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Progressive upper-body resistance training improves straight punch frequency-speed (punches per 10 s) in pencak silat athletes: a four-week pretest-posttest study

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ABSTRACT

This study examined whether a four-week progressive upper-body resistance training program improves straight punch frequency-speed in club-level pencak silat athletes, for whom sport-specific upper-limb training evidence is scarce. A one-group pretest-posttest quasi-experimental design was used. Twelve athletes (aged 14 years or over, at least one year of training experience, injury-free) were purposively selected from 65 active club members in Padang, Indonesia. Participants completed 16 supervised sessions (four per week for four weeks) combining progressively loaded bench press, shoulder press and triceps extension (60% to 75-80% 1RM) with explosive transfer work (explosive push-ups, medicine-ball chest passes and throws, plyometric push-ups). The outcome measure was the number of legal straight punches delivered to a bag in a maximal 10 s effort, scored by the same rater under an identical protocol at both time points. Both distributions were normal (Shapiro-Wilk $p = 0.561$ and $p = 0.190$) and were analysed with a paired-samples t test ($\alpha = 0.05$). Punch frequency rose from 46.33 ± 5.84 to 54.00 ± 3.52 punches/10 s, a mean gain of 7.67 punches (16.6%; 95% CI 5.25 to 10.08), $t(11) = 6.99$, $p < 0.001$, Cohen's $d_z = 2.02$ (95% CI 1.00 to 3.01); between-athlete variability also fell significantly (Pitman-Morgan $t(10) = 2.67$, $p = 0.024$). Progressively loaded upper-body training with explosive transfer work therefore appears to be a practical, low-cost way of raising punch frequency-speed in pencak silat, most plausibly through early neural adaptation. Because the design was uncontrolled and the sample small, these findings are preliminary and require confirmation in randomised controlled trials.

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Introduction

The place combat sports are taking in international competitions and those leading to Olympic participation are becoming very pronounced. pencak silat, on the one hand, is a traditional Indonesian martial art that used to just be for self-defence and for cultural enjoyment but is now a codified, internationally governing competitive sport that is played at multi-sport games throughout Southeast Asia. Sparring (tanding) is one of the contemporary styles of pencak silat performance and it requires the simultaneous demonstration of technical expertise, tactical foresight, and the physical attributes such as strength, speed, and integrated bodily power resulting from training, which, in addition to the skill, will determine success of a competitor.

The straight punch in pencak silat technique has always been a common weapon in the offensive arsenal of martial artists because their linear movement gives athletes control over the fight tempo, as well as the opportunity to score with a relatively risk-free, high-frequency action. Fast delivery of the straight punch is a key tactical factor: quick execution minimizes the reaction, dodging or countering window of the opponent, resulting to higher chance of scoring the point. Consequently, the rate at which one strikes a straight punch is not only a technical feature but also a physical ability that coaches have to teach and keep track of in training programs. Existing descriptions of the pencak silat straight punch nevertheless remain largely kinematic and observational (Hidayat & Sugiharto, 2024; Lubis & Wardoyo, 2014); they document how the technique is executed but do not establish how much of the between-athlete variance in punch speed is trainable through conditioning, which is the question a coach actually faces when allocating training time.

In terms of biomechanics and neuromuscular aspects, a straight punch speed is hardly dependent upon only arm strength; indeed, it results from the action of proximal to distal kinetic chain in which the force is generated through leg motion, increased with hip and trunk rotation, then transferred through the shoulder, and lastly the elbow is stretched to complete the action. The ability to do so quickly is also due to characteristics of muscle nerves such as recruitment of motor units, rate of discharges, and coordination of muscles, all of which can be altered through practice. Resistance exercise is considered to speed up those nervous system adaptations, which is even before significant growth takes place and, therefore, enables a quicker activation of the target muscles during, for instance, hitting. These mechanisms are experimentally documented rather than assumed: four weeks of strength training changes motor unit recruitment thresholds and discharge rates before measurable hypertrophy occurs (Del Vecchio et al., 2019), and the direction of those adaptations is specific to the contraction velocity that is trained (Del Vecchio et al., 2022). Comparable neuromuscular transfer from loaded and ballistic training to sport-specific striking capacity has been reported across combat-sport populations (Ojeda-Aravena et al., 2023). Narrative reviews of punching biomechanics converge on the same proximal-to-distal description, identifying leg drive and hip-trunk rotation as the principal contributors to fist velocity that the upper limb then transmits and refines (Lenetsky et al., 2013), and profiling reviews of amateur boxing similarly report that both upper- and lower-body muscular strength are central physical determinants of striking performance (Chaabène et al., 2015).

