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by Agus Tri Tri

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Eye-Hand Coordination and Arm Muscle Power as Predictors of Tennis Serve Ability among Physical Education Students

Agus Tri Wibowo[1]
[1] Universitas PGRI Pontianak, Indonesia
Corresponding Author: agustriwibowo3108@gmail.com

Abstract

Objectives: This study aimed to determine the relationship between eye-hand coordination and arm muscle power with tennis serve ability among students of the Faculty of Sports and Health Education, Universitas PGRI Pontianak.

Materials and Methods: This research used a quantitative correlational design. The participants were 28 students selected through purposive sampling. Eye-hand coordination was measured using the racket-wall bounce test, arm muscle power using the medicine ball overhead throw test, and tennis serve ability using the ITF Hewitt Tennis Skills Test. Data were analyzed using descriptive statistics, normality and linearity tests, Pearson product-moment correlation, and multiple correlation analysis.

Results: Eye-hand coordination had a significant positive relationship with tennis serve ability ($r = 0.949 > r$ table $= 0.347$). Arm muscle power also showed a significant positive relationship with serve ability ($r = 0.950 > r$ table $= 0.347$). Simultaneously, eye-hand coordination and arm muscle power were strongly related to tennis serve ability, as indicated by F change significance $= 0.000 < 0.05$ and $R^2 = 0.979$.

Conclusions: Eye-hand coordination and arm muscle power are important biomotor components associated with tennis serve performance. These findings suggest that tennis learning and training programs should integrate visual-motor coordination drills and explosive arm-power exercises to improve serve accuracy, consistency, and power.

Keywords: eye-hand coordination; arm muscle power; tennis serve; physical education; correlational study

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Introduction

Sport is an integral part of efforts to improve human resources, particularly in relation to physical health, mental readiness, and athletic performance. Tennis is one of the most demanding racket sports because it requires physical fitness, technical mastery, tactical intelligence, and psychological control. Among the basic techniques in tennis, the serve has a strategic role because it is the first stroke used to start the game and, at the same time, can function as an offensive weapon to gain direct points or pressure the opponent from the beginning of the rally.

A successful tennis serve is not determined solely by technical knowledge. From a biomechanical and kinesiological perspective, serve performance depends on the integration of several biomotor components. Eye-hand coordination is required to synchronize visual information from the ball toss with the motor response of the arm and racket. When coordination is weak, the timing of racket-ball contact becomes unstable, resulting in inaccurate placement or service faults. In contrast, good eye-hand coordination enables players to control the ball toss, identify the optimal contact point, and direct the ball into the target service box.

Arm muscle power is also an essential determinant of serve performance. Power represents the combination of strength and speed during explosive movement. In tennis service mechanics, arm and shoulder power contribute to racket acceleration during the forward swing phase. The greater the explosive capacity of the arm muscles, the greater the potential to produce a fast, powerful, and difficult-to-return serve. Therefore, the quality of a tennis serve requires the simultaneous contribution of visual-motor control and explosive arm movement.

The urgency of this study is based on the practical problems found among students in tennis practice classes at the Faculty of Sports and Health Education, Universitas PGRI Pontianak. Several students still show inconsistent service performance, weak ball speed, unstable ball tossing, poor racket-ball contact, and low service accuracy. These problems may be related to insufficient eye-hand coordination and arm muscle power. As prospective physical education teachers and sport practitioners, students need to master not only the theoretical aspects of tennis but also the physical and technical components that support effective performance.

The novelty of this study lies in its simultaneous examination of eye-hand coordination and arm muscle power as predictors of tennis serve ability in physical education students. Previous discussions often emphasized service technique or isolated physical components, whereas this study integrates both visual-motor coordination and explosive arm power within a specific university-based tennis learning context. Therefore, this study provides empirical evidence that can be used to design more targeted tennis learning and training programs.

Based on these considerations, this study aimed to determine the partial and simultaneous relationship between eye-hand coordination and arm muscle power with tennis serve ability among students of the Faculty of Sports and Health Education, Universitas PGRI Pontianak.

Materials and Methods

Study Design

This study employed a quantitative correlational research design. The design was used to examine the relationship between two independent variables, namely eye-hand coordination and arm muscle power, and one dependent variable, namely tennis serve ability. This approach was considered appropriate because the study aimed to determine the strength and direction of the relationship among the variables without manipulating the research conditions.

