerged as the strongest predictor of under passing ability ($\beta = 0.454$; $p = 0.002$). Indirect effects indicated that arm muscle strength contributed 13.3% and hand-eye coordination 30.9% to under passing ability through motivation. The model explained 82.2% of the variance in under passing ability ($R^2 = 0.822$). In conclusion, effective volleyball training programs should integrate physical conditioning and psychological development to optimize athlete performance.

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INTRODUCTION

Volleyball is one of the most popular sports in Indonesia, widely played across educational levels from elementary schools to universities. Within higher education settings, volleyball serves not only as a recreational activity but also as a structured platform for athlete development and competitive achievement (Arga, 2025; H et al.,

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2024; Inpres, 2023; Muh. Amin et al., 2026; Natasha et al., 2024). At the university level, particularly within the Universitas Negeri Makassar, the Sparta FIKK UNM volleyball club has demonstrated significant progress, achieving notable accomplishments such as first place in PORMA V Makassar (2022), first place in Padaelo Cup 3 Bone Regency (2025), and second place in UNHAS Cup XIII South Sulawesi (2023) (Suriah Hanafi et al., 2025).

Despite these achievements, fundamental technical skills remain critical determinants of performance. Among these, under passing (forearm passing) is a foundational skill that directly influences team coordination, serve reception, and offensive construction (Gusti Ayu Nirmala Putri, 2018; Haslindah et al., 2025; Sahabuddin et al., 2025). Ineffective under passing disrupts ball control, limits tactical execution, and reduces scoring opportunities. Therefore, understanding the determinants of under passing ability particularly among female volleyball athletes becomes an urgent research priority.

From a physiological perspective, arm muscle strength and hand-eye coordination are two key physical components strongly associated with under passing performance. Arm muscle strength enables athletes to generate controlled force during ball contact, particularly through isotonic contractions involving elbow flexion and extension (Aulria, 2025; Suryati et al., 2020). Meanwhile, hand-eye coordination facilitates the integration of visual input with motor execution, allowing athletes to respond accurately to ball trajectory, speed, and direction (Kaherani et al., 2024; Natasha et al., 2024). However, performance in sports is not solely determined by physical attributes. Psychological factors—especially motivation—play a crucial role in shaping athletes' consistency, effort, and overall performance outcomes (Ash Shiddiq et al., 2023; Osman et al., 2022; Petrachkov et al., 2024).

Thus, a central problem emerges: how do physical factors (arm muscle strength and hand-eye coordination) and psychological factors (motivation) interact to influence under passing ability in female volleyball athletes?

Recent studies in sports science highlight the multidimensional nature of athletic performance, integrating physical, technical, and psychological components (Bompa & Buzzichelli, 2019; Suchomel et al., 2018). In volleyball, under passing is widely recognized as a complex motor skill requiring coordination, timing, and force control (H et al., 2023; Karmila et al., 2024; Yusril et al., 2024). Empirical findings indicate that athletes with higher upper-body strength demonstrate better ball control and passing accuracy due to improved force absorption and redirection capabilities (Suryati et al., 2020; Aulria, 2025).

Similarly, hand-eye coordination has been identified as a critical determinant of motor skill execution in ball sports. Studies show that athletes with superior coordination exhibit faster reaction times, better spatial awareness, and higher movement precision (Kaherani et al., 2024; H et al., 2024). In volleyball contexts, coordination enables players to adjust body positioning and arm angles effectively during serve reception and defensive plays.

On the psychological dimension, motivation has been extensively studied as a key driver of sports performance. According to contemporary sport psychology frameworks,

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intrinsic and extrinsic motivation influence training adherence, persistence, and competitive behavior (Osman et al., 2022; Petrachkov et al., 2024). Athletes with higher motivation levels tend to engage more intensely in training, demonstrate greater resilience under pressure, and optimize their physical capabilities during performance (Ash Shiddiq et al., 2023).

Furthermore, recent studies emphasize the importance of integrating physical and psychological variables in performance models. The interaction between physical fitness and motivation has been shown to significantly influence skill acquisition and execution (Haslindah et al., 2025; Sahabuddin et al., 2025). However, most existing studies treat these variables independently rather than examining their interconnected relationships within a comprehensive analytical framework.

