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The Effect Of Plyometric Exercises On Leg Muscle Variation On The Crescent Kick Ability Of Pencak Silat Athletes Persinas Asad Gowa Regency

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ABSTRACT

Pencak silat is an Indonesian martial art that has developed into a competitive sport requiring technical mastery, physical readiness, tactical awareness, and strong character. One of the important attacking techniques in pencak silat competition is the crescent kick, which demands lower-limb explosive power, balance, coordination, speed, and accuracy. However, many young athletes still experience difficulties in executing fast and powerful crescent kicks. Therefore, an appropriate physical training method is needed to support technical improvement. This study aimed to determine the effect of varied lower-limb plyometric training on the crescent kick ability of Persinas ASAD pencak silat athletes in Gowa Regency. This research used a quantitative approach with a pre-experimental method and a One-Group Pretest–Posttest Design. The sample consisted of 15 athletes aged 14–17 years who were selected randomly from approximately 50 athletes. The intervention was conducted for 12 training sessions from February to April 2025 at the Persinas ASAD Training Center, Gowa Regency. The training program consisted of varied lower-limb plyometric exercises, including box jumps and single-leg hops. Data were collected using a 10-second crescent kick test and analyzed through descriptive statistics, normality testing, and paired-samples t-test. The results showed that the mean pretest score was 16.87, while the mean posttest score increased to 21.73, with a mean difference of 4.86 and an improvement percentage of approximately 29.03%. The t-test result showed that t-count = 8.72 was higher than t-table = 2.145, with a significance value of 0.000 < 0.05. It can be concluded that varied lower-limb plyometric training significantly improves the crescent kick ability of pencak silat athletes.

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INTRODUCTION

Pencak silat is not merely a traditional Indonesian martial art, but also a cultural, educational, and competitive sport system that integrates physical excellence, discipline, respect, self-control, and moral character. The recognition of pencak silat as part of Indonesia's intangible cultural heritage strengthens its position as both a cultural identity and a modern sport that requires systematic coaching, scientific training, and evidence-based performance development (UNESCO, 2019; Ediyono, 2022; Hariono et al., 2024). In competitive pencak silat, athletes are expected to demonstrate technical

accuracy, tactical intelligence, physical readiness, and mental toughness under dynamic match conditions. Therefore, the development of athlete performance cannot rely only on repeated technical practice, but must be supported by structured physical conditioning that matches the biomechanical demands of pencak silat techniques.

One of the most decisive attacking techniques in pencak silat competition is the crescent kick or tendangan sabit. This technique is characterized by a curved kicking trajectory that allows athletes to attack the opponent's body area with speed, power, reach, and tactical surprise. The effectiveness of the crescent kick depends on the integration of lower-limb explosive power, hip flexibility, trunk stability, dynamic balance, coordination, and reaction speed (Wijaya et al., 2022; Hidayat & Haryanto, 2021; Sulfa et al., 2024). Empirical studies show that leg muscle explosive power has a significant relationship with crescent kick performance, while balance and agility also contribute to the ability to execute kicks quickly and accurately (Hadisan, 2024; Ahmad, 2026). However, preliminary coaching problems commonly found among pencak silat athletes, including athletes of Persinas ASAD in Gowa Regency, are the limited ability to produce explosive kicking force, unstable body control during the kicking phase, inconsistent accuracy, and insufficient speed in repeated attacking situations. These weaknesses indicate the need for a specific training model that directly targets lower-limb explosive ability and its transfer to crescent kick performance.

Recent sport science literature emphasizes that muscular strength and power are fundamental determinants of athletic performance, especially in sports requiring rapid force production, acceleration, jumping, kicking, and change of direction (Suchomel et al., 2016; Suchomel et al., 2018; Cid-Calfucura et al., 2023). Plyometric training is widely recognized as an effective method for improving explosive performance because it utilizes the stretch-shortening cycle, which combines eccentric loading and rapid concentric contraction to enhance neuromuscular efficiency, motor-unit recruitment, rate of force development, and tendon stiffness (Slimani et al., 2016; Deng et al., 2022; Kons et al., 2023). In youth and athlete populations, plyometric jump training has been shown to improve maximal dynamic strength, sprint speed, horizontal and vertical jump performance, reactive strength index, and sport-specific skills such as kicking velocity (Ramírez-Campillo et al., 2023; Chen et al., 2023).

