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## The Effect of Speed, Flexibility, and Leg Muscle Explosive Power on Crescent Kick Ability of Young Pencak Silat Athletes

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### Abstract

**Study purpose.** Crescent kick performance is essential in pencak silat, yet limited evidence exists on how speed, flexibility, and leg muscle explosive power interact to determine this skill among young athletes, particularly given the suboptimal achievement in Kabupaten Pelalawan at the POPDA competition. This research examines the direct and indirect influences of these three biomotor components on crescent kick proficiency among young athletes aged 14-17 years in Pangkalan Kerinci District.

**Materials and methods.** A quantitative approach with path analysis design was employed. The study population comprised 44 young pencak silat athletes aged 14 - 17 years in Pangkalan Kerinci District using saturated sampling. Data collection utilized a 30 meter sprint test, front split test, standing long jump test, and 10 second repetitive kicking test. Data analysis used Jamovi version 2.6.44.

**Results.** Speed directly influenced crescent kick ability (0.657;  $p < 0.001$ ). Flexibility also demonstrated a direct effect (0.281;  $p < 0.001$ ). Leg muscle explosive power showed a direct effect (0.332;  $p < 0.001$ ). Speed exhibited an indirect effect through leg muscle explosive power (31.1%;  $p < 0.001$ ), while flexibility demonstrated a stronger indirect effect (63.4%;  $p < 0.001$ ). All three variables simultaneously influenced crescent kick ability ( $F = 320$ ;  $p < 0.001$ ;  $R^2 = 0.960$ ). The main strength is the use of path analysis, while the limitation is the cross-sectional design and 4% unexplained variance.

**Conclusions.** Speed, flexibility, and leg muscle explosive power significantly affect crescent kick ability. Leg muscle explosive power functions as a partial mediator, particularly dominant in the flexibility crescent kick relationship. The theoretical implication enriches sports science knowledge regarding mediation mechanisms. Practically, training programs should integrate these three components systematically. Future experimental research is recommended to test training program effectiveness and consider additional factors such as coordination, balance, and psychological aspects.

**Keywords:** Speed; Flexibility; Leg Power; Crescent Kick; Path Analysis.

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## **Introduction**

Pencak silat represents one of Indonesia's indigenous cultural heritage assets that has existed since ancient times. Historically, this martial art was created as a survival mechanism, including defending against wild animals and hunting activities (Ediyono et al., 2022). In line with its development, pencak silat has transformed into a competitive sport regularly contested at both national and international levels (Federation, 2022). The primary objective of this sportification process is to achieve competitive excellence through scientifically-based and research-informed development programs (Effandy & Ihsan, 2021).

In competitive pencak silat, physical condition serves as the fundamental foundation affecting the effectiveness of technical and strategic application during matches. Athletes possessing good technique but lacking adequate physical condition tend to experience performance deterioration, particularly in intensive and long-duration matches (Turner & Comfort, 2022a). Among the various attacking techniques, the crescent kick (*tendangan sabit*) represents one of the most effective and frequently employed kicking techniques. Crescent kick ability is assessed not only by target accuracy but also encompasses execution speed, kick force, movement coordination, and application effectiveness during match situations (Tofikin, 2024).

Three biomotor components are theoretically interrelated and collectively determine crescent kick performance: speed, flexibility, and leg muscle explosive power. Speed determines attack success as faster execution provides opponents with limited opportunity to block or avoid the attack (Tofikin, 2024). Flexibility, particularly in the thigh and hip muscles, plays an important role in determining swing width, kick height, and movement trajectory efficiency (Suyudi et al., 2024). Leg muscle explosive power is crucial because crescent kick movement requires both strength and speed simultaneously (Suwirman, 2025).

Kabupaten Pelalawan, particularly Pangkalan Kerinci District, serves as a pencak silat development center in Riau Province. However, performance evaluation of youth athletes at the POPDA event revealed suboptimal achievements, securing only one silver and eight bronze medals in 2024 (Raf, 2024). Observations by coaches indicate that athletes' suboptimal physical condition, particularly in speed and explosive power aspects, impacts the effectiveness of crescent kicks, which tend to be easily anticipated or captured by opponents (Forenza et al., 2021).

Previous studies have examined the relationships between physical fitness components and kicking ability partially. (Tofikin, 2024) investigated the effect of leg muscle explosive power, speed, and agility on crescent kick speed but did not examine mediating mechanisms. (Saripudin & Kamarudin, 2023) only analyzed correlation using bivariate analysis. None have comprehensively integrated speed, flexibility, and leg muscle explosive power as both direct predictors and mediators in a single path analysis model for young athletes aged 14–17 years.