Although numerous studies have examined the effects of arm muscle strength, hand-eye coordination, and motivation on sports performance, several critical gaps remain. First, existing research predominantly focuses on direct effects, analyzing physical and psychological variables separately without considering their interaction or mediation mechanisms. This approach limits the understanding of how these variables collectively influence performance outcomes. Second, studies investigating mediating variables, particularly motivation, in the relationship between physical attributes and technical skills are still limited. In reality, physical capacity alone does not guarantee optimal performance; it must be supported by psychological readiness and engagement. Third, there is a lack of research specifically targeting female volleyball athletes in higher education settings, especially within Indonesian contexts. Gender-specific physiological and psychological characteristics may influence performance differently, necessitating more focused investigation. Fourth, the application of path analysis models in volleyball performance research remains underutilized. This analytical approach allows for the examination of both direct and indirect relationships among variables, providing a more comprehensive understanding of performance determinants. Therefore, this study addresses these gaps by proposing a mediated performance model, where motivation acts as an intervening variable linking arm muscle strength and hand-eye coordination to under passing ability.

Based on the identified problems and gaps, this study aims to analyze the structural relationships among arm muscle strength, hand-eye coordination, motivation, and under passing ability in female volleyball athletes of Sparta FIKK UNM.

Specifically, the objectives of this study are to examine: The direct effect of arm muscle strength on motivation, The direct effect of hand-eye coordination on motivation, The direct effect of arm muscle strength on under passing ability, The direct effect of hand-eye coordination on under passing ability, The direct effect of motivation on under passing ability, The indirect effect of arm muscle strength on under passing ability through motivation, The indirect effect of hand-eye coordination on under passing ability through motivation.

The novelty of this study lies in its integrative analytical framework, which combines physical and psychological variables within a path analysis model. Unlike

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previous studies that examine variables independently, this research offers a more holistic perspective by exploring both direct and mediated relationships.

Additionally, this study contributes to the limited body of literature focusing on female university-level volleyball athletes, providing empirical evidence relevant to training program design, coaching strategies, and athlete development in higher education contexts.

In conclusion, under passing ability in volleyball is a multidimensional skill influenced not only by physical factors such as arm muscle strength and hand-eye coordination but also by psychological factors, particularly motivation. However, the interaction between these variables remains insufficiently explored, especially within female collegiate athletes. By employing a path analysis approach, this study seeks to provide a comprehensive understanding of both direct and indirect effects, thereby contributing to the advancement of sport science research and practical training applications in volleyball.

METHODS

This study employed a quantitative approach using a path analysis design, which allows for the simultaneous examination of direct and indirect relationships among variables within a unified structural model. Path analysis is widely recognized as an extension of multiple regression that enables researchers to test complex causal models involving mediating variables (Hair et al., 2019; Kline, 2016). This design is particularly appropriate for sports science research where performance outcomes are influenced by multidimensional factors, including physical and psychological components (Tabachnick & Fidell, 2019; Field, 2018).

The study involved four variables categorized into exogenous, intervening, and endogenous constructs. Arm muscle strength (X_1) and hand-eye coordination (X_2) were treated as exogenous variables, motivation (X_3) as the intervening variable, and under passing ability (Y) as the endogenous variable. The structural model consisted of two substructures: Substructure 1 examined the effects of X_1 and X_2 on X_3, while Substructure 2 analyzed the effects of X_1, X_2, and X_3 on Y. This two-stage modeling approach enables a comprehensive understanding of both direct and mediated influences (Byrne, 2016; Hayes, 2018).

The population of this study comprised all members of the BKMF Sparta FIKK UNM volleyball club, totaling 65 athletes. A purposive sampling technique was applied to ensure the relevance of participants to the research objectives. The inclusion criteria were: (1) registered as female volleyball athletes of Sparta FIKK UNM, (2) actively participating in training programs, and (3) physically fit to perform all test procedures. Based on these criteria, a final sample of 25 athletes was obtained. Purposive sampling is commonly used in sport performance research to ensure the selection of participants with specific characteristics relevant to the study variables (Etikan et al., 2016; Creswell & Creswell, 2018).