Weight training with gradually increasing resistance is one of the most commonly used techniques among strength and conditioning coaches. Resistance training has a potential, via changes in loading, movement volume, and velocity, to target various components of strength such as pure (maximal) strength, force-generation speed (rate of force development). Striking sports athletes mostly work on the power system through upper-body resistance exercises like bench press and shoulder pressing. The athletes incorporate medicine-ball and plyometric work in a hope that they will convert their strength gains into fast sport movement patterns for the better performance.

Many examples from boxing and other combat sports support this theory. A series of reviews looking at resistance training in athletes has consistently found that strength, jump, and sprint performance improve following structured programs (Baena-Marín et al., 2022; Loaiza-Betancur et al., 2026), and similar results have been obtained for throwing- and power-based team-sport actions (Bragazzi et al., 2020). In boxing, several well-controlled studies have shown that resistance-based training, no matter if it is a blood-flow restricted low load protocol, variable-resistance complex training, or contrast training consisting of heavy lifts and medicine-ball throws, produces significant increase in punch force/power, punch power, or punch speed after a period of training of four to eight weeks (Awana et al., 2025; Finlay, 2025; Liu et al., 2024; Pinto et al., 2026). Broader systematic reviews of Olympic combat-sport athletes reach the same conclusion, reporting that structured strength training reliably improves physical fitness qualities linked to match performance across striking and grappling disciplines alike (Cid-Calfucura et al., 2023; Kons et al., 2021). In pencak silat, most intervention studies have focused on leg explosive power and kicking speed, for instance, plyometric and circuit-based programs directed towards the sickle or front kick (Ahmad et al., 2026; Lubis et al., 2024), compared to the straight punch, there has been little upper-body resistance training research on it.

This gap in the literature, due to one-sided reporting is a very real research problem. Despite the fact that the neuromuscular mechanisms underlying resistance-training-induced punch-performance gains have been largely elucidated by boxing and other international combat sports, it is as-yet unknown if such a comparable short-term, progressively loaded upper body workout regimen can result in punch speed improvement on-the-record among pencak silat athletes that are club (perguruan) level athletes, who are typically limited as to their access to laboratory-grade force plates or velocity-based training technology. This issue has yet to be experimentally determined The majority of available pencak silat fitness and conditioning research also focuses on general fitness measures instead of one that is related to the specifics of the sport like the punch-frequency limit for a certain time period that reflects the requirements of actual sparring exchanges. Stated argumentatively, the existing evidence cannot answer the present question for three reasons. First, the boxing studies that demonstrate resistance-training transfer measure punch force, impact power or single-punch velocity, whereas scoring in tanding depends on repeated-punch frequency, which is a different performance construct. Second, the available pencak silat intervention studies manipulate lower-limb explosive power, so their findings cannot be extrapolated to the upper-limb kinetic chain without evidence. Third, both literatures depend on laboratory instrumentation that is unavailable at perguruan level, so the dose-response information they yield is not directly usable by club coaches. The present study is designed to close that specific gap.

The current study fills in the missing link by measuring how a structured four-week progressive resistance training block as well as the effect of, in the case of athletes from pencak silat perguruan would improve their punch speed in straight punches, through a 10-second field-based maximal punch test. We believe that this study is one of the very first to introduce a combination of percentage-of-one-repetition-maximum progression with explosive power exercises to achieve the most power from the straight punch in this athlete group. We further explain the resulting increase through the use of effect size and confidence interval estimates which will enable comparisons with the larger combat-sports sports strength and conditioning studies.

