



The Effect of Rubber Tire Modification Training on the Speed of the Sickle Kick of Naga Kembar Pencak Silat Athletes of Pasangkayu District

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ABSTRACT

This study aims to determine the effect of tire modification training on increasing the speed of the sickle kick in Naga Kembar pencak silat athletes from Pasangkayu Regency. The method used was an experiment with a One-Group Pretest-Posttest Design. The research sample consisted of 20 athletes determined through a total sampling technique. The instrument used was a 15-second sickle kick speed test, adapted from the pencak silat sickle kick ability instrument developed by Kamarudin, Zulrafi, & Irma (2023). The intervention program was implemented for 15 meeting sessions with a frequency of three times per week for five weeks, lasting from April 11 to May 14, 2026. Data analysis used the Paired Sample T-Test assisted by JASP software. The results of the Shapiro-Wilk normality test showed a normal data distribution (pretest: $p = 0.371$; posttest: $p = 0.775$). The results of the hypothesis test showed a t value = -12.06, $df = 19$, and $p < 0.001$, so the null hypothesis was rejected. The average speed of the sickle kick increased from 17.25 to 20.80 (an increase of 20.58%), with Cohen's $d = 2.696$ which is included in the large effect category. The conclusion of this study is that tire rubber modification training has a significant effect on increasing the speed of the sickle kick of the Naga Kembar pencak silat athletes of Pasangkayu Regency and can be used as an economical alternative method for developing achievements at the regional level.

ARTICLE INFO

Article history:
Received 20 April,
2026
Revised 15 May
2026,
Accepted 29 June,
2026

Keywords: Modified Tire Rubber; Sickle Kick Speed; Resistance Training; Pencak Silat; Resistance Training

Journal Homepage <https://ojs.staialfurqan.ac.id/IJoASER/>

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INTRODUCTION

Pencak silat is a cultural heritage native to Indonesia, possessing artistic, spiritual, self-defense, and sporting values (Setiawan & Mulyana, 2023). In the context of modern pencak silat competitions, attack techniques are the primary determinant of points earned. Among the various attack techniques available, the crescent kick holds a strategic position due to its effectiveness in reaching the opponent's target through a circular, difficult-to-anticipate trajectory. This is supported by statistical analysis data from matches at the 2024 UNAIR Cup VII, where the crescent kick was recorded as the technique with the highest average success rate, at 7.3 times per match among the best athletes in its class (Aldiansah & Wahyudi, 2024).

The success of a sickle kick in a match situation is largely determined by the physical component of speed. Speed is the ability of the body or leg segments to produce movement in the shortest possible time. Without optimal speed, a sickle kick will be easily read,

anticipated, or avoided by an opponent. Therefore, coaches and sports trainers are required to be selective in selecting the appropriate physical training methods to support this technique's characteristics.

One innovative training method that can be applied to increase leg speed is resistance training based on modified rubber tires. Mechanically, rubber tires have high elasticity and spring force properties that are ideal for resistance training. When athletes perform kicking movements against the elastic pull of the rubber, the prime mover muscles (agonists) are forced to contract more strongly to generate explosive power. This dynamic load trains the neuromuscular system to recruit fast-twitch muscle fibers more efficiently (Markovic & Mikulic, 2010). Biomechanically, a similar mechanism is found in circular kicks in other martial arts: Saputri et al. (2022) proved that spring force training media significantly increased the speed of Mawashi Geri kicks in Shoto-Kai karate athletes in Bengkulu City, confirming the effectiveness of the elastic resistance principle for kicking techniques with rotational trajectories. Specifically in the context of pencak silat, Dahlan et al. (2025) found that leg muscle strength training significantly affected the speed of crescent kicks ($t = 11.158$; $p < 0.001$) in BKMF Pencak Silat FIKK UNM athletes. In line with that, Ali et al. (2026) emphasized that neuromuscular adaptation through resistive training is specific to the movement pattern being trained (principle of specificity) and is only optimal if the load given exceeds normal habits in a controlled manner (principle of overload), as found in ankle weight and resistance band training, both of which have been proven to increase the speed of the sickle kick of SMAN 2 Lamongan pencak silat athletes.