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Data collection was conducted using four standardized instruments. First, arm muscle strength was measured using a Pull and Push Dynamometer, where participants performed maximal pulling actions from a standing position. The highest score from three trials was recorded. This instrument has been widely used for assessing upper-body strength in athletes due to its reliability and validity (Pranata, 2020; Suchomel et al., 2018). Second, hand-eye coordination was assessed using a wall toss test (ball throw-and-catch against a wall for 60 seconds), measuring the number of successful controlled rebounds. This test is frequently applied in ball sports to evaluate coordination efficiency and reaction speed (Rizkal et al., 2024; Davids et al., 2017).

Third, motivation was measured using a 33-item Likert-scale questionnaire encompassing intrinsic dimensions (needs, expectations, and interest) and extrinsic dimensions (family support, environment, and rewards). Each item was scored on a scale of 1 to 5. The use of multidimensional motivation scales aligns with contemporary sport psychology frameworks that emphasize both internal and external drivers of performance (Ryan & Deci, 2017; Osman et al., 2022). Fourth, under passing ability was measured using the Brumbach forearm pass wall-volley test, in which participants performed repeated passes against a target wall for 60 seconds. Each accurate pass was scored as one point, and the best score from three trials was recorded (Rizkal et al., 2024; American Volleyball Coaches Association, 2019).

Data analysis was conducted in three stages. First, descriptive statistics were used to summarize the data, including mean, standard deviation, minimum, and maximum values for each variable. Second, prerequisite tests were performed, including normality testing using the Kolmogorov-Smirnov test, linearity testing through deviation from linearity, and multicollinearity testing using Variance Inflation Factor (VIF). These tests are essential to ensure the validity of regression-based analyses (Field, 2018; Hair et al., 2019).

Finally, hypothesis testing was conducted using path analysis through multiple regression equations with a significance level of $\alpha = 0.05$. All analyses were performed using **SPSS Statistics version 25. The structural equations applied in this study were:

$$X_3 = \rho x_3 x_1 X_1 + \rho x_3 x_2 X_2 + \varepsilon_1$$

$$Y = \rho y x_1 X_1 + \rho y x_2 X_2 + \rho y x_3 X_3 + \varepsilon_2$$

This analytical approach enables the identification of both direct and indirect effects, providing a comprehensive understanding of how physical and psychological factors interact to influence under passing performance in female volleyball athletes.

RESULTS AND DISCUSSION

Result

Descriptive Analysis

A descriptive statistical analysis was conducted to provide an overview of the four research variables: arm muscle strength (X_1), hand-eye coordination (X_2), motivation (X_3), and under passing ability (Y). The results are presented in Table 1.

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Table 1.
Descriptive Statistics of Research Variables (n = 25)

Variable	N	Range	Min.	Max.	Sum	Mean	Std. Deviation
Arm Muscle Strength (X_1)	25	29	17	46	604	30.20	7.445
Hand-Eye Coordination (X_2)	25	17	25	42	659	32.95	5.501
Motivation (X_3)	25	65	95	160	2420	121.00	16.596
Under Passing Ability (Y)	25	19	27	46	733	36.65	1.188

The data indicate that arm muscle strength has a mean score of 30.20 (SD = 7.445), with values ranging from 17 to 46, reflecting a relatively wide variation in physical capacity among athletes. Hand-eye coordination shows a mean of 32.95 (SD = 5.501), suggesting a relatively homogeneous level of coordination within the group. Motivation has an average score of 121.00 (SD = 16.596) out of a maximum of 160, indicating that the athletes generally possess a moderate to high level of training motivation. Meanwhile, under passing ability has a mean of 36.65 (SD = 1.188), suggesting that most athletes fall within the moderate to good performance category.

Normality Test

Table 2.
Results of Normality Test (Kolmogorov-Smirnov / Shapiro-Wilk)

Variable	Statistic	Sig.	Interpretation
Arm Muscle Strength (X_1)	0.166	0.149	Normal
Hand-Eye Coordination (X_2)	0.254	0.200	Normal
Motivation (X_3)	0.194	0.200	Normal
Under Passing Ability (Y)	0.136	0.200	Normal

All variables show significance values greater than 0.05, indicating that the data are normally distributed. Therefore, the dataset satisfies the normality assumption required for further parametric analysis.