Thus, the main purpose of this research study was to see how a 4-week gradually increasing weights workout programme for upper body affects straight punch speed of pencak silat players at Perguruan Empat Banding Budi Air Tawar Timur, Padang, Indonesia, and then to estimate how strong this effect was by using standard statistical measures. Straight punch speed was operationally defined as the number of legal straight punches delivered to a punching bag during a maximal 10 s effort (punches/10 s), scored by the same rater under an identical protocol at pretest and posttest. Two hypotheses were tested: H1, posttest punch frequency would be significantly higher than pretest punch frequency; and H2, between-athlete variability in punch frequency would be significantly reduced after the training block. Because a single-group design cannot separate the training stimulus from concurrent technical practice, test familiarisation and maturation, these confounders were controlled procedurally as far as the setting allowed (identical test protocol, the same rater at both time points, and no change to the club's technical training schedule during the block) and are examined explicitly in the Discussion and Limitations.

Methods

Research Design

We conducted a pre-and post-test quasi-experimental design study on one group. We chose this design as our study is to find proof-of-concept evidence for a within-subject training effect of a group of athletes with a very small size and intact composition at one training location. In a non-training control condition it was neither logical nor feasible to assign the study subjects by means of randomization. The club constituted a single intact training squad in which every member follows one common technical programme, so withholding the conditioning block from part of that squad would have been contaminated by daily contact between groups and would not have been accepted by the coaching staff during competitive preparation. A within-subject design was therefore selected as the appropriate first step for estimating the magnitude of the effect and for generating the variance estimates needed to power a subsequent controlled trial. The study flow was as follows: screening of the source population (n = 65), eligibility assessment against the inclusion criteria, pretest in Week 0, the four-week intervention across Weeks 1 to 4 comprising 16 supervised sessions, and posttest in Week 5; all 12 enrolled athletes completed both measurement points, so there was no attrition.

Participants

The source population consisted of 65 athletes who were affiliated with the Empat Banding Budi Air Tawar Timur pencak silat school inPadang, Indonesia. Participants who were selected after the eligibility criteria were checked through a purposive sampling technique are: (a) actively and regularly participating in training sessions; (b) aged 14 years or above (adolescent-to-adult category); (c) having a minimum of one year of pencak silat training experience; and (d) injury-free at the time of testing. The application of these criteria ended up with the recruitment of 12 athletes for the study.

Sampling Technique

Purposive sampling, a non-probability technique in which participants are deliberately selected because they possess characteristics relevant to the research question rather than through random selection, was conducted in this manner, giving precedence to athletes fulfilling all the inclusion criteria simultaneously, instead of random selection for the reasons of practical feasibility and to recruit all participants from a single club as well as the need to ensure participants could safely complete a resistance training program of a predetermined structure (Etikan & Bala, 2017). Because no previous study had reported the change in punch frequency after upper-body resistance training in pencak silat, an a priori power analysis based on an expected effect size was not possible, and a sensitivity analysis was conducted in its place. With n = 12, alpha = 0.05 (two-tailed) and power set at 0.80, the smallest within-subject effect detectable in this design is dz = 0.89, which corresponds to a mean change of approximately 3.4 punches/10 s. The study was therefore adequately powered for large effects only and is framed explicitly as a pilot/feasibility investigation: smaller but still practically meaningful changes could have gone undetected. The selection bias introduced by purposive sampling, and the consequent restriction of inference to trained, injury-free club athletes of this profile, is addressed in the Limitations section.

Intervention

The independent variable included a four-week upper-body resistance training program that included four sessions per week and was progressive. The program focused on the primary muscle groups for a straight punch propulsion (large pectorals, front deltoids, triceps, and abdominal muscles). Training began with acquiring basic technique on low intensity and gradually moved up towards the high-intensity, high-velocity exercises, according to the principle of progressiveoverload:

Table 1. Four-Week Progressive Upper-Body Resistance Training Program

Week	Primary lifts	Sets × reps	Intensity	Explosive/transfer component
1	Bench press, shoulder press, triceps extension	3 × 12	60% 1RM	Explosive push-ups (3 × 8)
2	Bench press, shoulder press, triceps extension	3 × 10	65% 1RM	Medicine ball chest pass, 2-4 kg (3 × 8)
3	Bench press, shoulder press, triceps extension	4 × 8	70% 1RM	Plyometric push-ups (3 × 6)
4	Bench press, shoulder press, triceps extension	4 × 6	75-80% 1RM	Medicine ball chest throw, 2-4 kg (3 × 6)

Table 1. Summary of the four-week progressive resistance training program. Inter-set recovery increased from 60 s (Week 1) to 90 s (Weeks 3-4) in parallel with rising intensity. 1RM = one-repetition maximum.