In combat sports, the relevance of plyometric training becomes even stronger because athletes must combine explosive force, technical precision, balance recovery, and rapid attack execution. A systematic review and meta-analysis by Ojeda-Aravena et al. (2023) reported that plyometric jump training improved maximal strength, vertical jump, change-of-direction speed, and sport-specific performance among combat sport athletes, including taekwondo, karate, wrestling, judo, fencing, and silat. Similarly, Yuan et al. (2025) confirmed that plyometric training produced positive effects on muscle strength and power in martial arts athletes. Specific to pencak silat, recent studies found that plyometric exercises significantly improved sabit kick speed and kicking performance (Setiawan et al., 2024; Sudirman & Hasyim, 2025). Other studies also reported that plyometric, functional, circuit, resistance-band, and core-stability training models contributed to improving lower-limb power, kicking speed, accuracy, and movement control in pencak silat athletes (Sinulingga et al., 2023; Lubis et al., 2024; Sudirman et al., 2024; Juliansyah & Mashud, 2025; Manihuruk & Siahaan, 2025). These findings indicate that training methods involving explosive lower-limb actions have strong theoretical and empirical relevance for enhancing crescent kick performance.

Although many studies have examined plyometric training in general sport performance and several recent studies have investigated its effect on pencak silat kicking skills, important gaps remain. First, many studies still focus on single-form plyometric exercises, such as jump in place, tuck jump, stair jump, or box jump, without systematically combining varied lower-limb muscle plyometric drills that reflect the multidirectional, unilateral, and rotational demands of the crescent kick (Sudiana et al., 2023; Setiawan et al., 2024). Second, previous research has often emphasized speed alone, while crescent kick ability in competition is not determined only by speed, but also by power, balance, hip mobility, body control, rhythm, and the ability to repeat explosive attacks under tactical pressure (Wijaya et al., 2022; Sulfa et al., 2024; Ahmad et al., 2024). Third, evidence on pencak silat athletes at the regional club level remains limited, particularly within Persinas ASAD Gowa Regency, where training programs often require practical, low-cost, and coach-friendly exercise models.

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Furthermore, current meta-analytic evidence recommends further trials that examine optimal plyometric dosage, exercise variation, and sport-specific transfer in martial arts athletes (Ojeda-Aravena et al., 2023; Yuan et al., 2025). This means that research on varied lower-limb plyometric training for crescent kick ability is still scientifically relevant. It can contribute not only to the practical improvement of athletes, but also to the development of training models that are more contextual for pencak silat coaching in Indonesia.

Based on the research problem and literature gap, this study aims to determine the effect of varied lower-limb plyometric training on the crescent kick ability of Persinas ASAD pencak silat athletes in Gowa Regency. The novelty of this study lies in the specific integration of lower-limb plyometric variations designed to stimulate explosive power, dynamic balance, hip-knee-ankle coordination, and movement speed that are directly related to the biomechanical structure of the crescent kick. Unlike general conditioning programs, the proposed training model emphasizes sport-specific transfer through explosive, repetitive, and directionally varied movements that resemble the force demands of pencak silat kicking actions.

In conclusion, pencak silat performance development must be grounded in both cultural preservation and modern sport science. The crescent kick is a strategic technique that requires the integration of technical mastery and explosive lower-limb capacity. Plyometric training offers a scientifically supported approach to improve the neuromuscular qualities needed for effective kicking performance. Therefore, this study is expected to provide empirical evidence for coaches, athletes, and researchers in designing more effective, specific, and competitive training programs for pencak silat athletes, particularly within Persinas ASAD Gowa Regency.