Linearity Test

Table 3.
Results of Linearity Test

Variable Relationship	F-value	Sig.	Interpretation
$X_2 \rightarrow X_3$ (Motivation)	1.896	0.248	Linear
$X_1 \rightarrow Y$ (Passing Ability)	1.150	0.996	Linear
$X_2 \rightarrow Y$ (Passing Ability)	1.952	0.570	Linear
$X_3 \rightarrow Y$ (Passing Ability)	1.345	0.941	Linear

The linearity test results show that all relationships between variables have significance values above 0.05, indicating linear relationships. This confirms that the regression-based path model is appropriate for the data.

Multicollinearity Test

Table 4.
Results of Multicollinearity Test

Variable	Tolerance	VIF	Interpretation
Arm Muscle Strength (X_1)	0.481	2.080	No Multicollinearity
Hand-Eye Coordination (X_2)	0.485	2.060	No Multicollinearity
Motivation (X_3)	0.945	1.016	No Multicollinearity

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The Variance Inflation Factor (VIF) values are all below 10 and tolerance values exceed 0.10, indicating that there is no multicollinearity among the independent variables. Each variable contributes uniquely to the model.

Hypothesis Testing (Path Analysis)

Hypothesis testing was conducted in two stages based on the proposed structural model.

Substructure 1: Effects of X_1 and X_2 on Motivation (X_3)

Table 5.
Path Coefficients for Substructure 1

Path	Coefficient (β)	t-value	Sig.
$X_1 \rightarrow X_3$	0.293	2.405	0.001
$X_2 \rightarrow X_3$	0.681	5.056	0.000

The results show that both arm muscle strength and hand-eye coordination significantly influence motivation. The model explains 71.6% of the variance in motivation ($R^2 = 0.716$; $F = 7.863$; Sig. = 0.002). Hand-eye coordination ($\beta = 0.681$) has a stronger effect compared to arm muscle strength ($\beta = 0.293$).

The structural equation is:

$$\mathbf{X_3 = 0.293X_1 + 0.681X_2 + \varepsilon_1}$$

Substructure 2: Effects of X_1, X_2, and X_3 on Under Passing Ability (Y)

Table 6.
Path Coefficients for Substructure 2

Path	Coefficient (β)	t-value	Sig.
$X_1 \rightarrow Y$	0.282	3.834	0.001
$X_2 \rightarrow Y$	0.274	2.608	0.000
$X_3 \rightarrow Y$	0.454	3.147	0.002

The second model demonstrates stronger explanatory power, accounting for 82.2% of the variance in under passing ability ($R^2 = 0.822$). Motivation emerges as the strongest predictor ($\beta = 0.454$), followed by arm muscle strength ($\beta = 0.282$) and hand-eye coordination ($\beta = 0.274$).

The structural equation is:

$$\mathbf{Y = 0.282X_1 + 0.274X_2 + 0.454X_3 + \varepsilon_2}$$

Indirect Effects

The indirect effects analysis reveals that: Arm muscle strength influences under passing ability through motivation by **0.293 × 0.454 = 0.133 (13.3%)**, and Hand-eye coordination influences under passing ability through motivation by **0.681 × 0.454 = 0.309 (30.9%).**

These findings confirm that motivation plays a significant mediating role, particularly strengthening the influence of hand-eye coordination on under passing performance.

Overall, the results indicate that both physical factors (arm muscle strength and hand-eye coordination) and psychological factors (motivation) significantly contribute to under passing ability. Among these, motivation serves as a key mediator, enhancing the effectiveness of physical capacities in improving volleyball performance.

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Discussion

The findings of this study provide strong empirical evidence that both physical and psychological factors significantly contribute to under passing ability in female volleyball athletes. Specifically, arm muscle strength and hand-eye coordination were found to have both direct and indirect effects on performance, with motivation acting as a crucial mediating variable. These results reinforce the multidimensional perspective of sports performance, which integrates physiological, biomechanical, and psychological components into a unified framework (Bompa & Buzzichelli, 2019; Suchomel et al., 2018; Davids et al., 2017).

Arm Muscle Strength and Motivation

The results indicate that arm muscle strength has a significant direct effect on motivation (β = 0.293). This finding suggests that athletes with higher levels of physical strength tend to exhibit greater motivation during training and competition. From a theoretical standpoint, physical competence is closely linked to self-efficacy, which is a key determinant of intrinsic motivation (Ryan & Deci, 2017; Moradi et al., 2020). Athletes who perceive themselves as physically capable are more confident, leading to increased engagement and persistence in training activities.