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Study Participants

The participants in this study were 28 physical education students at Universitas PGRI Pontianak who were enrolled in tennis learning activities. The sampling technique used was purposive sampling, in which participants were selected based on specific criteria relevant to the research objectives. The criteria included active student status, participation in tennis practice sessions, and willingness to complete all tests required in the study. The sample consisted of students who had basic experience in performing tennis serve techniques.

Study Organization

The research was conducted through a series of physical skill tests and measurements. Data collection involved three main instruments. Eye-hand coordination was measured using the Racket-Wall Bounce Test, in which participants continuously bounced a tennis ball against a wall using a racket for 30 seconds. The final score was the number of valid successful bounces.

Arm muscle power was measured using the Medicine Ball Overhead Throw Test. Participants threw a 2-kg medicine ball explosively from behind the head, and the longest distance from three attempts was recorded as the final score.

Tennis serve ability was assessed using the ITF Hewitt Tennis Skills Test. Each participant performed 10 serve attempts, consisting of five serves from the deuce court and five serves from the ad court. The serve target area was divided into scoring zones, and the total score from all successful serves was used as the final serve ability score.

Statistical Analysis

Describe the The collected data were analyzed using descriptive and inferential statistics. Descriptive statistics were used to determine the minimum score, maximum score, mean, standard deviation, frequency, and percentage of each variable. Before hypothesis testing, normality and linearity tests were conducted to ensure that the data met the assumptions for parametric analysis.

The relationship between each independent variable and tennis serve ability was analyzed using the Pearson Product Moment correlation test. Furthermore, multiple correlation analysis was used to examine the simultaneous relationship between eye-hand coordination and arm muscle power with tennis serve ability. The level of significance was set at $p < 0.05$.

Results

Descriptive Statistics

The descriptive analysis showed that the eye-hand coordination scores ranged from 14 to 35, with a mean score of 24.29 and a standard deviation of 5.817. The distribution of eye-hand coordination scores is presented in Table 1.

Table 1. Distribution of Eye-Hand Coordination Scores

Score Interval	Frequency	Percentage
> 33	1	4%
29-33	7	25%
24-28	8	29%
19-23	7	25%
< 19	5	18%
Total	28	100%

The arm muscle power scores ranged from 3.5 to 7.5 meters, with a mean score of 5.82 and a standard deviation of 0.647. The distribution of arm muscle power scores is shown in Table 2.

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Table 2. Distribution of Arm Muscle Power Scores

Score Interval	Frequency	Percentage
> 7.3	7	25%
6.3-7.3	10	36%
5.3-6.2	7	25%
4.2-5.2	2	7%
< 4.2	0	0%
Total	28	100%

The tennis serve ability scores ranged from 9 to 35, with a mean score of 22.61 and a standard deviation of 5.82. The distribution of tennis serve scores is displayed in Table 3.

Table 3. Distribution of Tennis Serve Ability Scores

Score Interval	Frequency	Percentage
> 32	7	25%
25-32	11	39%
19-24	6	21%
12-18	0	0%
< 12	2	7%
Total	28	100%

Assumption Testing

The normality test showed that eye-hand coordination and arm muscle power data were normally distributed because the significance value for both variables was 0.200, which was greater than 0.05. The results are presented in Table 4.

Table 4. Normality Test Results

Variable	Significance	Interpretation
Eye-hand coordination	0.200	Normal
Arm muscle power	0.200	Normal

The linearity test showed that the relationship between eye-hand coordination and tennis serve ability was linear ($p = 0.101 > 0.05$). The relationship between arm muscle power and tennis serve ability was also linear ($p = 0.543 > 0.05$). These results are shown in Table 5.

Table 5. Linearity Test Results

Variable	Significance	Interpretation
Eye-hand coordination	0.101	Linear
Arm muscle power	0.543	Linear

Correlation Analysis

The Pearson product-moment correlation test showed that eye-hand coordination had a significant positive relationship with tennis serve ability. The calculated r value was 0.949, which was higher than the r table value of 0.347. Arm muscle power also had a significant positive relationship with tennis serve ability, with a calculated r value of 0.950, which was higher than the r table value of 0.347.

