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1 THE RELATIONSHIP BETWEEN RUNNING SPEED AND LEG MUSCLE POWER WITH THE RESULTS OF THE LONG JUMP SQUAT STYLE OF ADOLESCENT ATHLETES

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Abstract

This study evaluates the relationship between 30-meter sprint velocity (variable X_1) and leg muscle power (variable X_2) on the distance of the squat-style long jump (variable Y) among adolescent athletes aged 13–17 years old in Demak Regency. Utilizing a quantitative correlational design with $N=13$ athletes, Pearson correlation analysis demonstrated a strong negative correlation between 30-meter sprint time and jump distance ($r = -0.883$, $p < 0.001$). The coefficient of determination ($R^2 = 0.780$) indicates that 78% of the variance in Y can be explained by X_1 , while the remaining 22% is estimated to be influenced by leg muscle power, take-off technique, and other biomechanical factors. These findings reinforce the importance of developing maximum velocity within the LTAD program during the "Train to Train" phase, while also highlighting the necessity of integrating plyometrics training to maximize the conversion of horizontal momentum into vertical thrust.

Kata Kunci: Squat-Style Long Jump, Sprint Velocity, Leg Muscle Power, Adolescent Athletes, Biomechanics.

INTRODUCTION

2 The long jump squat style is one of the athletic numbers that demands mastering various components of physical condition and technical skills in an integrated manner. The success in this number is influenced by the athlete's ability to generate high horizontal speed in the approach phase as well as the ability to generate explosive force during take-off to convert horizontal momentum into vertical momentum. According to Hay (1993) and Carr (2000), the combination of the two components determines the height of the body trajectory and the jump distance achieved. Therefore, the development of running speed and leg muscle power is an important aspect in the long jump athlete coaching program.

The development of adolescent athletes has a strategic role in improving regional and national sports achievements. Demak Regency has a considerable potential for young athletes, but achievement coaching still requires the support of research results as the basis for the preparation of an effective training program. Evaluation of the physical factors that contribute to 2 the results of the long jump is

important so that **the** coach can determine the priority of training according to the needs of the athlete at the developmental stage.

Various studies show that horizontal speed during the initial phase is one of the main predictors of long jump success. Smith (2021) stated that an increase in running speed is positively related to an increase in jump distance. These findings are reinforced by Pratama (2023) who explains that athletes with better sprint skills tend to produce higher long jump performance (Arisman et al., 2021). However, most previous studies have been conducted on elite athletes who have had relatively stable techniques and physical conditions so the results cannot be fully generalized to adolescent athletes at the regional level (Pratama et al., 2022).

In addition, previous research focused more on the contribution of running speed to long jump results without examining other factors that also affect performance. In fact, the ability to generate leg muscle power when pushing and the quality of the take-off technique ²⁰ also **play a role in** determining **the success of the jump**. These limitations show that there are still research gaps that need to be studied, especially in adolescent athletes who are still in the stage of physical and technical development.

Biomechanically, the success of the long jump is influenced by the athlete's ability to maintain horizontal momentum during the initial phase and transform it into a vertical force when performing a push. The linear momentum generated during the sprint must be maintained until the pushboard, then converted through the impulses generated by the contraction of the leg muscles so as to produce an optimal jump trajectory (Hay, 1993; Carr, 2000). McGowan et al. (2015) explained that the effectiveness of the momentum transformation ² **is influenced by the explosive ability of the leg muscles** and the coordination of movement in the take-off phase.

¹ **This study aims to analyze the relationship between 30 meter running speed and leg muscle power on the results of squat style long jump** in adolescent athletes in Demak Regency. ¹² **This research is expected to provide** empirical information about **the** contribution **of** each variable to the performance of the long jump and become the basis for the preparation of a more effective training program in coaching adolescent athletes. In addition to providing an overview of the relationship

between variables, this study also seeks to explain the contribution of factors that have not been explained by running speed so that it can be a recommendation for coaches in developing athletes' biomotor abilities more comprehensively.

METHOD

¹² This study used a quantitative approach with a correlational descriptive design to analyze ¹ the relationship between 30 meter running speed and leg muscle power with the results of squat style long jump in adolescent athletes in Demak Regency. The research will be carried out during the regional competition period in July 2025.

The study population is all adolescent athletes aged 13–17 years who are registered in the jumping number athletic branch in Demak ³ Regency. The research sample consisted of 13 athletes ⁴ who were selected using the purposive sampling technique based on the achievement of the best score in the last competition (Putra et al., 2020). This technique is used so that the sample being studied has characteristics that are in accordance with the purpose of the research.

