ORIGINAL ARTICLE

Relationship between leg muscle explosive power and sickle kick speed in pencak silat athletes

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Abstract

Background and Study Aim: Pencak silat is a traditional martial art originating from Indonesia, characterized by dynamic movements and complex techniques. Practitioners are required to possess a high level of physical fitness, including strength, speed, and precision, particularly during attack and defense actions. One of its essential techniques is the sickle kick, which demands both leg muscle explosiveness and execution speed. This study aimed to examine the relationship between leg muscle explosive power and sickle kick speed.

Material and Methods: This study used a descriptive method with a correlational design and a quantitative approach. The sampling technique was total sampling, involving 42 pencak silat athletes. The research instruments included a vertical jump test to assess leg muscle explosive power and a sickle kick speed test, which involved performing kicks toward a kicking box for 1 minute (30 seconds with the left leg and 30 seconds with the right). Data were analyzed using normality, linearity, and correlation tests with the assistance of SPSS version 21.

Results: The results showed that the significance value for the relationship between leg muscle explosive power and sickle kick speed was 0.01 < 0.05, indicating a statistically significant relationship.

Conclusions: There is a significant relationship between leg muscle explosive power and sickle kick speed in pencak silat athletes. These findings can serve as a reference for identifying physical factors that contribute to improving kick speed in pencak silat athletes.

Keywords: pencak silat, leg muscle explosive power, sickle kick speed, vertical jump, martial arts performance

Introduction

Pencak silat, as a traditional Indonesian martial art, encompasses a wide range of dynamic techniques that combine elements of self-defense, discipline, and athleticism. Effective performance in this sport depends not only on technical mastery but also on the athlete's physical attributes, particularly strength, speed, and coordination. Among the core techniques, the sickle kick stands out due to its complexity and reliance on explosive leg power to achieve both speed and accuracy. Understanding the physical components that contribute to the effectiveness of this movement is essential for improving athletic performance in pencak silat.

Sport consists of a series of physical activities performed in a structured and systematic manner to improve an individual's functional abilities, both individually and in groups [1, 2]. One of the traditional sports of Indonesia is pencak silat [3]. This martial art represents an important part of the country's cultural heritage, embodying traditional values and practices passed down from generation to generation [4, 5].

This form of pencak silat serves not only as a means of self-defense but also as a way to connect individuals with the cultural roots and identity of the Indonesian nation [6]. The complex movements and techniques of pencak silat engage the entire body, combining a harmonious blend of physical strength, mental agility, and spiritual awareness [7]. As a martial art, pencak silat is characterized by the use of all body parts and limbs as tools for self-defense. Techniques can be performed either bare-handed or with weapons [4]. The movements in pencak silat are purposeful, controlled, directed, and coordinated [8]. They encompass four main interconnected aspects: mental-spiritual, self-defense, sport, and art.

Syaifullah and Lingsir Maghribi [9] explain that an attack in pencak silat is a self-defense action involving the use of the arms or legs to strike a specific target on the opponent's body. During a match, an athlete must demonstrate proper stance, balanced footwork, and a variety of attack and evasion techniques before returning to the original position [10]. Standard attack techniques in pencak silat include kicks, punches, falls, and sweeps. Among these, kicks are used more frequently in competition because they are awarded higher scores than punches. A punch is worth 1 point, while a kick is worth 2 points. If an athlete successfully avoids an opponent's attack while delivering a kick that hits a valid target, the athlete receives a score of 1+2 [11].

The results of a study by Saphie et al. [12] indicate that pencak silat athletes who deliver a greater number of kicks demonstrate not only

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aggressiveness in competition but also strategic superiority and technical mastery. Kicks often yield higher points than punches when they accurately hit the opponent [13]. In pencak silat, various types of kicks are used, including straight, crescent, side, and back kicks [14]. The sickle kick is one such technique and is commonly employed during matches as an offensive move [15]. To be effective, kicks must be fast and accurately targeted so that the opponent cannot easily anticipate the attack [16]. Consistent and precise kicking increases the opportunity to score, thereby allowing the athlete to dominate the match [17].

