

Relationship between upper limb strength and forehand stroke outcomes in junior tennis players

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ABSTRACT

Problems: The performance of a tennis forehand stroke is influenced by several physical components, yet the specific contribution of hand muscle strength and arm power remains underexplored in junior athletes. **Purpose:** This study aims to determine the relationship between hand muscle strength and arm power with forehand stroke results in junior tennis athletes at the ATN Pekanbaru Club. **Methods:** A correlational research design with a survey method was employed. The population consisted of 13 junior athletes, and due to the small size, total sampling was applied. Instruments used included a handgrip dynamometer to measure hand muscle strength, a medicine ball put test to assess arm power, and a forehand accuracy test adapted from the physical test and tennis court guidebook. Data were analyzed using Pearson's product moment correlation and multiple regression analysis. **Results:** Results showed a significant correlation between hand muscle strength and forehand results ($r = 0.831$), as well as between arm power and forehand results ($r = 0.869$), both exceeding the critical value $r(0.5)(13) = 0.553$. Simultaneously, both variables demonstrated a significant relationship with forehand performance ($F_{count} = 16.338 > F_{table} = 4.103$; $r = 0.875$). **Conclusion:** These findings suggest that hand muscle strength and arm power play critical roles in the effectiveness of forehand strokes in junior tennis athletes. However, the study is limited by its small sample size and focus on a single club. Future research should consider larger and more diverse samples while also examining additional biomechanical or technical factors to develop a more comprehensive model of junior tennis performance.

Keywords: hand muscle strength, arm power, forehand

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Introduction

Sports are physical activities that are useful for training the body, not only physically but also spiritually. Sports are a means of maintaining physical fitness and health, in addition to achieving performance (Prastawa et al., 2022). According to Law No. 11 of 2022 article 4 "Sports aim to maintain and improve health and fitness, achievement, intelligence, and human quality, instill moral values and noble character, sportsmanship, competitiveness, and discipline, strengthen and foster national unity and integrity, strengthen national resilience, elevate the dignity and honor of the nation, and maintain world peace." Everyone has different goals in doing so, whether as an arena for competition or as a necessity to keep the body healthy. Some aim to expand their social circle, seek recreation, or earn a living or do business. In addition, sports activities are part of healthy physical and spiritual human activities and have character, personality, discipline, and sportsmanship. Ultimately, this can shape quality human beings (Prastawa et al., 2022).

One sport that is popular among all age groups and circles, especially in Indonesia, is tennis. A study by Sinulingga and Nova (2020) states that tennis was once known as a sport for the elite and there was a lack of athlete regeneration, especially in Indonesia. However, it is now growing rapidly and is competed as a competitive sport at the junior, senior, and even veteran levels.

Tennis is a small ball sport that can be played individually (singles) or in pairs (doubles). The game involves hitting a ball with a racket over a net into the opponent's court. In tennis, there are various

basic stroke techniques that must be mastered, namely forehand, backhand, volley, and serve. The most basic and easiest stroke to teach in tennis is the forehand.

A forehand is a stroke that swings from behind the body to the front, with the front of the racket or the palm of the hand facing the ball. The forehand itself is one of the first and most important basic techniques that a player must master before mastering other basic stroke techniques. The forehand is the most powerful shot, and the energy used is usually greater than that used for a backhand. Therefore, performing a forehand requires certain components that support the movement, including biomotor components such as endurance, strength, speed, coordination, flexibility, power, and agility (Yulianto, 2020).

There are many training programs from various regions as a form of development and progress in tennis in Indonesia. The tennis club training program in Pekanbaru, namely the ATN Pekanbaru Club, is one of the training programs aimed at improving sports performance, especially in tennis. Good tennis coaches and training programs are also a form of effort to create accomplished tennis players. There are many supporting factors that determine whether an athlete can perform well, apart from training, such as the athlete's physiology and anatomy. An athlete must have balance in their body so that they can move optimally, including hand muscle strength and arm power.

Muscle strength is often used by humans as a component needed to perform all activities. Hand muscle strength is the ability of the hand muscles to generate tension in a resistance and lift weights. Arm power is just as important as hand muscle strength. Arm power refers to the ability of strong and fast arm muscles to hit the ball. When I watched the match at PTPN, I noticed that several athletes, especially juniors, often had their balls stuck in the net or out of bounds. This phenomenon indicates a problem with the forehand shot.