Table 6. Product-Moment Correlation Results

Variable	r calculated	r table	Result
Eye-hand coordination	0.949	0.347	Significant
Arm muscle power	0.950	0.347	Significant

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The multiple correlation analysis indicated that eye-hand coordination and arm muscle power were simultaneously related to tennis serve ability. The significance value of F change was 0.000, which was lower than 0.05, and the coefficient of determination (R^2) was 0.979. This means that 97.9% of the variance in tennis serve ability was associated with the combined contribution of eye-hand coordination and arm muscle power, while the remaining variance was related to other factors not examined in this study.

Discussion

The findings of this study indicate that eye-hand coordination has a significant positive relationship with tennis serve ability. This result is logical because the tennis serve requires accurate visual perception, stable ball tossing, and precise racket-ball contact. Students with better eye-hand coordination are more capable of adjusting racket movement to the position of the tossed ball, which supports service accuracy and consistency. This finding is in line with Widya et al. (2023), who reported that eye-hand coordination was related to tennis service ability among physical education students.

From a movement analysis perspective, eye-hand coordination supports the timing of the service movement. In tennis, the serve begins with the ball toss, followed by preparation, backswing, forward swing, impact, and follow-through. If the visual and motor systems are not synchronized, the ball may be struck too early, too late, or outside the optimal impact point. Therefore, coordination drills that combine ball tracking, racket control, and target-based service practice should be included in tennis learning programs.

The study also found a significant positive relationship between arm muscle power and tennis serve ability. This finding supports the idea that explosive arm action is needed to generate racket speed and ball velocity during the serve. Arm muscle power enables players to accelerate the racket during the forward swing phase and produce a stronger service trajectory. This result is consistent with the findings of Intan Khairati Arsyika et al. (2026), who emphasized the importance of arm muscle strength and service accuracy in tennis players.

The simultaneous analysis showed a very strong relationship between eye-hand coordination, arm muscle power, and tennis serve ability. This suggests that an effective tennis serve cannot be achieved only through accuracy or power alone. A player with strong arm power but poor coordination may produce a fast but inaccurate serve. Conversely, a player with good coordination but limited arm power may serve accurately but without sufficient ball speed. Thus, both components must be developed together to improve serve performance.

These results support previous tennis learning studies emphasizing that serve performance can be improved through structured practice and feedback. Naldi et al. (2024) showed that drill-based practice contributed to the improvement of tennis service skills, while Ivan et al. (2025) highlighted the role of video feedback in improving tennis serve performance. The present study extends these findings by showing that physical and coordinative factors should also be considered when designing service training programs.

The practical implication of this study is that tennis instruction for physical education students should include integrated exercises. Eye-hand coordination can be improved through racket-wall bounce activities, ball tracking drills, toss-control practice, and target service exercises. Arm muscle power can be developed through medicine ball throws, resistance-based upper-body exercises, and explosive movement drills. When

these components are trained together, students are more likely to develop a serve that is accurate, consistent, and powerful.

Nevertheless, this study has limitations. The sample consisted of only 28 students from one university, so the findings should be generalized carefully. The study also used a correlational design, meaning that it cannot establish causal effects. Future studies are recommended to use experimental designs, larger samples, and different levels of tennis players to examine whether coordination and arm-power training programs directly improve tennis serve performance.

Conclusions

This study concluded that eye-hand coordination has a significant positive relationship with tennis serve ability among students of the Faculty of Sports and Health Education, Universitas PGRI Pontianak. The better the students' visual-motor coordination, the more accurate and consistent their tennis serve performance.

Arm muscle power also has a significant positive relationship with tennis serve ability. Students with greater explosive arm power tend to produce stronger and more effective serves. Simultaneously, eye-hand coordination and arm muscle power have a very strong relationship with tennis serve ability, as indicated by the R^2 value of 0.979. These findings suggest that tennis learning and training programs should be designed integratively by combining coordination-based exercises and explosive arm-power training. Such an approach can support the development of tennis serves that are accurate, consistent, and powerful.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article. All research processes, data analysis, interpretation of results, and manuscript preparation were conducted independently and without any financial, personal, or institutional relationships that could influence the findings of this study.

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