The application of resistance training using rubber materials specifically for pencak silat athletes at the regional level is still rarely scientifically documented, including among Naga Kembar athletes in Pasangkayu Regency. A common problem encountered in the field is the fluctuation in athletes' kicking speed performance during competition situations, which is partly due to limited variation in physical training programs. Furthermore, the use of manufactured resistance bands, as used in several previous studies, has a relatively high procurement cost for regional clubs.

Based on this background, this study aims to empirically determine the effect of tire modification training on increasing the speed of sickle kicks in Naga Kembar pencak silat athletes from Pasangkayu Regency. The results of this study are expected to provide theoretical contributions to the development of pencak silat coaching science and serve as a practical guide for coaches and athletes in optimizing physical performance using economical and accessible tools.

METHOD

Research Design

This study used a quantitative approach with an experimental method and a One-Group Pretest-Posttest Design. Through this design, the intervention's effects were measured by comparing the athletes' kicking speed before (pretest) and after (posttest) the training program. The research design can be described as follows:

$$O_1 \rightarrow X \rightarrow O_2$$

Description: O_1 = Pretest; X = Intervention; O_2 = Posttest

Population and Sample

The study was conducted at the Naga Kembar Pencak Silat Padepokan, Pasangkayu Regency, from April 11 to May 14, 2026. The study population was homogeneous, comprising all active athletes training at the padepokan. Total sampling was used, with all members of the population who met the inclusion criteria being included as research subjects, with a total of 20 athletes.

Operational Definition and Research Instruments

The independent variable in this study was tire modification training, a physical

intervention using elastic load media from modified used tires that were attached to the athlete's dominant ankle to provide resistance when the athlete performed the sickle kick movement. The dependent variable was sickle kick speed, which was the athlete's leg motoric ability to repeatedly perform a circular (crescent) kick trajectory hitting the target in the shortest possible time.

The measurement instrument used was the 15-Second Crescent Kick Speed Test (adapted from Kamarudin, Zulraflī, & Irma, 2023). The final score was determined based on the number of valid kicks hitting the target with the correct trajectory technique within 15 seconds. Supporting equipment included a pencak silat mat, a kicking target (kick pad), a stopwatch, and a scoring sheet.

Experimental Implementation Procedures

Pretest Stage

Athletes performed a standard warm-up for 15 minutes, then performed a 15-second crescent kick speed test without additional load to obtain baseline ability data before the intervention.

Intervention Stage

The tire modification training program was provided in 15 sessions outside the initial and final test sessions, with a frequency of three times per week (Monday, Wednesday, and Friday) at 15.00 WITA. The total duration of each session was 45–60 minutes, including a warm-up (15 minutes) in the form of light cardio activity and dynamic stretching; core training in the form of a crescent kick movement with tire resistance for 3 sets × 10 repetitions focused on the dominant leg; and a cool-down (10 minutes) in the form of static stretching and daily performance evaluation.

Posttest Stage

After completing the entire intervention program, athletes were retested using identical protocols and instruments to the pretest phase.

Data Analysis Techniques

The data were processed using JASP statistical software in two stages. First, the Shapiro-Wilk method (with a threshold of $p > 0.05$ as a requirement for normal distribution) was used, chosen considering the small sample size ($N = 20$) was used for normality testing. Second, the hypothesis was tested using the Paired Sample T-Test after the normality assumption was met, with the alternative hypothesis (H_a) being accepted if the p value was < 0.05 . The effect size was calculated using Cohen's d coefficient, with the following interpretations: small ($d < 0.2$), medium ($0.2 \leq d < 0.8$), and large ($d \geq 0.8$).

RESULT AND DISCUSSION

Research result

A series of experiments were conducted at the Padepokan Naga Kembar, Pasangkayu Regency, for one full month (April 11–May 14, 2026). Data were collected from $N = 20$ athletes through three stages: initial ability measurement (pretest), 15 sessions of elastic weight training intervention programs based on modified rubber tires, and final ability measurement (posttest).