In the context of Pencak Silat, general physical attributes such as muscular strength, speed, and coordination must be effectively transferred into specific technical movements. Kicking techniques, in particular, require the rapid transformation of muscular force into high-velocity motion. Understanding how foundational physical qualities like lower-limb explosive power directly influence the speed and precision of kicks is essential for optimizing athletic performance.

The execution of a sickle kick relies on several key components that contribute to the effectiveness of the movement. One of the primary components is the explosive power of the leg muscles [18, 19]. This refers to the ability of the leg muscles to generate force rapidly, which is essential for producing high-speed and powerful kicks. In pencak silat, greater leg muscle explosive power enables faster and stronger kicks, increasing the likelihood of delivering an effective attack against the opponent [5, 20].

Analysis of previous research findings has shown that the effectiveness of kicks in pencak silat is closely linked to technical execution, physical conditioning, and in particular, the explosive power of the legs. Researchers emphasize that explosive leg strength plays a decisive role in achieving optimal speed and accuracy during offensive movements, especially sickle kicks. Given the complexity and competitive importance of this technique, understanding the physical factors that influence its performance remains a relevant area of exploration. In this context, examining the connection between leg muscle explosive power and sickle kick performance offers valuable insights for both training and competition.

It is assumed that athletes with greater explosive leg power are able to perform sickle kicks with higher speed and precision, which may contribute to better scoring outcomes during competition. This assumption aligns with the idea that muscular explosiveness enhances both the mechanical efficiency and tactical effectiveness of kicking techniques. Therefore, this study aims to examine the relationship between leg muscle explosive power and sickle kick speed in pencak silat athletes.

Materials and Methods

Participants

The population in this study consisted of all 42 martial artists from the Melati Sakti School in Pekalongan City. A total sampling technique was applied, meaning that all members of the population were included as research participants.

The sample included 27 male and 15 female athletes, aged between 16 and 22 years (mean age: 18.5 ± 1.8 years). Their training experience ranged from 2 to 6 years. All participants were actively involved in regular pencak silat training at the time of the study.

A formal power analysis was not conducted due to the total sampling method; however, the inclusion of all 42 available athletes was considered sufficient for detecting moderate correlations ($r \geqslant 0.5$) with a power of 0.80 and alpha of 0.05, based on standard guidelines.

This study was conducted in accordance with the ethical standards of the institutional research committee and the principles of the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of Semarang State University. All participants were informed about the purpose and procedures of the study, and written informed consent was obtained prior to data collection.

Research Design

The study employed a quantitative method with a cross-sectional design. The explosive power of the lower limbs was assessed using the vertical jump test performed on the Just Jump System (Probotics, USA), a portable contact mat that estimates jump height based on flight time. This method is widely used in field settings due to its practicality and strong test-retest reliability [21]. However, validation studies have shown that the Just Jump System systematically overestimates jump height compared to force platforms. To improve measurement accuracy, a correction equation proposed by McMahon et al. [22] was applied:

$$H_{corrected} = 0.825 \cdot H_{JJ} + 1.7$$

Where: H_{JJ} – the jump height (in centimeters) as measured by the Just Jump System; 0.825 and 1.7 – empirically derived coefficients based on comparison with gold-standard force platform measurements.

Participants were instructed to maintain a consistent body posture during take-off and landing to minimize measurement error. The protocol followed standard procedures for assessing explosive power in martial artists [21]. Additionally, the device was calibrated before each session, and jump trials were repeated if execution did not meet posture consistency standards.

The speed of the sickle kick was assessed using the Pecing Box kick test, as described in traditional

Pencak Silat practice [22]. The test consisted of a 1-minute trial, divided into two 30-second sessions: one for the left leg and one for the right leg. Participants performed continuous crescent (sickle) kicks against a padded target (Pecing Box), and the total number of accurately executed kicks within each time interval was recorded. This number served as the performance indicator for kick speed. Similar test formats have been applied in previous research on Pencak Silat athletes to evaluate kicking performance under time constraints [23, 24].