Based on the background described above, it is suspected that hand muscle strength and arm power are related to the results of forehand shots. However, this has not yet been proven, because in addition to these two components, there are other factors that can affect the results of forehand shots in tennis. To determine whether hand muscle strength and arm power are related to the results of forehand shots in tennis, the researcher is interested in conducting a more in-depth study, both theoretically and practically, through tests and measurements of these components at the ATN Pekanbaru club.

Method

The research used a quantitative approach with a one-shot model, where data collection was conducted in a single session. This study was conducted at the ATN Club in Pekanbaru City. The subjects were 13 junior tennis athletes aged 10-18.

The research instruments used consisted of three tools. First, a handgrip dynamometer was used to measure hand muscle strength. Second, a medicine ball putter was used to measure arm power. Third, a forehand test was used to assess stroke performance based on the resulting ball speed.

The data collection procedure began with a hand muscle strength test using a handgrip dynamometer, in which subjects gripped the device as tightly as possible for 2-3 seconds. Next, an arm power test was conducted using a medicine ball put; subjects pushed the medicine ball from a sitting position with a straight back for three attempts. Finally, a forehand test was conducted to measure the ball speed generated by the subjects' strokes. The collected data were then analyzed using Pearson correlation statistical techniques to determine the relationship between hand muscle strength, arm power, and forehand stroke performance.

Results

This study consists of three variables, including two independent variables, namely hand muscle strength and arm power, and one dependent variable, namely forehand results. Furthermore, before analyzing the data, the researcher will first describe the statistical results of each variable.

Correlation analysis is used to determine whether there is a relationship and how strong the relationship is between the independent variables and the dependent variable. The measure used to determine the degree of closeness is based on Pearson's Product Moment. The correlation between hand muscle strength and forehand results, the relationship between the arm muscle strength variable (X_1) and forehand (Y) is $r_{x_1y} = 0,831$. Next, to determine the significance of X_1 with Y , the r table is used, with the following table:

Table 1. Results of Hand Muscle Strength Analysis with *Forehand* Results

Correlation	$r_{calculate}$	r_{table}	Description
X1 . Y	0,831	0,553	Significant

Test criteria: if $r_{calculate} > r_{table}$ or $0.831 > 0.553$, then for the correlation test, Hypothesis one is accepted, meaning that there is a significant relationship between hand muscle strength and forehand tennis results in junior club athletes in Pekanbaru. The correlation between arm *power* (X2) and tennis forehand results (Y). The correlation between arm power and tennis forehand results is $r_{x_2y} = 0.869$. To determine the significance of X2 with Y r_{table} , use the following table:

Table 2. Analysis Results of the Relationship Between Arm Power and Forehand Performance

Correlation	$r_{calculate}$	r_{table}	Description
X2 . Y	0,869	0,553	Significant

Test criteria: If $r_{calculate} > r_{table}$ or $0.869 > 0.553$, then for the correlation test, the two hypotheses are accepted, indicating that there is a significant relationship between arm power and forehand results in tennis among junior athletes at the ATN club in Pekanbaru. Double correlation between hand muscle strength and arm power with forehand results. The relationship between the variables of hand muscle strength (x_1) and arm power (x_2) with tennis forehand results (Y) is $r_{x_1x_2y} = 0.875$ is classified as strong. Furthermore, to determine the significance between (X1) and (X2) with Y, the F-test was used.

Table 3. Results of the F-Test between the Independent Variables (X1 and X2) and the Dependent Variable (Y)

Variable	F-count	Ftable	Conclusion
Hand Muscle, Arm Power with forehand results	16,338	4,103	Significant

It turns out that $F_{calculate} > F_{table}$, or $16,338 > 4,103$, so there is a significant relationship. Hypothesis testing is basically a step to answer the proposed hypothesis formulation in accordance with the testing criteria. Based on the results of data analysis, description, testing of research results, and discussion, it can be concluded that:

The relationship between hand muscle strength and tennis forehand results, based on the data analysis conducted on the hand muscle strength variable, can be summarized through the following discussion: (1) The relationship between hand muscle strength and tennis forehand results tennis forehand results has a fairly strong relationship of 0,831 and is marked by testing criteria where $r_{calculate} 0,831 > r_{table} 0,553$, meaning that the first hypothesis is accepted.