The novelty of this research lies in: (1) integrating three biomotor variables simultaneously within a single path analysis model; (2) positioning leg muscle explosive power as a mediator to test indirect effects; and (3) focusing on beginner adolescent athletes aged 14–17 years, representing the *train to train* and *train to compete* phases in the Long Term Athlete Development (LTAD).

The adolescent age range of 14–17 years is a highly strategic phase characterized by rapid physical growth and improved motor skills development. Appropriate training interventions during this phase will significantly impact future performance (Lloyd et al., 2021). The suboptimal achievement at POPDA 2024 indicates an urgent need for evidence-

based training programs. Therefore, this research is necessary to provide empirical evidence for designing more effective, targeted, and measurable training programs.

Based on this background, this study aims to analyze: (1) the direct effect of speed on crescent kick ability; (2) the direct effect of flexibility on crescent kick ability; (3) the direct effect of leg muscle explosive power on crescent kick ability; (4) the indirect effect of speed on crescent kick ability through leg muscle explosive power; (5) the indirect effect of flexibility on crescent kick ability through leg muscle explosive power; and (6) the simultaneous effect of speed, flexibility, and leg muscle explosive power on crescent kick ability.

## Materials and methods

### Study participants

The study population consisted of 44 young pencak silat athletes aged 14 to 17 years who were actively engaged in training activities within Pangkalan Kerinci District, Kabupaten Pelalawan, Riau Province. The population exhibited relatively homogeneous characteristics as all participants followed structured training programs and were in the physical and technical development phase. The inclusion criteria for participants were: (1) active athletes aged 14 -17 years; (2) had been in training for at least one year; (3) were in good health and free from injury; and (4) were willing to participate in the research by signing an informed consent form. The exclusion criteria were: (1) athletes who were injured during the testing period; and (2) athletes who were absent without explanation.

### Sampling Technique

A census sampling technique was implemented, making the entire population the research sample (Sembiring et al., 2024). This technique was chosen based on statistical and practical considerations. From a statistical perspective, the limited and relatively small population size (44 athletes) meets the criteria for using census sampling, while also supporting the needs of path analysis which requires an adequate sample size to estimate model parameters stably. Practically, the homogeneous and accessible population allowed for a comprehensive census. Thus, this technique avoids sampling error and allows direct generalization of findings to the studied population. The total sample consisted of 44 athletes, comprising 19 males and 25 females.

This study employs a quantitative approach with path analysis (path analysis) as the main strategy in analyzing the influence between variables that have been determined (Sugiyono, 2022). The variables in this study consist of exogenous variables, namely speed ( $X_1$ ) and flexibility ( $X_2$ ), an intervening variable, namely leg muscle explosive power ( $Y$ ), and an endogenous variable, namely crescent kick ability ( $Z$ ) as shown in Figure 1. This research model not only examines the direct effects between independent variables (speed and flexibility) and the dependent variable (crescent kick ability), but also simultaneously tests the indirect effects through the mediating role of leg muscle explosive power. The path analysis approach is highly relevant in this context because it allows researchers to identify the extent to which the mediating variable strengthens or weakens the influence of speed and flexibility on crescent kick ability in young pencak silat athletes. This research design is explanatory, as it aims to explain the complex patterns of influence between the variables under study based on theoretical models developed from previous studies (Sugiyono, 2022).in Figure 1.

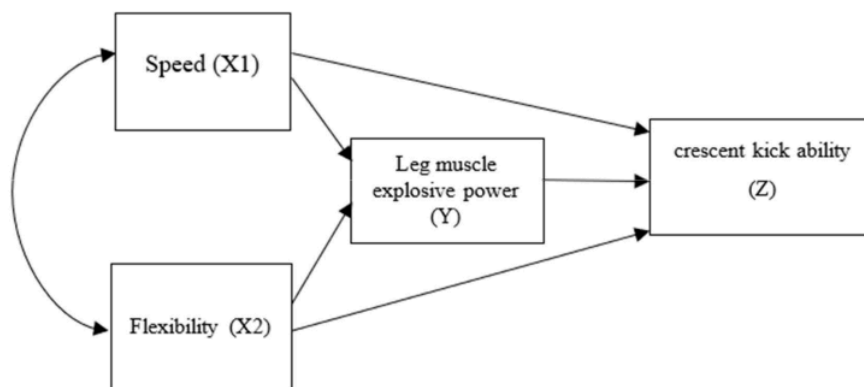


Figure 1. Conceptual Framework

### Study organization

The instruments employed in this study were standardized and academically validated for sports science research. Each variable was measured using instruments that have been validated in various scientific literature as follows:

#### 1. Speed Variable ( $X_1$ )

Speed was measured using a 30 meter sprint test (Arsil & Antoni Despita, 2024). This test aims to assess the speed of muscle contraction during dynamic movements as well as the subject's motor response to stimuli. The validity of this instrument has been tested with a validity coefficient of 0.89 and reliability coefficient of 0.94 in the context of measuring speed in adolescent athletes.