This finding is consistent with previous research showing that improvements in muscular strength contribute to enhanced psychological readiness and motivation in athletes (Osman et al., 2022; Petrachkov et al., 2024). In volleyball contexts, arm muscle strength plays a critical role in executing technical skills, particularly under passing, which requires controlled force and stability (Suryati et al., 2020). When athletes experience success in executing such movements, it reinforces their motivation through positive feedback mechanisms (Ash Shiddiq et al., 2023).

Empirically, the contribution of arm muscle strength to motivation (29.3%) suggests that physical conditioning programs should not only aim to improve performance but also consider their psychological impact. As highlighted in the dataset , athletes with stronger arm muscles demonstrate better readiness and enthusiasm in performing passing techniques. This reinforces the concept that physical preparedness can serve as a foundation for psychological engagement in sports.

Hand-Eye Coordination and Motivation

The study further reveals that hand-eye coordination has a stronger direct effect on motivation (β = 0.681), making it the most dominant predictor in Substructure 1. This result highlights the importance of coordination as a key factor influencing athletes' confidence and enjoyment during performance. Coordination is closely related to motor control efficiency, which directly impacts an athlete's ability to execute skills accurately (Schmidt & Lee, 2019; Kaherani et al., 2024).

Athletes with better coordination are able to perform movements more smoothly and effectively, reducing errors and increasing success rates. This success experience enhances intrinsic motivation, as athletes feel more competent and in control of their performance (Ryan & Deci, 2017). In volleyball, hand-eye coordination is essential for tracking the ball trajectory and synchronizing body movements during passing (Riko et al., 2021).

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The strong contribution of coordination to motivation (68.1%) aligns with findings from motor learning studies, which emphasize that skill mastery is a key driver of motivation (Davids et al., 2017). As described in , effective coordination enables athletes to execute passing movements with greater precision and speed, thereby increasing their confidence and willingness to engage in training.

This finding suggests that training programs focusing on coordination development may have dual benefits: improving technical performance and enhancing athlete motivation.

Arm Muscle Strength and Under Passing Ability

The results demonstrate that arm muscle strength significantly affects under passing ability (β = 0.282). This finding confirms that physical strength is a fundamental component in executing volleyball techniques effectively. Under passing requires controlled force generation to absorb and redirect the ball accurately, which depends heavily on upper-body strength (Suchomel et al., 2018). Biomechanically, the under passing movement involves elbow extension and shoulder stabilization, requiring coordinated muscle contractions to control ball trajectory (Lees et al., 2016). Athletes with greater arm muscle strength are better able to regulate these forces, resulting in more accurate and stable passes. This finding is supported by previous studies indicating that muscular strength significantly correlates with passing accuracy in volleyball (Hakim & Sukamto, 2019; Suryati et al., 2020). As highlighted in , the ability to generate appropriate force during passing enables athletes to control the direction and speed of the ball effectively. However, the contribution of arm muscle strength (28.2%) is lower compared to motivation, suggesting that physical strength alone is not sufficient to optimize performance. This reinforces the importance of integrating physical and psychological training components.

Hand-Eye Coordination and Under Passing Ability

Hand-eye coordination was also found to have a significant direct effect on under passing ability (β = 0.274). This result emphasizes the role of perceptual-motor skills in volleyball performance. Coordination enables athletes to accurately judge ball trajectory and adjust their movements accordingly (Schmidt & Lee, 2019). In volleyball, under passing requires precise timing and spatial accuracy. Athletes must position their bodies correctly and synchronize arm movements with incoming ball trajectories. Poor coordination can lead to misjudgment and errors in passing execution (Riko et al., 2021). The findings align with previous research demonstrating that coordination is a key determinant of technical skill performance in ball sports (Davids et al., 2017; Kaherani et al., 2024). As noted in , athletes with better coordination are able to transition between movement patterns more efficiently, resulting in improved passing accuracy. This suggests that coordination training should be a core component of volleyball training programs, particularly for developing fundamental skills such as under passing.