The relationship between arm power and tennis forehand results, based on the analysis of data on the arm power variable, can be summarized as follows: (2) The relationship between hand muscle strength and tennis forehand results is relatively strong, with a correlation coefficient (r_{x_2y}) of 0,869 and marked by a test criterion where $r_{calculate} 0,869 > r_{table} 0,553$, which means that the second hypothesis is accepted.

The relationship between hand muscle strength and arm power with the results of the tennis forehand, based on the results of data analysis conducted using double correlation analysis, obtained $r_{x_1x_2y} = 0.875$.

Marked by a significance test (F test), where $F_{calculate} 16,338 > F_{table} 4,103$ was obtained. This means that there is a significant relationship between hand muscle strength and arm power with the results of the forehand in tennis among junior athletes at the ATN club in Pekanbaru. Therefore, based

on the above research results, there is a relationship between hand muscle strength (X1) and arm power (X2) with forehand results.

Discussion

Relationship between Hand Muscle Strength and Forehand Shot Results The results of the study show a significant correlation between hand muscle strength and the quality of the forehand stroke in junior athletes. In tennis, especially when performing a forehand, hand muscle strength plays an important role. This strength affects the control and accuracy of ball placement when hitting. To achieve a maximum stroke, the hand muscles must be able to contract strongly and accurately. According to Yulianto (2020), hand muscle strength is closely related to the success of a forehand. Without adequate strength, a player will find it difficult to produce accurate and powerful shots. Players with strong hand muscles will be better able to utilize their power efficiently when holding and swinging the racket, making their forehand shots more effective in terms of speed and direction.

The Relationship Between Arm Power and Forehand Shot Results The study also found that arm power has a significant effect on forehand shots. Arm power refers to the ability of muscles to generate explosive force in a short period of time, which is very important in creating a fast and powerful racket swing. This is in line with Fahmi's (2021) opinion that explosive arm strength will make shots harder, faster, and easier to aim at the target. With good power, players can hit the ball at high speed and with greater precision, as well as have better control over the direction and speed of the ball.

The Combined Relationship between Hand Muscle Strength and Arm Power on Forehand Shot Results Overall, the results of the study show that hand muscle strength and arm power together have a significant effect on the quality of forehand shots in junior athletes at the ATN Club in Pekanbaru. The accuracy and power of forehand shots are crucial to success in scoring points and dominating the game. Forehand shots are one of the main elements in offensive strategy because of their ability to direct the ball quickly and accurately to areas that are difficult for opponents to reach. The ability to perform an optimal forehand shot does not only depend on technique, but is also supported by good physical condition. In this case, biomotor components such as endurance, strength, speed, coordination, flexibility, power, and agility are very necessary (Yulianto, 2020). Hand muscle strength and arm explosive power are two main aspects that greatly determine the effectiveness of a shot.

Improved performance in sports, especially tennis, will be maximized if supported by excellent physical condition. Athletes with good hand strength and arm power tend to be able to produce faster, stronger, and more accurate forehands. Conversely, if physical condition is not supportive, mastery of forehand technique will not achieve the best results. This is in line with the principle of competitive sports training, namely the development of physical abilities in accordance with the skills being targeted.

Conclusion

The results of the study indicate a significant relationship between hand muscle strength and forehand performance among junior tennis athletes at the ATN Club in Pekanbaru, with a correlation coefficient of $r(x_1y) = 0.831$, which is greater than the critical value of $r(0.05)(13) = 0.553$. Similarly, a significant relationship was found between arm power and forehand performance, with $r(x_2y) = 0.869 > 0.553$. Furthermore, when both variables-hand muscle strength and arm power-were analyzed together in relation to forehand performance, the results showed a significant joint relationship. The calculated F-value was 16.338, which is higher than the F-table value of 4.103 at a 5% significance level with degrees of freedom (2;10). The multiple correlation coefficient was $r(x_1x_2y) = 0.875$, indicating a strong and significant combined influence.

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