**Equipment:** 30 meter running track, cones, stopwatch, test form, and pen.

**Procedure:** (1) Athletes stood behind the start line; (2) At the "ready" command, athletes assumed a standing start position. At the "go" command, athletes ran as fast as possible for 30 meters until crossing the finish line; (3) Officials activated the stopwatch from the "go" command and stopped it when the athlete crossed the finish line, then recorded the time; (4) Athletes were considered to have failed if they crossed or went out of their lane; (5) Each athlete was given three attempts with 3-5 minutes rest between attempts; (6) Officials took the best time and used it as the test result. Results were expressed in seconds, where lower times indicated better speed performance.

#### 2. Flexibility Variable ( $X_2$ )

Flexibility was measured using the front split test (Arsil & Antoni Despita, 2024). This test aims to assess the maximal passive range of motion, reflecting an individual's level of flexibility and functional mobility. The validity coefficient of this test is 0.87 and reliability coefficient is 0.92.

**Equipment:** Ruler, test form, and pen.

**Procedure:** (1) Athletes stood with feet shoulder-width apart; (2) Athletes spread their legs as wide as possible (front-back) and could place hands on the floor for balance; (3) Athletes performed the split maximally until reaching a sitting position or until unable to spread further, maintaining the position for 3 seconds; (4) Assessment was made when the athlete reached the lowest point; the measurer used a ruler to measure the distance from the floor to

the groin; (5) The best score was taken from 3 attempts. Results were expressed in centimeters, where smaller distances indicated better flexibility.

### **3. Leg Muscle Explosive Power Variable (Y)**

Leg muscle explosive power was measured using the standing long jump test (Narlan & Juniar Dicky Tri, 2020). This test aims to assess lower limb explosive power and elastic strength. The validity coefficient of this test is 0.91 and reliability coefficient is 0.88.

**Equipment:** Non-slippery floor area, measuring tape (meter), test form, and pen.

**Procedure:** (1) Athletes stood behind the start line with feet shoulder-width apart; (2) Athletes bent their knees and leaned their bodies forward while swinging both arms backward, then jumped forward as far as possible using both feet simultaneously while maintaining balance; (3) Officials helped mark the athlete's landing point at the heel or the body part closest to the start line; (4) Each athlete was given three attempts; (5) The score taken was the farthest jump from 3 attempts. Results were expressed in meters, where longer jumps indicated better leg muscle explosive power.

### **4. Crescent Kick Ability Variable (Z)**

Crescent kick ability was measured using a 10 second kicking test (Lubis et al., 2016). This test is designed to determine the speed of crescent kick ability of pencak silat athletes with a reliability value of 0.87 and content validity with face validity.

**Equipment:** 50 kg sandsack/target (hand box), stopwatch, test form, and pen.

**Procedure:** (1) Athletes prepared to stand behind the target with the supporting foot behind the line at a distance of 50 cm for females and 60 cm for males; (2) At the "go" command, athletes performed a kick with the right foot and returned to the starting position by touching the floor behind the line, then continued kicking as fast as possible for 10 seconds. The same was done with the left foot; (3) Execution could be done 3 times and the best number was taken; (4) The score was based on the highest number of kicks from both right and left feet.

All instruments used in this study have been tested for validity and reliability in previous studies. The 30 meter sprint test has a validity coefficient of 0.89 and reliability of 0.94. The front split test has a validity coefficient of 0.87 and reliability of 0.92. The standing long jump test has a validity coefficient of 0.91 and reliability of 0.88. The 10 second crescent kick test has a reliability value of 0.87. These values indicate that all instruments are highly valid and reliable for use in adolescent athlete populations.