METHODS

This study employed a quantitative approach using a pre-experimental method with a One-Group Pretest–Posttest Design. This design was selected because the main objective of the study was to examine the statistical effect of varied lower-limb plyometric training on the crescent kick ability of pencak silat athletes. The pretest–posttest model is relevant for sport intervention studies because it allows researchers to compare athletes' performance before and after a structured training program, particularly when the intervention focuses on neuromuscular adaptation, explosive power, and sport-specific skill improvement. Plyometric training was considered appropriate because previous studies have shown that jump-based and explosive exercises can improve strength, power, reactive ability, change-of-direction performance, and sport-specific actions in youth and combat-sport athletes (Slimani et al., 2016; Suchomel et al., 2016; Ramírez-Campillo et al., 2023; Kons et al., 2023; Ojeda-Aravena et al., 2023). The research was conducted from February to April 2025 at the Persinas ASAD Training Center, Gowa Regency. The intervention consisted of 12 training sessions carried out over four weeks, with a frequency of three sessions per week. This training duration was designed to provide sufficient stimulus for lower-limb explosive development while maintaining safety and technical quality among adolescent athletes. The independent variable was varied lower-limb plyometric training, while the dependent variable was crescent kick ability, measured through kicking speed and kicking frequency within a fixed time.

The population consisted of approximately 50 pencak silat athletes from Persinas ASAD Gowa Regency. A total of 15 athletes were selected randomly based on inclusion criteria: aged 14–17 years, having at least one year of pencak silat training experience, being physically healthy, and being willing to participate in the complete training program. The sample size was considered adequate for a focused pre-experimental study in a club-based training context, although the findings should be interpreted within the limitation of a single-group design.

Operationally, varied lower-limb plyometric training referred to explosive exercises involving the stretch-shortening cycle, including box jumps, squat jumps, lateral jumps, and single-leg hops. These exercises were arranged progressively by controlling sets, repetitions, box height, movement direction, and rest intervals. The training emphasized landing mechanics, balance, hip–knee–ankle coordination, and rapid force production, which are essential for effective crescent kick execution (Yuan et al., 2025; Setiawan et al., 2024; Rahman et al., 2025). Crescent kick ability was measured using

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a 10-second crescent kick test with a kicking square pad, stopwatch, and observation sheet. Data were collected through direct observation, pretest, implementation of the plyometric program, and posttest. The data were analyzed descriptively using mean, standard deviation, minimum, and maximum scores, followed by a normality test. If the data were normally distributed, hypothesis testing was conducted using a paired-samples t-test at a significance level of 0.05 to determine whether varied lower-limb plyometric training significantly improved crescent kick ability.

RESULTS AND DISCUSSION

Result

The results of this study describe the effect of varied lower-limb plyometric training on the crescent kick ability of Persinas ASAD pencak silat athletes in Gowa Regency. The analysis was conducted through descriptive statistics, normality testing, and hypothesis testing using a paired-samples t-test. The crescent kick ability was measured before the intervention through a pretest and after 12 sessions of plyometric training through a posttest. The training program emphasized lower-limb explosive movements, including box jumps, single-leg hops, and other plyometric variations designed to improve kicking speed, power, balance, and movement coordination.

Descriptive Analysis

Table 1.
Descriptive Statistics of Crescent Kick Ability

Test	N	Sum	Mean	Std. Dev	Range	Min.	Max.
Pretest Crescent Kick Ability	15	253.00	16.87	1.767	6.00	14.00	20.00
Posttest Crescent Kick Ability	15	326.00	21.73	1.981	7.00	18.00	25.00

Based on Table 1, the pretest results show that the crescent kick ability of Persinas ASAD pencak silat athletes before receiving varied lower-limb plyometric training had a total score of 253.00 from 15 athletes. The mean score was 16.87 with a standard deviation of 1.767. The score range was 6.00, with the lowest score being 14.00 and the highest score being 20.00. These results indicate that before the training intervention, the athletes' crescent kick ability was still relatively moderate and showed variation among individuals.