The padded Pecing Box target was positioned at a standardized height of 1 meter from the ground. Kicks were considered valid if they made clean contact with the target without loss of balance or form. Observers were trained to record only clearly executed kicks, and ambiguous movements were excluded. The assessment was performed by two independent observers. Inter-rater reliability was established prior to testing (Cohen's kappa = 0.91), ensuring consistency in kick evaluation.

All tests were conducted indoors on a non-slip rubber surface in the training hall of the club. The temperature was maintained between 24–26°C, and assessments were carried out between 08:00 and 11:00 a.m. to ensure consistency and minimize circadian variation in physical performance.

Statistical Analysis

The statistical analysis included several steps. First, descriptive statistics were calculated to summarize the participants' physical performance scores, including means and standard deviations for both leg muscle explosive power and sickle kick speed. The normality of data distribution was assessed using the Kolmogorov–Smirnov test to determine the suitability of parametric tests. To verify whether the relationship between variables met the assumption of linearity, a deviation from linearity test was conducted. Following the assumption checks, Pearson product-moment correlation analysis was used to examine the relationship between leg muscle explosive power and the speed of the sickle kick. All statistical procedures were performed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). A significance level of $p < 0.05$ was adopted for all tests.

Results

Descriptive statistics were calculated for the two main variables: the explosive power of the leg muscles and the speed of the sickle kick. Table 1 presents the minimum, maximum, mean, and standard deviation values for each variable measured in the sample of 42 Pencak Silat athletes.

Based on the data in Table 1, the athletes demonstrated moderate variation in both physical performance measures. The average vertical jump height was 53.77 cm, with a standard deviation of 8.44 cm, indicating variability in lower-limb explosive strength. The average sickle kick speed was 19.58 kicks per minute, with a standard deviation of 3.62, reflecting differing levels of kicking efficiency across participants.

A normality test was conducted using the Kolmogorov–Smirnov method to determine whether the data for each variable followed a normal distribution. The results are presented in Table 2.

As shown in Table 2, the significance value for explosive power of the leg muscles was 0.463, and for sickle kick speed it was 0.070. Since both values are greater than the threshold of 0.05, the null hypothesis of normality cannot be rejected. Therefore, both variables are considered to be normally distributed.

To determine whether a linear relationship exists between the two variables, a linearity test was conducted. The results are shown in Table 3.

As shown in Table 3, the significance value for the Deviation from Linearity is 0.101, which exceeds the threshold of 0.05. This indicates that the relationship between leg muscle explosive power and sickle kick speed does not significantly deviate from linearity. Therefore, it is appropriate to proceed with parametric correlation analysis.

Table 1. Descriptive Statistics for Explosive Leg Power and Sickle Kick Speed

Variable	Minimum	Maximum	Mean	Standard Deviation
Explosive power of leg muscles (cm)	33	70	53.77	8.44
Sickle kick speed (kicks/min)	14	27	19.58	3.62

Note: Explosive leg power was measured using the vertical jump test on the Just Jump System, with jump height recorded in centimeters. Sickle kick speed was measured as the total number of correctly executed kicks performed within one minute, divided equally between the left and right legs.

Table 2. Kolmogorov–Smirnov Test of Normality

Variable	Statistic	df	Sig.	Interpretation
Explosive power of leg muscles	0.975	42	0.463	Normally distributed
Sickle kick speed	0.951	42	0.070	Normally distributed

Note: The threshold for normality was set at $p > 0.05$.

Table 3. Linearity Test: Deviation from Linearity

Variables	Mean Square	F	Sig.	Interpretation
Explosive power of leg muscles × Sickle kick speed	103.313	1.778	0.101	Linear relationship confirmed

Note: A significance value (p) greater than 0.05 in the Deviation from Linearity test indicates a linear relationship.