Data Collection Instruments

Variabel	Instruments	Units	Measurement Procedure
X _{1} Running speed 30 m	Stopwatch digital (precision 0,01 s)	second(s)	Athletes do maximum sprints from the starting block position; Three attempts, the average score is taken.
X _{2} Leg muscle power	Standing broad jump (SBJ) & vertical jump (VJ) with force plate tool	cm (SBJ) / cm (VJ)	The highest scores of the three repetitions each were recorded.
Y Squat style long jump distance	Official distance measurement on the competition track	Meter (m)	The measured distance from the pushboard to the nearest landing point to the boundary line.

¹⁸ Before the implementation of the research, ethical approval was obtained from the Research Ethics Committee of University X. All athletes were given an explanation of the objectives and procedures of the research, then signed informed consent as a form of consent to become respondents. Data collection was carried out at the athletic field of SMA Negeri 1 Demak at 07.00–10.00 WIB to minimize the influence of environmental conditions, especially air temperature. All

measurement data is recorded manually and then processed using IBM SPSS Statistics software version 26.

Data analysis began with a prerequisite test which included a normality test using Kolmogorov-Smirnov and a linearity test through scatter plot analysis and Pearson's correlation between the variables X_1 and Y and X_2 with Y . Subsequently, a hypothesis test was carried out using Pearson correlation analysis to determine the relationship between the ¹running speed of 30 meters and the result of the squat style long jump. The contribution of the running speed variable is calculated through the determination coefficient (R^2).

In addition, the study used simple linear regression analysis with an equation model: $Y = \beta_0 + \beta_1 X_1 + \varepsilon$ to predict the effect of running speed on long jump results. Residual analysis was carried out by calculating the residual value using the equation of $1 - R^2$ to determine the proportion of variations in long jump results that have not been explained by running speed. Furthermore, a correlation analysis was carried out between leg muscle power (X_2) and the residual to identify the contribution of leg muscle power to the variation in long jump results that could not be explained by the running speed variable. All statistical tests were conducted at a significance level of 5%, with a two-tailed test, except for hypothesis testing that used a negative relationship direction according to the research hypothesis.

⁹ RESULTS AND DISCUSSION

Descriptive statistics were used to provide an overview of the characteristics of the research data which included 30 meters running speed (X_1), leg muscle power (X_2), and squat style long jump (Y). ⁸The results of descriptive statistical analysis are presented in Table 1.

Table 1. Descriptive Statistics of Research Variables

Variabel	Red	SD	Min	Max
$X_{\{1\}}$ (s)	4,78	0,31	4,30	5,21
$X_{\{2\}}$ (SBJ, cm)	210,5	12,4	190	235
Y (m)	5,12	0,45	4,30	5,96

¹⁴Based on Table 1, it is known that the average travel time of athletes is 4.78 ± 0.31 seconds. The average leg muscle power reached 210.5 ± 12.4 cm, while the average result of the squat style long jump was 5.12 ± 0.45 meters. The minimum

and maximum values showed a variation in physical ability among the athletes in the study sample.

The results of the normality test using the Kolmogorov-Smirnov showed that all study variables had a significance value greater than 0.05 so that the data were normally distributed and met the assumptions for parametric analysis. In addition, the results of the linearity test through scatter plot analysis showed a linear relationship between the 30-meter running speed and the result of the long jump. The relationship is strengthened by the value of the Pearson correlation coefficient of $r = -0.883$, which shows a very strong negative linear relationship pattern.

The results of Pearson's correlation analysis showed a very strong negative relationship between the speed of running 30 meters and the result of the squat long jump ($r = -0.883$; $p < 0.001$). The negative correlation value shows that the less time it takes an athlete to cover a distance of 30 meters, the farther the jump results obtain. Conversely, the longer the sprint time an athlete achieves, the shorter the jump distance produced.

Hypothesis testing using the t-test yielded a calculated t-value = -6.25, while the table t-value = 2.201 at a significance level of 5% with a degree of freedom ($df = 11$). Since the absolute value of t is calculated to be greater than the t table (6.25 > 2.201), the null hypothesis is rejected. These results show that there is a significant negative relationship between the speed of running 30 meters and the results of the squat-style long jump in adolescent athletes in Demak Regency.