After the athletes participated in 12 sessions of varied lower-limb plyometric training, the posttest results showed a clear improvement. The total score increased to 326.00, with a mean score of 21.73 and a standard deviation of 1.981. The range was 7.00, with the lowest score increasing to 18.00 and the highest score reaching 25.00. This improvement indicates that the athletes demonstrated better crescent kick performance after the plyometric training program. The increase in the mean score from 16.87 to 21.73 shows that the training intervention contributed positively to the development of kicking ability, especially in terms of speed and explosive lower-limb movement.

Normality Test

Before conducting hypothesis testing, a normality test was carried out to determine whether the pretest and posttest data were normally distributed. The normality test used the Kolmogorov-Smirnov and Shapiro-Wilk tests, with a significance level of 0.05.

Table 2.
Normality Test Results

Variable	Kolmogorov-Smirnov		Shapiro-Wilk		α	Description
	Statistic	Sig.	Statistic	Sig.		
Pretest	0.155	0.200	0.955	0.612	0.05	Normal
Posttest	0.139	0.200	0.973	0.895	0.05	Normal

Based on Table 2, the pretest data obtained a Kolmogorov-Smirnov statistic value of 0.155 with a significance value of 0.200. The Shapiro-Wilk test showed a statistic value of 0.955 with a significance value of 0.612. Since both significance values are greater than 0.05, the pretest data can be categorized as normally distributed.

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The posttest data also showed normal distribution. The Kolmogorov-Smirnov statistic value was 0.139 with a significance value of 0.200, while the Shapiro-Wilk statistic value was 0.973 with a significance value of 0.895. Both values were higher than the significance level of 0.05. Therefore, the posttest data were also normally distributed. Because both data sets met the normality assumption, the hypothesis testing was continued using a parametric test, namely the paired-samples t-test.

Hypothesis Testing

The paired-samples t-test was used to determine whether there was a significant difference between the crescent kick ability of athletes before and after receiving varied lower-limb plyometric training.

Table 3.
Paired-Samples t-Test Results

Variable	Test	Mean	Mean Difference	t-count	df	Sig. (2-tailed)	t-table
Crescent Kick Ability	Posttest Pretest	21.73 16.87	4.86	8.72	14	0.000	2.145

Based on Table 3, the mean score of crescent kick ability increased from 16.87 in the pretest to 21.73 in the posttest, with a mean difference of 4.86. The t-test result showed that the t-count value was 8.72, while the t-table value at a significance level of 0.05 with 14 degrees of freedom was 2.145. Since the t-count value was higher than the t-table value, and the significance value was 0.000, which is lower than 0.05, the difference between the pretest and posttest scores was statistically significant.

These results indicate that varied lower-limb plyometric training had a significant effect on improving the crescent kick ability of Persinas ASAD pencak silat athletes in Gowa Regency. The increase in performance can be interpreted as the result of improved lower-limb explosive power, better neuromuscular coordination, stronger balance control, and faster kicking execution after the training program. Therefore, the research hypothesis is accepted: varied lower-limb plyometric training significantly improves crescent kick ability among pencak silat athletes.

Overall, the findings confirm that a structured plyometric training program can be used as an effective conditioning method to support technical performance in pencak silat, particularly in improving crescent kick execution. This result is practically important for coaches because the crescent kick requires not only technical mastery, but also strong physical support from the lower-limb muscles.

Discussion

The findings of this study demonstrate that varied lower-limb plyometric training significantly improved the crescent kick ability of Persinas ASAD pencak silat athletes in Gowa Regency. The descriptive results showed an increase in the mean score from 16.87 in the pretest to 21.73 in the posttest, with a mean difference of 4.86 points. In percentage terms, the individual performance improvement reached approximately 29.03%, indicating that the intervention was not only statistically meaningful but also practically relevant for pencak silat training. The paired-samples t-test further confirmed this improvement, as the t-count value of 8.72 was higher than the t-table value of 2.145, with a significance value of 0.000 < 0.05. Therefore, the research hypothesis is accepted: varied lower-limb plyometric training has a significant positive effect on crescent kick ability.