Table 4. Pearson Correlation Between Explosive Leg Power and Sickle Kick Speed

Variable	1. Explosive Power (cm)	2. Sickle Kick Speed (kicks/min)
1. Explosive Power	1.000	0.513*
2. Sickle Kick Speed	0.513*	1.000
Sig. (2-tailed)	–	0.001
N	42	42

Note: * = Correlation is significant at the 0.05 level (2-tailed).

A Pearson correlation analysis was conducted to examine the strength and direction of the relationship between leg muscle explosive power and sickle kick speed. The results are presented in Table 4.

The results in Table 4 show a statistically significant positive correlation between leg muscle explosive power and sickle kick speed ($r = 0.513$, $p = 0.001$). Since the p-value is below the 0.05 threshold, the relationship is considered significant. The correlation coefficient of 0.513 indicates a moderate positive relationship, suggesting that higher explosive leg power is associated with greater sickle kick speed in Pencak Silat athletes.

According to Cohen's criteria, this corresponds to a moderate effect size. The 95% confidence interval for the correlation ranged from 0.22 to 0.72, confirming the reliability of the observed association.

Discussion

This study aimed to examine the relationship between leg muscle explosive power and sickle kick speed. The results revealed a statistically significant moderate positive correlation between these two variables ($r = 0.513$, $p = 0.001$). Athletes with greater leg muscle explosiveness demonstrated a higher number of effective kicks within the one-minute test, indicating that explosive strength plays a meaningful role in kick performance.

Good physical condition enhances overall fitness and improves the functional capacity of the body's systems, thereby enabling athletes to achieve better performance outcomes [26, 27]. The main components of physical condition include stamina, strength, muscular endurance, and speed – all of which are essential for supporting pencak silat training and competition [28, 29]. To perform optimally, an athlete must maintain a high level of physical fitness [30]. In sports, explosive power is a key biomotor ability, as it determines how forcefully an athlete can strike, kick, sprint, or push off during performance [31, 32, 33, 34]. Explosive power is considered a fundamental component of physical condition required in nearly all sports, including pencak silat [35].

The results of this study indicate a significant positive relationship between leg muscle explosive power and the speed of the sickle kick. Athletes with higher explosive strength in their leg muscles demonstrated a greater ability to perform fast and powerful sickle kicks. These findings are consistent with the results of Jamal et al. [17], who reported that explosive muscle power significantly influences the speed of the front kick in pencak silat, with a contribution of 13.6%. This is further supported by Zaqi Arief Firmanto et al. [36], who found a significant relationship between leg muscle strength and kick speed in silat athletes. While the findings of this study are consistent with previous research by Jamal et al. [17] and Zaqi Arief Firmanto et al. [36], a critical comparison reveals some important distinctions. For instance, while Jamal et al. focused on front kicks in adolescent athletes and reported a lower contribution (13.6%), the current study investigated sickle kicks in a mixed-gender population and found a moderate correlation ($r = 0.513$). This suggests that the contribution of explosive leg power may vary depending on the kick type and technical complexity. Additionally, while Doewes et al. [37] emphasized the biomechanical basis of lower-limb strength in rotational acceleration, our findings provide empirical confirmation of this principle in a real athlete sample, reinforcing its relevance for training applications.

Biomechanically, kicking in pencak silat highlights the critical role of lower limb strength in generating optimal acceleration, especially during kicking techniques. This strength affects the production of torque, rotational kinetic energy,

and ultimately determines both the speed and accuracy of the kick. Executing an effective kick requires explosive contraction of the leg muscles, particularly the quadriceps, hamstrings, and gluteal muscles. The movement starts with a powerful push from the supporting leg, followed by a free leg swing that generates high rotational momentum [37].

The explosive power of an athlete's muscles reflects the overall quality of their performance. Athletes with insufficient leg strength are often more predictable, making it easier for opponents to anticipate and counter their kicks [38]. Explosive strength in the leg muscles, particularly in the feet and lower limbs, is a key factor in enabling athletes to compete at a high level [39]. This type of muscular power plays a crucial role in generating an effective sickle kick. When the explosive power of the leg muscles is at an optimal level, the execution of the sickle kick tends to be more effective in terms of strength, speed, and accuracy [40].