### ***Data Collection Procedures***

Data collection was conducted over two days (February 7 - 8, 2026) following standardized procedures to minimize fatigue effects on test results. The sequence of tests was standardized as follows: (1) Day 1: Anthropometric measurement, 30 meter sprint test (speed), and front split test (flexibility); (2) Day 2: Standing long jump test (leg muscle explosive power) and 10 second kicking test (crescent kick ability). Each test was preceded by a standardized warm-up of 10-15 minutes including light jogging and dynamic stretching. Rest intervals of 10-15 minutes were provided between tests to ensure optimal recovery. The measurement process was carried out by a research team that had received prior training and briefing to maintain procedural consistency and recording objectivity. All data obtained were documented in observation sheets.

This research was conducted after obtaining ethical approval from the Faculty of Sports Science, Universitas Negeri Padang, and a research permit from the management of IPSI Kabupaten Pelalawan (Letter No. 042/IPSI-PLW/III/2026). Before data collection began, all participants were given a clear explanation of the research objectives, procedures, benefits, and potential risks. Written informed consent was obtained from parents or legal

guardians of all participants because the participants were minors (aged 14 - 17 years). Participants were also given the right to withdraw from the research at any time without any consequences. All participant data were kept confidential and used only for research purposes.

#### **Statistical Analysis**

Data analysis was performed using Jamovi version 2.6.44 through several stages (Sihombing Robinson Pardomuan et al., 2024):

**Stage 1: Data Screening.** Data screening was conducted to check for outliers and data completeness as described by (Tabachnick & Fidell, 2019) All variables were first checked to ensure no missing information. Outlier identification was also performed carefully because extreme values could alter regression analysis results and disrupt the accuracy of statistical inference.

**Stage 2: Descriptive Statistics.** Descriptive analysis was used to describe the distribution and characteristics of each variable. The statistics used include mean, median, standard deviation, minimum and maximum values, and frequency distribution. This stage aims to determine the general description of the data before conducting inferential analysis.

**Stage 3: T-score Transformation.** T-score transformation was applied to equalize measurement units from different scales (seconds, centimeters, meters, and scores) into a uniform scale with a mean of 50 and standard deviation of 10. For variables where higher scores indicate better performance (flexibility, leg muscle explosive power, crescent kick ability), the formula  $T = 50 + 10((X - \bar{X})/S)$  was used. For variables where lower scores indicate better performance (speed/30 meter sprint time), the modified formula  $T = 50 - 10((X - \bar{X})/S)$  was used.

**Stage 4: Classical Assumption Tests.** Prior to hypothesis testing, classical assumption tests were conducted to ensure the regression model used met statistical requirements, including:

- **Normality test** using Shapiro-Wilk ( $p > 0.05$  indicates normal distribution)
- **Linearity test** using residual plots (random scatter pattern around zero indicates linearity)
- **Multicollinearity test** using Variance Inflation Factor ( $VIF < 10$  and tolerance  $> 0.10$  indicates no multicollinearity)

**Stage 5: Multiple Linear Regression Analysis.** Multiple linear regression analysis was used to test the simultaneous influence of independent variables on the dependent variable.

**Stage 6: Path Analysis.** Path analysis was conducted to test direct and indirect effects between variables, as well as to test whether leg muscle explosive power mediates the relationship between speed and flexibility on crescent kick ability. To test the mediation effect, the bootstrap method with 5000 samples was used as a robust non-parametric method because it does not require the assumption of normal distribution.

**Stage 7: Hypothesis Testing.** Hypothesis testing used a significance level of  $\alpha = 0.05$ , where  $H_0$  is rejected if  $p < 0.05$ . All analyses were conducted using Jamovi version 2.6.44 statistical software to obtain accurate and scientifically sound results.

#### **Results**

The results of this study indicate a significant influence between speed, flexibility, and leg muscle explosive power on crescent kick ability in young pencak silat athletes aged

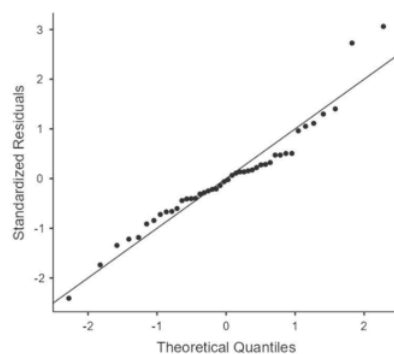
14 -17 years in Pangkalan Kerinci District. Based on descriptive analysis of 44 athletes, the average speed score was 5.29 seconds (SD = 0.636), the average flexibility score was 11.6 cm (SD = 5.67), the average leg muscle explosive power score was 1.89 meters (SD = 0.366), and the average crescent kick ability score was 21.7 (SD = 2.08).