This finding is consistent with the theoretical foundation of plyometric training, which emphasizes the use of the stretch-shortening cycle to develop explosive muscular action. In pencak silat, the crescent kick requires rapid force production from the lower limbs, coordinated hip rotation, trunk control, balance, and accurate timing. Plyometric exercises such as box jumps, squat jumps, lateral jumps, and single-leg hops stimulate the neuromuscular system to produce force quickly, which is directly related to kicking speed and kicking frequency. This is in line with Slimani et al. (2016), who reported that short-term plyometric training performed two to three times per week can improve jump, sprint, and agility performance. Similarly, Suchomel et al. (2018) emphasized that muscular strength

and explosive power are essential qualities for athletic performance because they support acceleration, rapid movement, and forceful sport-specific actions.

The increase in crescent kick performance in this study can be explained through several physiological and biomechanical adaptations. First, plyometric training improves motor-unit recruitment and firing frequency, allowing athletes to produce stronger and faster contractions during kicking movements. Second, repeated explosive jumps improve tendon stiffness and elastic energy utilization, enabling more efficient force transfer from the lower limb to the striking foot. Third, unilateral drills such as single-leg hops develop balance and limb stability, which are essential when athletes kick while standing on one supporting leg. These explanations are supported by Kons et al. (2023), who found that plyometric training produces meaningful improvements in physical performance across different sports, and by Ramachandran et al. (2021), who showed that plyometric jump training can improve balance performance in healthy participants.

The result also strengthens previous evidence in youth and adolescent athlete populations. The participants in this study were adolescent pencak silat athletes aged 14–17 years, a developmental period in which neuromuscular adaptation can occur effectively when training is supervised and progressively structured. Chen et al. (2023) reported that plyometric training significantly improves jumping performance in adolescent athletes, while Ramírez-Campillo et al. (2023) found that plyometric jump training enhances maximal strength, sprint speed, horizontal jump ability, reactive strength index, and sport-specific performance in youth participants. Wu et al. (2025) also confirmed that plyometric jump training can improve children's sprint and jump performance. Therefore, the improvement found in this study is reasonable because the athletes received repeated explosive stimuli through 12 structured sessions over four weeks.

From a combat-sport perspective, the findings are also relevant. Combat sports demand explosive attacks, fast defensive reactions, body control, and technical precision. Ojeda-Aravena et al. (2023) reported that plyometric jump training improves physical fitness among combat-sport athletes, including strength, jumping ability, change-of-direction performance, and sport-specific actions. Yuan et al. (2025) further confirmed through meta-analysis that plyometric training effectively enhances muscle strength and power in martial arts athletes. These findings are closely connected to pencak silat because the crescent kick is not merely a technical movement, but a high-speed striking action that depends on explosive lower-limb force, coordination, and balance.

The empirical evidence in pencak silat studies also supports the result of this research. Setiawan et al. (2024) found that plyometric exercises improved sabit kick speed in pencak silat athletes. Hadisan (2024) reported a significant correlation between leg muscle explosive power and sickle kick ability, while Islam (2025) also showed that leg muscle explosive power is strongly related to sickle kick speed. Ahmad et al. (2026) reported that leg muscle explosive power contributed 53.1% to sickle kick speed, while balance contributed 45.7%. These findings confirm that the crescent kick requires more than technical repetition; it requires physical conditioning that specifically develops explosive power and postural control. In the present study, the use of varied lower-limb plyometric exercises addressed these needs by combining vertical, horizontal, and unilateral movement patterns.