However, many silat athletes continue to exhibit below-average performance in executing the sickle kick. This suggests deficiencies in both technical execution and physical conditioning that support the movement, highlighting the need for targeted and specific training programs to enhance its effectiveness and efficiency. Several factors can influence the quality of a sickle kick, including distance to the target, balance of the supporting leg, body positioning, kick trajectory, and pelvic rotation [41, 42, 43]. Proper foot positioning must be consistently trained to develop automatic and efficient movement patterns for power application. The success of the kick largely depends on reaction speed, response time, and execution accuracy [44].

The training process is a crucial factor in enhancing athletic performance [45]. Regular training, particularly targeting the leg muscles, is essential for developing strong and technically sound kicking skills [46, 47]. Powerful, fast, and accurate kicks require specialized training programs that focus on leg strength, leg length, muscular endurance, and the application of effective training methods [48]. Speed-oriented training, ballistic exercises, and plyometrics have been shown to improve kick performance that demands high power output [45]. Based on the findings of this study, there is a significant relationship between leg muscle explosive power and the speed of the sickle kick. The greater the explosive power, the higher the kick speed and effectiveness. These results suggest that optimizing explosive leg strength through structured and specific programs such as plyometric and speed training is essential for improving sickle kick performance in athletes.

The results of this study have practical implications for coach education and the design of training curricula in martial arts disciplines. Specifically, the findings support the inclusion of targeted plyometric and speed-strength exercises in skill development programs to enhance kicking performance. For physical education and coaching curricula, this highlights the importance of integrating biomechanical principles and evidence-based training protocols to improve specific techniques such as the sickle kick. Martial arts instructors could incorporate performance diagnostics, such as jump tests, into regular assessments to monitor explosive strength development in student-athletes.

This study confirms a significant and meaningful relationship between leg muscle explosive power and sickle kick speed in pencak silat athletes. The findings emphasize the critical role of lower-limb strength in executing fast and effective kicks, highlighting the biomechanical and practical importance of explosive muscle performance. These results support the integration of specific strength and speed training protocols in pencak silat practice to enhance kick execution and competitive success.

Although the study does not present a new pedagogical model, it reinforces the relevance of integrating physical testing and conditioning into sport-specific skill development. The findings can inform coaching practice by linking a measurable physical quality (explosive leg strength) to technical performance. Embedding such evidence-based approaches into training programs and coach education can strengthen the alignment between sports science and martial arts pedagogy.

Limitations and Future Research

This study has several limitations. It was conducted on a specific group of athletes within a limited age and experience range, which may affect the generalizability of the findings to other populations or levels of competition. Additionally, only two performance variables were analyzed, without considering other potentially influential factors such as coordination, flexibility, or psychological readiness. Future research should explore these additional components and examine the long-term effects of targeted training interventions on sickle kick performance across broader athlete populations.

Although the study confirms the importance of leg muscle explosiveness in kicking performance, it does not introduce an intervention, comparative protocol, or theoretical advancement. The correlational design provides validation of existing findings within a new athlete sample, but lacks experimental manipulation, such as comparing different training methods (e.g., plyometric vs. traditional). Future research could enhance novelty by exploring how specific training interventions influence biomechanical outcomes, or by comparing elite and novice athlete populations. Investigating

interactions between multiple physical and cognitive variables would also extend the theoretical contributions of such studies.

Conclusions

There is a significant relationship between leg muscle explosive power and the speed of the sickle kick in pencak silat athletes. The results of this study can serve as a reference for designing training programs and as a benchmark for developing each athlete's potential to achieve success at various levels of competition. These findings have important implications for pencak silat training. Coaches and athletes are encouraged to focus on improving explosive leg strength through consistent and progressive training. The application of specific speed- and strength-based training methods is believed to enhance the effectiveness of the sickle kick from both technical and physical perspectives.

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Conflict of Interest

The authors declare no conflict of interest.

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