Individual Data of Research Subjects

Table 1. Data on the Results of the Crescent Kick Speed Test for All Research Subjects

No	Athlete Name (Initials)	Pretest	Posttest	Difference
1	FL	16	20	4
2	AN	18	22	4

No	Athlete Name (Initials)	Pretest	Posttest	Difference
3	SF	15	18	3
4	RT	17	23	6
5	YT	20	24	4
6	TU	16	20	4
7	TT	19	23	4
8	RT	14	17	3
9	UI	17	19	2
10	WR	21	25	4
11	WE	15	19	4
12	TR	18	21	3
13	TY	20	22	2
14	YH	16	21	5
15	IU	17	22	5
16	OP	19	23	4
17	BO	14	18	4
18	RK	18	20	2
19	US	20	24	4
20	KP	15	15	0
Amount		345	416	71
Average (Mean)		17.25	20.80	3.55

Source: Primary Research Data (2026)

Based on Table 1, all athletes showed improvement or similar scores between the pretest and posttest. One subject (KP, No. 20) achieved identical scores on the pretest and posttest (15 kicks), reflecting the objectivity of data collection. Overall, the accumulated kick frequency increased from 345 to 416 kicks, a total difference of 71 kicks.

Descriptive Analysis and Normality Prerequisite Test

Table 2. Descriptive Statistics and Results of the Shapiro-Wilk Normality Test

Variables	N	Mean	Standard Deviation	Shapiro-Wilk	p-value	Min	Max
Pretest	20	17.25	2,124	0.950	0.371	14	21
Posttest	20	20.80	2,608	0.971	0.775	15	25

Source: JASP Output (2026)

Based on the analysis results in Table 2, the pretest data produced a Shapiro-Wilk coefficient value of 0.950 with a significance of $p = 0.371$, while the posttest data produced a Shapiro-Wilk value of 0.971 with a significance of $p = 0.775$. Considering that both probability values were consistently above the threshold of $\alpha = 0.05$, it is concluded that the sickle kick speed data is normally distributed. The fulfillment of this normality assumption provides legitimacy to continue hypothesis testing using parametric statistics.

Hypothesis Testing

Table 3. Paired Sample T-Test Results and Effect Size (Cohen's d)

Variable 1	vs	Variable 2	t-count	df	p-value	Cohen's d	Category
Pretest	-	Posttest	-12.06	19	< 0.001	2,696	Large

Source: JASP Output (2026)

Based on the analysis results in Table 3, the t value = -12.06 was obtained with degrees of freedom (df) = 19 and a probability of $p < 0.001$. The negative values of t and Cohen's d reflect the direction of the calculation (Pretest – Posttest); the absolute value $|d| = 2.696$ is used for interpretation. Considering the p value is much smaller than the specified significance parameter ($p < 0.05$), the null hypothesis (H_0) is rejected and the working hypothesis (H_a) is accepted.

The average sickle kick velocity increased from 17.25 to 20.80 repetitions per 15 seconds, a percentage increase of 20.58%. The |Cohen's d | value of 2.696 falls within the large effect category ($d \geq 0.8$), proving that this increase has strong practical significance and is not simply a product of statistical chance.

Discussion

The empirical findings in this study confirm that a training program using modified rubber tires has a significant positive impact on the acceleration of athletes' sickle kick speed. From a sports physiology perspective, this improvement in motor performance is closely related to the elastic resistance training mechanism, which triggers the principle of progressive overload. When the athlete's legs swing in a circle against the elasticity of the rubber tire, the primary driving muscle groups—such as the quadriceps femoris, hamstrings, and ilio-psoas—are forced to contract more strongly to overcome dynamic tension proportional to the distance of the stretch.