The improvement in performance categories also provides an important practical interpretation. For example, athlete number 5, who was initially in the "very poor" category, improved to the "sufficient" category with an increase of 28.57%. Athlete number 7 reached the highest category, "very good," with 25 kicks in the posttest. These individual changes suggest that plyometric training improved not only the number of kicks performed within the test duration, but also the athletes' ability to execute the crescent kick more efficiently. In other words, the training effect was not merely quantitative but also qualitative. Better lower-limb explosiveness, improved balance, and more coordinated movement may have allowed athletes to kick faster without losing technical control.

The use of varied plyometric training is also important because pencak silat movements are multidirectional. The crescent kick involves curved movement, hip rotation, trunk stabilization, and rapid return to fighting stance. Therefore, training should not rely only on one type of jump. Moran et al. (2021) showed that horizontally oriented plyometric training is particularly useful for multi-vector sport performance, while Nobari et al. (2023) explained that both vertical and horizontal plyometric training

can improve sprint and change-of-direction performance. This supports the training model used in this study, which combined several lower-limb plyometric variations rather than using a single drill. Such variation likely helped athletes adapt to the dynamic movement demands of pencak silat competition.

The findings also have practical value for coaches. Plyometric training is relatively simple, inexpensive, and easy to apply in club-based training settings. It does not require sophisticated equipment, yet it can produce meaningful improvement when applied with correct technique, progressive overload, and adequate recovery. However, coaches must pay attention to landing mechanics, training volume, athlete maturity, and fatigue control. Hammami et al. (2016) showed that the sequencing of balance and plyometric training can improve physical performance in youth athletes, while Sañudo et al. (2019) emphasized that integrative neuromuscular training can support performance and injury prevention. Thus, plyometric training for adolescent pencak silat athletes should be implemented carefully, beginning with simple movements before progressing to more complex and unilateral drills.

Despite the significant findings, this study has limitations. The research used a one-group pretest-posttest design without a control group, so external factors such as regular technical training, motivation, or maturation cannot be completely excluded. The sample size was also limited to 15 athletes from one pencak silat club, which means that generalization should be made cautiously. Nevertheless, the statistical improvement, clear mean difference, and consistency with previous literature provide strong preliminary evidence that varied lower-limb plyometric training is effective for improving crescent kick ability.

Overall, the results of this study confirm that varied lower-limb plyometric training is an effective training method for improving crescent kick performance among Persinas ASAD pencak silat athletes in Gowa Regency. The improvement was reflected in the increase in mean score, the positive change in performance categories, and the significant result of the paired-samples t-test. Theoretically, the improvement is supported by neuromuscular adaptation, increased explosive power, better balance, and more efficient coordination. Practically, this training model can be recommended for pencak silat coaches as a structured conditioning strategy to improve kicking performance, especially for adolescent athletes who require explosive, fast, and accurate attacking techniques.

CONCLUSION

Based on the results of the study, it can be concluded that varied lower-limb plyometric training has a significant effect on improving the crescent kick ability of Persinas ASAD pencak silat athletes in Gowa Regency. The descriptive analysis showed a clear increase in performance after the training intervention. The mean score of crescent kick ability increased from 16.87 in the pretest to 21.73 in the posttest, with a mean difference of 4.86 points. This improvement indicates that the athletes were able to perform more kicks after completing the plyometric training program. In percentage terms, the increase reached approximately 29.03%, which reflects a meaningful improvement in kicking performance.

The normality test showed that both pretest and posttest data were normally distributed, allowing the use of parametric statistical analysis. The paired-samples t-test result showed a t-count value of 8.72, which was higher than the t-table value of 2.145 at a significance level of 0.05 with 14 degrees of freedom. The significance value was 0.000, which is lower than 0.05. Therefore, the research hypothesis is accepted, meaning that varied lower-limb plyometric training significantly improves crescent kick ability.

This improvement can be understood as the result of better explosive power, leg muscle strength, balance, coordination, and neuromuscular response developed through exercises such as box jumps and single-leg hops. These physical components are highly relevant to the execution of the crescent kick, which requires speed, power, accuracy, and body control. Thus, varied lower-limb plyometric training can be recommended as an effective training method for coaches to improve the technical performance of adolescent pencak silat athletes.

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