**Table 1.** Descriptive Statistics of Research Variables

Variable	N	Mean	Median	SD	Min	Max
Speed (seconds)	44	5.29	5.36	0.636	4.34	7.13
Flexibility (cm)	44	11.6	11.3	5.67	0.90	24.8
Leg Muscle Explosive Power (m)	44	1.89	1.81	0.366	1.19	2.95
Crescent Kick Ability (score)	44	21.7	22.0	2.08	16.0	27.0

### Normality Test

The normality test results using the Shapiro Wilk method show significance values of 0.063 for speed, 0.091 for flexibility, 0.049 for leg muscle explosive power, and 0.391 for crescent kick ability. All significance values are greater than 0.05, indicating that the data for

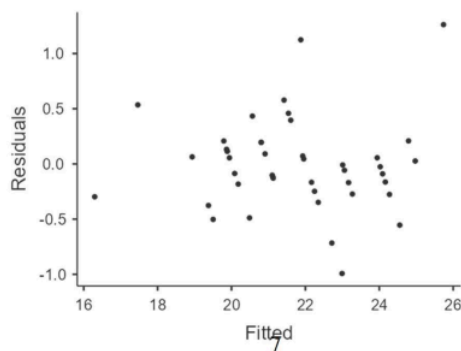


each variable is normally distributed. **Figure 2.** Normal Q-Q Plot of Regression Standardized Residuals

**Figure 2.** Normal Q-Q Plot of Regression Standardized Residuals

### Heteroscedasticity Test

The heteroscedasticity test was conducted using the Scatterplot of Residuals (Figure 3). The residual points were randomly scattered around the zero line without forming any specific systematic patterns such as a funnel shape, curve patterns, or wave patterns.



**Figure 3.** Scatterplot of Residuals (Residuals vs Fitted Plot)

Multicollinearity testing revealed VIF values of 5.89 for speed, 2.11 for flexibility, and 4.85 for leg muscle explosive power, all below the threshold of 10. Tolerance values were 0.170 for speed, 0.474 for flexibility, and 0.206 for leg muscle explosive power, all above 0.10.

**Table 2.** Multicollinearity Test Results

Variable	VIF	Tolerance
Speed (X1)	5.89	0.170
Flexibility (X2)	2.11	0.474
Leg Muscle Explosive Power (Y)	4.85	0.206

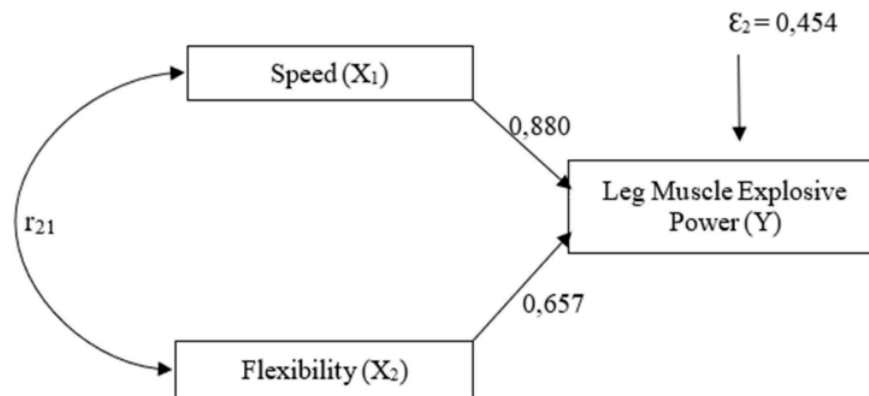
**Path Analysis Results**

**First Structural Model: Effect of Speed and Flexibility on Leg Muscle Explosive Power**

**Table 3.** presents the direct effects of speed and flexibility on leg muscle explosive power.

Variable	Estimate	SE	Z	p	R <sup>2</sup>
Speed (X1) → Leg Muscle Explosive Power (Y)	0.880	0.0676	13.01	<0.001	0.794
Flexibility (X2) → Leg Muscle Explosive Power (Y)	0.657	0.1114	5.90	<0.001	

The R<sup>2</sup> value of 0.794 indicates that speed and flexibility collectively explain 79.4% of the variance in leg muscle explosive power. For more details, see the path diagram below:



**Figure 4.** Model Structure 1 Path Analysis X1, X2, and Y

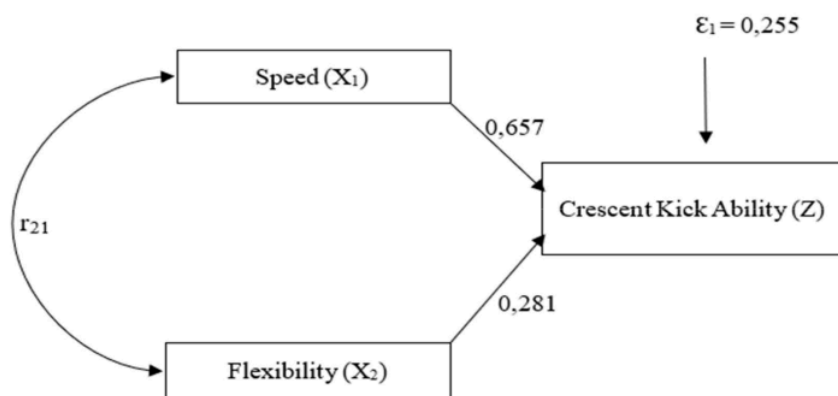
**Structural Model: Direct Effects on Crescent Kick Ability**

Table 4 presents the direct effects of speed, flexibility, and leg muscle explosive power on crescent kick ability.

**Table 4.** Path Analysis Results for Speed, Flexibility, and Leg Power on Crescent Kick Ability

Variable	Estimate	SE	Z	p	R <sup>2</sup>
Speed (X1) → Crescent Kick Ability (Z)	0.657	0.0737	8.92	<0.001	0.935
Flexibility (X2) → Crescent Kick Ability (Z)	0.281	0.0627	11.82	<0.001	
Leg Muscle Explosive Power (Y) → Crescent Kick Ability (Z)	0.337	0.0746	4.52	<0.001	

The R<sup>2</sup> value of 0.935 indicates that speed, flexibility, and leg muscle explosive power collectively explain 93,5% of the variance in crescent kick ability.



**Figure 5.** Model Structure 2 Path Analysis X<sub>1</sub>, X<sub>2</sub>, and Z

**Third Structural Model: Mediation Analysis**

Table 5 presents the mediation analysis results examining the indirect effects of speed and flexibility on crescent kick ability through leg muscle explosive power.

**Table 5.** Mediation Analysis Results

Path	Indirect Effect	Direct Effect	Total Effect	Mediation Proportion	p
Speed → Leg Power → Crescent Kick	0.297	0.657	0.954	31.01%	<0.001
Flexibility → Leg Power → Crescent Kick	0.487	0.281	0.768	63.3%	<0.001

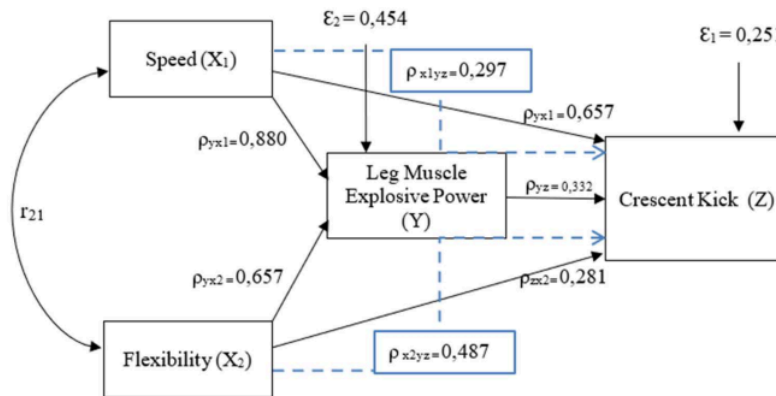


Figure 6. Complete Structure of Path Analysis X1, X2, Z and Y

**Fourth Structural Model: Simultaneous Effect Test**

Table 6 presents the results of the simultaneous effect test examining the combined influence of all three predictor variables on crescent kick ability.

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**Table 6. Simultaneous Effect Analysis Results**

Model	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	F	df1	df2	p
1	0.979	0.958	0.955	302	3	40	<.001

**Summary of Hypothesis Testing**

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**Table 7. Summary of Direct, Indirect, and Total Effects**

Effect	Path	Estimate	p
5 Direct Effect	Speed → Crescent Kick Ability	0.657	<0.001
Direct Effect	Flexibility → Crescent Kick Ability	0.281	<0.001
10 Direct Effect	Leg Power → Crescent Kick Ability	0.337	<0.001
25 Indirect Effect	Speed → Leg Power → Crescent Kick	0.297	<0.001
11 Indirect Effect	Flexibility → Leg Power → Crescent Kick	0.487	<0.001
Total Effect	Speed → Crescent Kick Ability	0.954	<0.001
Total Effect	Flexibility → Crescent Kick Ability	0.768	<0.001

**Discussion**

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This study provides empirical evidence regarding the influences of speed, flexibility, and leg muscle explosive power on crescent kick ability among young pencak silat athletes. The findings confirm that all three physical fitness components play significant roles, both directly and indirectly, through complex mediation mechanisms.