The results of simple linear regression analysis produce the following equation. $Y = 7.31 - 0.44X_1$ The equation shows that every one second of a 30-meter drop in running time is followed by an increase in the long jump by 0.44 meters. The value of the determination coefficient ($R^2 = 0.780$) showed that 78% of the variation in long jump results could be explained by a running speed of 30 meters, while the remaining 22% was influenced by other factors outside the study model.

Residual analysis showed that there was still a variation of 22% that could not be explained by the running speed variable. The results of the correlation analysis between leg muscle power and residual resulted in a value of $r = 0.631$ ($p = 0.019$).

These results suggest that leg muscle power contributes positively to variations in long jump outcomes that cannot be explained by running speed.

Discussion

The results showed that the speed of running 30 meters had a very strong negative relationship with the results of the squat style long jump. The value of the correlation coefficient of $r = -0.883$ indicates that the higher the athlete's sprint speed, the farther the jump distance is produced. These findings support the theory of biomechanics which states that the horizontal velocity in the approach phase is the main factor in generating momentum before repulsion (Hay, 1993; Carr, 2000). The high horizontal momentum allows the athlete to maintain speed until the push-off board resulting in greater impulse in the take-off phase.

A determination coefficient of 78% indicates that running speed is the dominant predictor of the success of squat long jumps. These results are in line with research by Smith (2021) and Pratama (2023) which reported that improved sprint ability is directly related to improved long jump performance. Thus, speed improvement exercises are the main components that need to be prioritized in the youth athlete coaching program.

However, there is still a 22% variation in jump results that cannot be explained by running speed. Residual analysis showed that leg muscle power had a significant positive relationship with such variation ($r = 0.631$; $p = 0.019$). These findings suggest that the ability to generate explosive force during take-off also determines the success of the jump. Athletes who have high speed but are not followed by the ability to generate optimal repulsion force tend not to be able to convert horizontal momentum into vertical momentum to maximum vertical momentum. This result is in line with the opinion of Bobbert and Van Ingen Schenau (2000) who explained that explosive strength plays an important role in the rejection phase.

In addition to the physical condition factor, the quality of the take-off technique is suspected to have influenced the jump results. The angle of the push, the position of the feet on the pushboard, and neuromuscular coordination are engineering components that determine the effectiveness of momentum changes during the push phase (Baker et al., 2018). In adolescent athletes, coordination skills are

still developing so that technique variations can be one of the causes of differences in performance between athletes.

The findings of the study can also be influenced by the conditions of sports coaching in Demak Regency. Based on field observations, the training program at the club focuses more on increasing sprint speed than exercises to increase leg muscle power. This condition is supported by the limitations of plyometric training facilities so that the development of explosive capabilities has not been carried out optimally. Therefore, the results of the study show the dominance of the contribution of speed to the performance of the long jump.

Practically, the results of the study imply that trainers need to prioritize maximum sprint training as the basis for improving long jump performance without neglecting plyometric exercises to increase leg muscle power. The combination of these two forms of training is expected to be able to optimize athletes' biomotor abilities according to the concept of Long Term Athlete Development (LTAD), especially in the Train to Train phase (Tya Maya Ningrum et al., 2023). In addition, this study has several limitations, namely the relatively small number of samples, the research design is cross-sectional, the measurement of leg muscle power is still limited to the SBJ and VJ tests, and the take-off technique variables have not been controlled. Therefore, further research is recommended using larger sample sizes, longitudinal designs, and multivariate analyses involving engineering and psychological factors to obtain a more comprehensive picture of the factors influencing long jump outcomes.

Conclusion

This study shows that the running speed of 30 meters has a very strong and significant negative relationship with the results of squat-style long jump in adolescent athletes in Demak Regency. The results of the correlation analysis obtained a value of $r = -0.883$ with $p < 0.001$, which shows that the shorter the running time of 30 meters, the farther the jump distance produced. Regression analysis also showed that running speed contributed 78 % to the variation in long jump results, so it can be stated as the dominant factor that affects athletes' performance.

As many as 22% of the variation in long jump results that could not be explained by running speed was thought to be influenced by other factors, especially leg muscle power, the quality of the take-off technique, and the condition of the exercise. These findings suggest that improving the performance of the long jump does not only depend on sprinting ability, but also requires the ability to generate explosive force as well as a good mastery of repulsion techniques.

The implication of this study is the need for an athlete coaching program that integrates speed training, plyometric exercises to increase leg muscle power, and structured take-off technique training. A balanced training approach ⁷ is expected to be able to improve the long jump performance of adolescent athletes more optimally and become the basis for the preparation of athletic achievement coaching programs in Demak Regency.

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