Repeated mechanical loading over 15 training sessions stimulates functional adaptation of the neuromuscular system. This process accelerates motor unit recruitment and triggers the activation of fast-twitch muscle fibers (types IIa and IIx), which play a dominant role in producing explosive movements (Markovic & Mikulic, 2010). This finding aligns with research by Saputri et al. (2022) which demonstrated that spring-style training significantly increased the speed of the Mawashi Geri kick in karate—a technique with a rotational biomechanical pattern analogous to the sickle kick in pencak silat. Broader empirical support was provided by Gaamouri et al. (2023) in a randomized controlled trial of female adolescent handball athletes, who found that 10 weeks of elastic band training significantly increased peak power and muscle contraction speed in the legs and arms, with the mechanism of performance improvement being more due to neural adaptations—such as motor unit activation, synchronization, and rate coding—than solely muscle hypertrophy.

The effectiveness of this method is also supported by the principle of movement specificity. Unlike static weight training, the tire modification allows athletes to execute the crescent kick trajectory according to its natural biomechanics. When the device is removed during the posttest, athletes experience the phenomenon of Post-Activation Potentiation (PAP), a condition in which the central nervous system remains accustomed to sending high-level contraction signals, enabling the athlete's legs to move at a more optimal speed (Wilson et al., 2013).

This finding is also consistent with the results of research by Dahlan et al. (2025) on BKMF Pencak Silat FIKK UNM athletes, where the group given leg muscle strength training showed a significant increase in sickle kick speed ($t = 11.158$; $p < 0.001$) and was statistically significantly different compared to the control group ($t = 4.562$; $p < 0.001$), proving that the increase in performance was not caused by maturation factors alone, but rather a direct impact of the training intervention. Similarly, Ali et al. (2026) found that resistance band training in pencak silat athletes from SMAN 2 Lamongan consistently increased sickle kick speed (mean gain = 10.67), a result that is in line with the principle that elastic resistance provides a mechanical stimulus that is closer to the functional movement pattern of the kick than static loads.

Compared to the research of Muhtadin & Syarif (2026) who used commercial resistance bands and obtained significant results in increasing the acceleration of the sickle kick, this study found comparable results with an even higher effect size value ($|d| = 2.696$). The novelty of this study lies in the empirical proof that economical modification of used tire rubber can produce equivalent, or even more optimal, physical performance output. This is a very relevant alternative solution for pencak silat clubs at the regional level that have limited budgets for procuring training equipment.

A consistent three-times-per-week training schedule combined with an adequate recovery ratio has been shown to bring athletes' muscle tissue into a supercompensation phase, resulting in a gradual increase in functional capacity each week. These findings confirm that consistency and periodization are key factors in a successful physical training program.

CONCLUSION

Based on the research results and discussions that have been described, it can be concluded that there is a significant effect of the application of tire rubber modification training on increasing the speed of the sickle kick in Naga Kembar pencak silat athletes from Pasangkayu Regency ($t = -12.06$; $df = 19$; $p < 0.001$). The average speed of the sickle kick increased by 20.58%, from 17.25 to 20.80 repetitions per 15 seconds, with a Cohen's d value of 2.696 which is included in the large effect category. This research provides empirical evidence that modifying used tires is an economical, accessible, and effective alternative resistance training method for developing pencak silat performance at the regional level. The use of this local material could be a practical solution for clubs with limited budgets for training equipment.

Although the results of this study provide significant findings, there are several limitations that need to be acknowledged. First, the One-Group Pretest-Posttest study design without a control group limits the study's ability to isolate the intervention effect from other factors, such as athlete maturation, the effects of regular training outside the program, and history effects. This limitation was chosen pragmatically considering the limited population of 20 athletes at Padepokan Naga Kembar. Second, this study only measured kicking speed as the only dependent variable, so the effect of training on other physical aspects such as leg explosiveness and kicking accuracy cannot be concluded.

Future research is recommended to use an experimental design with a control group to strengthen internal validity, as demonstrated by Dahlan et al. (2025), who successfully demonstrated significant differences between the treatment and control groups. Furthermore, expanding the scope of measured dependent variables, such as explosive power and kicking accuracy, would provide a more comprehensive picture of the effects of tire modification training.

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