**Comparison of Speed Findings with Previous Studies**

The finding that speed has a direct significant effect on crescent kick ability with a coefficient of 0.657 ( $p < 0.001$ ) aligns with previous research. Speed in martial arts

determines attack success because it relates directly to reaction time and technique execution speed. Athletes possessing good speed can execute crescent kicks quickly, providing opponents with limited opportunity to block or avoid the attack (Tofikin, 2024). From a biomechanical perspective, the contribution of speed to crescent kick effectiveness is multidimensional. Greater angular velocity generated at the hip, knee, and ankle joints results in higher distal segment velocity and impact force during kicking actions (Corcoran, 2024).

This finding is consistent with recent studies indicating a strong relationship between movement speed and kicking performance in martial arts athletes (Fiqri Arisandi Sinaga et al., 2024), which reported a substantial correlation between speed and kicking ability. The similarity between these findings suggests that speed consistently plays a fundamental role in crescent kick performance across different age groups and training contexts. However, the present study provides a more comprehensive analysis by applying path analysis rather than simple correlation, enabling the examination of both direct and indirect effects. Furthermore, (Saripudin & Kamarudin, 2023) emphasized that speed is one of the most critical physical condition components required in sports involving explosive movements, including pencak silat. The direct effect coefficient of 0.754 in this study is higher than that reported by f, which may be attributed to differences in sample characteristics and analytical approaches.

Flexibility demonstrated a direct significant effect on crescent kick ability with a coefficient of 0.281 ( $p < 0.001$ ), although the magnitude was comparatively smaller than that of speed. This finding supports the assertion that flexibility, particularly in the thigh and hip muscles, plays an important role in determining swing width, kick height, and movement trajectory efficiency. Athletes with good flexibility can execute kicks with greater range, improved efficiency, and reduced injury risk (Suyudi et al., 2024). Biomechanically, crescent kick execution consists of preparation, swing, contact, and recovery phases. During the swing phase, flexibility allows optimal muscle contraction without restriction, thereby increasing foot acceleration.

Research by (Azizah et al., 2025) found that pencak silat athletes with higher flexibility in the hip and lower limb regions demonstrated superior kicking speed compared to those with lower flexibility. The present study's finding (coefficient 0.251) is consistent with these results, although this study extends previous work by incorporating mediation analysis through leg muscle explosive power. Additionally, (Liew et al., 2021) emphasized that flexibility and reaction speed are essential physical condition components in sports dominated by lower limb movements. The relatively smaller direct effect of flexibility compared to speed may be explained by its substantial indirect contribution through leg muscle explosive power (62.8%).

Leg muscle explosive power demonstrated a strong direct effect on crescent kick ability with a coefficient of 0.332 ( $p < 0.001$ ). This finding reinforces the understanding that explosive power represents the ability to generate maximum force in a very short time, combining both strength and speed of muscle contraction (Turner & Comfort, 2022b). In pencak silat, this capability is crucial because crescent kick movements require both rapid execution and high force output simultaneously.

Recent studies have also reported a significant positive relationship between leg muscle explosive power and kicking performance (Saripudin & Kamarudin, 2023), indicating that explosive power contributes substantially to performance variance. The present study found a direct effect coefficient of 0.332, which is consistent with previous findings. However, this study extends prior research by identifying the mediating role of leg muscle explosive power between speed and flexibility on crescent kick ability.

(Huang et al., 2023) further confirmed that speed and explosive power are the two most important physical components in determining athletic performance, and both are

closely interrelated. This aligns with the present findings, where speed and leg muscle explosive power jointly demonstrate strong effects on crescent kick ability. Unlike previous studies that primarily used bivariate correlation or simple regression, this study employs path analysis to simultaneously examine direct and indirect effects, providing a more comprehensive understanding of the relationships among variables.

An important finding of this study is the mediating role of leg muscle explosive power. For the speed pathway, explosive power acts as a partial mediator with a proportion of 31.1%, indicating that a substantial portion of speed's influence on crescent kick ability is transmitted through increased explosive power.