Motivation and Under Passing Ability

Motivation emerged as the strongest predictor of under passing ability (β = 0.454), highlighting its critical role in performance. This finding supports the notion that

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psychological factors significantly influence skill execution in sports (Ryan & Deci, 2017; Moradi et al., 2020). Motivated athletes tend to exhibit higher levels of focus, persistence, and effort during training and competition (Osman et al., 2022). These attributes directly contribute to improved skill acquisition and performance consistency. In volleyball, motivation enhances an athlete's ability to concentrate on technique execution and adapt to dynamic game situations (Petrachkov et al., 2024). As described in , motivation plays a crucial role in achieving accurate and controlled passing. Athletes with high motivation are more likely to engage in repetitive practice, which is essential for mastering under passing techniques (Nurjana, 2021). The strong contribution of motivation (45.4%) indicates that psychological training interventions, such as goal setting and self-regulation strategies, should be integrated into volleyball training programs.

Indirect Effects and Mediation Role of Motivation

One of the most important contributions of this study is the identification of motivation as a mediating variable. The indirect effect of arm muscle strength on under passing ability through motivation was 13.3%, while the indirect effect of hand-eye coordination was 30.9%. These findings suggest that motivation amplifies the impact of physical abilities on performance. In other words, athletes with strong physical capabilities will not reach optimal performance levels without sufficient motivation. This aligns with contemporary sport science theories that emphasize the interaction between physical and psychological factors in determining performance outcomes (Bompa & Buzzichelli, 2019; Davids et al., 2017). The mediation model also supports previous findings that motivation enhances the effectiveness of physical training (Moradi et al., 2020). As explained in , motivation serves as a driving force that translates physical potential into actual performance. Athletes with high motivation are more likely to utilize their strength and coordination effectively during gameplay. The findings of this study have important implications for volleyball coaching and training. First, training programs should adopt an integrated approach that combines physical conditioning, coordination training, and psychological development. Second, coaches should prioritize motivation-enhancing strategies, such as feedback, goal setting, and positive reinforcement. Additionally, coordination training appears to have the greatest overall impact, both directly and indirectly, suggesting that it should be a key focus area in athlete development programs. In summary, this study confirms that under passing ability in volleyball is influenced by a combination of physical and psychological factors. While arm muscle strength and hand-eye coordination play important roles, motivation emerges as the most influential factor and a critical mediator. These findings highlight the need for a holistic training approach that integrates physical and psychological components to optimize athlete performance.

CONCLUSION

This study concludes that under passing ability in female volleyball athletes is significantly influenced by both physical and psychological factors, particularly arm muscle strength, hand-eye coordination, and motivation. The findings provide strong empirical evidence supporting a multidimensional performance model in volleyball.

First, arm muscle strength has a significant direct effect on athlete motivation (β = 0.293; p = 0.001), indicating that better physical capacity contributes to increased psychological readiness and training engagement. Second, hand-eye coordination shows an even stronger direct effect on motivation (β = 0.681; p = 0.000), suggesting that athletes with higher coordination tend to be more confident and motivated during practice and competition.

In terms of technical performance, arm muscle strength significantly affects under passing ability (β = 0.282; p = 0.001), confirming its role in generating controlled force and stabilizing ball contact. Similarly, hand-eye coordination significantly contributes to under passing performance (β = 0.274; p = 0.000), highlighting the importance of perceptual-motor integration in executing accurate movements.

Motivation emerges as the strongest predictor of under passing ability (β = 0.454; p = 0.002), emphasizing its critical role in enhancing performance. Athletes with higher motivation demonstrate better focus, persistence, and consistency in skill execution.

Furthermore, this study reveals significant indirect effects through motivation. Arm muscle strength influences under passing ability through motivation by 13.3% ($p < 0.05$), while hand-eye coordination shows a stronger indirect effect of 30.9% ($p < 0.05$). These results confirm that motivation acts as a key mediating variable, strengthening the impact of physical factors on performance.

Overall, the combined contribution of arm muscle strength, hand-eye coordination, and motivation explains 82.2% of the variance in under passing ability ($R^2 = 0.822$). This finding highlights the importance of integrating physical conditioning and psychological development in volleyball training programs to achieve optimal athlete performance.

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It is hoped that the findings of this research will contribute meaningfully to the development of sports science, particularly in volleyball training and athlete performance optimization.

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