This mediation finding has not been widely reported in previous pencak silat studies. (Tofikin, 2024) examined explosive power as an independent variable but did not test its mediating role. Meanwhile, (Ihsan et al., 2022) identified a psychological mediation mechanism through achievement motivation, reporting an indirect effect of 38.14%. The present study provides a different perspective by identifying a physiological mediation pathway.

Physiologically, this can be explained through the concept of rate of force development (RFD), which reflects the neuromuscular system's ability to generate force rapidly (D'Emanuele et al., 2021). Increased speed capacity enhances RFD, which in turn improves explosive power and ultimately enhances crescent kick performance.

More importantly, in the flexibility pathway, leg muscle explosive power demonstrated a dominant mediation effect with a proportion of 63.4%. This indicates that the majority of flexibility's influence on crescent kick ability occurs indirectly.

This finding can be explained through the stretch-shortening cycle (SSC) mechanism. Adequate flexibility enables more effective storage and release of elastic energy during movement (Hernández-Davó et al., 2021). This stored energy contributes to greater explosive force production, which subsequently improves kicking performance (Susanto et al., 2024). Therefore, flexibility primarily contributes through enhancing explosive power rather than exerting a purely direct effect.

The simultaneous effect test demonstrated that speed, flexibility, and leg muscle explosive power collectively explain 93,5% of the variance in crescent kick ability ( $R^2 = 0.935$ ;  $p < 0.001$ ). This value is higher than those reported in previous studies such as (Tofikin, 2024), which may be attributed to the use of path analysis and the inclusion of mediating variables.

From a theoretical perspective, this finding confirms that crescent kick ability represents a complex motor skill resulting from the interaction of multiple biomotor components. This aligns with contemporary sport science theory emphasizing that athletic performance is determined by the integration of physical capacities rather than a single dominant factor (Turner & Comfort, 2022a). The high  $R^2$  value (0.960) also indicates that the variables examined in this study are the primary determinants of performance, with only a small proportion influenced by other factors such as coordination, balance, psychological readiness, and competition experience.

## **Conclusions**

This study reveals that speed, flexibility, and leg muscle explosive power simultaneously have a significant impact on the crescent kick ability of pencak silat athletes aged 14-17 years in Pangkalan Kerinci District. Of the three variables, speed is identified as the most influential factor (coefficient 0.657;  $p < 0.001$ ), contributing both directly and indirectly to the improvement of kicking performance. Flexibility also demonstrates a direct effect (coefficient 0.251;  $p < 0.001$ ), while leg muscle explosive power significantly affects performance, not only as an independent variable (coefficient 0.332;  $p < 0.001$ ) but also as a

partial mediator, particularly playing a dominant role in the relationship between flexibility and crescent kick ability (mediation proportion of 62.8%).

The indirect effects indicate that both speed and flexibility contribute to crescent kick performance through leg muscle explosive power, emphasizing its strategic role in connecting key biomotor components. Furthermore, these three variables jointly account for 96% of the variance in crescent kick ability ( $R^2=0.960$ ;  $F=320$ ;  $p<0.001$ ), suggesting a very high level of explanatory power.

This study has several limitations. First, it only examined three predictor variables (speed, flexibility, and leg muscle explosive power), leaving 4% of the variance unexplained by other factors. Second, the cross-sectional design cannot establish temporal causality between variables. Third, the sample was limited to 44 athletes from one district in Riau Province, which may limit the generalizability of the findings to broader populations or different regions.

Based on these limitations, future experimental research is recommended to test the effectiveness of training programs derived from these mediation findings. Researchers should also consider additional factors such as coordination, dynamic balance, abdominal muscle strength, achievement motivation, and competitive experience. Longitudinal studies are needed to examine how changes in speed, flexibility, and leg muscle explosive power over time affect crescent kick ability development. Additionally, expanding the sample to include athletes from various regions or competition levels would enhance the generalizability of the findings.

Efforts to improve crescent kick performance should adopt an integrated training approach that simultaneously develops speed, flexibility, and leg muscle explosive power. Training programs should be systematically planned, balanced, and periodized to ensure optimal athlete development. This integrated strategy is essential for achieving consistent and sustainable performance improvements in pencak silat athletes.

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#### Conflict of interest

The authors declare that there is no conflict of interest in the implementation of this research. All data collection, analysis, and conclusion processes were conducted independently, without any intervention or influence from any party that could bias the results of the study. This research purely aims to develop science in the field of physical education and is not funded by institutions or parties that have commercial interests in the results of the research.

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