Every time, there would be a 10-15 minutes, standardised warm-up that the subjects would first perform. After the training, they would cool down to prevent them getting injuries. During all the exercise sessions, not only the athletes' coaches but also the research team members were present, which allowed them to monitor and control the technical aspect and loading prescriptions of the activities.

Testing Protocol and Outcome Measurement

The independent variable, straight punch speed, was measured as the number of legal straight punches an athlete could do in 10 seconds, alternating hands, onto a Punching bag. Picking a maximal effort time of 10 seconds was based on exercise physiology standards that the main source of power for all out work during this period relies on the alactic anaerobic (ATP-PC) system such that score obtained is largely indicative of frequency-speed capacity at maximum levels with minimal lactated induced fatigue effects. Participants, after warming up as per the set instructions, got themselves in a guard stance ready to fight before the bag; the timer set by the researcher started with a signal from his side and participants punched as hard as they could for the duration of the test, a punch counted as legitimate only when the elbow was full extended at impact point of the hand and the arm has returned to the guard position before a new punch is thrown. The exact same test procedure and researcher was followed at pretest (before the four-week program) and posttest (after the program was completed). Testing used a standard hanging punching bag and a digital stopwatch with a resolution of 0.01 s, with bag height and the distance of the athlete from the bag standardised for every trial. The 10 s duration follows the exercise-physiology rationale that all-out work of this length is supplied predominantly by the alactic anaerobic (ATP-PC) system (Fox et al., 1993), and the count-based punch speed test itself follows established Indonesian sport testing practice (Widiastuti, 2015). All counts at both time points were made by the same trained researcher working from the same written counting criteria, and those criteria were rehearsed with each athlete before testing. Formal reliability coefficients, such as intra-class correlation coefficients for repeated counts, were not computed in this study; measurement consistency therefore rests on protocol standardisation rather than on quantified rater agreement, and this is recorded as a limitation.

Statistical Analysis

Descriptive statistics (mean, standard deviation, minimum, maximum) were used to analyse data. The Shapiro-Wilk test was employed to test the hypothesis whether pretest and posttest scores showed a normal distribution this type of test is suitable when the size of the sample is less than 50. As in both cases, the departure from normality was not statistically significant, a paired-samples t test was used to assess the effect of pre- to post-training on the speed of the straight punch, with statistical significance defined as $\alpha = 0.05$. In addition, the null-hypothesis significance test was complemented by calculation and interpretation of 95% confidence interval of the mean difference, the percentage improvement over the pretest, and Cohen's dz (mean difference divided by the standard deviation of the difference scores, which is a suitable measure in a case of repeated-measures designs) using well-known effect-size conventions, small ≈ 0.20, medium ≈ 0.50, and large ≥ 0.80. Cohen's dz was computed as the mean of the difference scores divided by the standard deviation of the difference scores (dz = 7.67 / 3.80), which is the recommended standardiser for within-subject designs (Lakens, 2013), and its 95% confidence interval was obtained from the non-central t distribution. Because the two sets of scores are paired rather than independent, the reduction in between-athlete variability was tested with the Pitman-Morgan test for correlated variances rather than with Levene's test, which assumes independent samples; the pretest-posttest correlation required for that test was derived from the reported standard deviations (r = 0.78).

Ethical Considerations
All participant were fully informed about the study (and in case of under 18 years old participants, their parents/legal guardians). Informed consent was signed by participants and their parents/legal guardians after giving a full explanation of the study and the participants' voluntary withdrawal right. All procedures were described to participants (and, for minors, to the parents or legal guardians) before they enrolled and a voluntary written informed consent (or parental/guardian consent with participant assent for athletes under 18 years) was the means of obtaining agreement. Such a mode of consent is compatible with the ethical principles for research based on involvement of human participants described in the Declaration of Helsinki. The athletes participated on a voluntary basis and were under no obligation to continue once they made the decision to participate. The academic research team led by the Department of Sports Coaching Education, Faculty of Sport Science of Universitas Negeri Padang conducted this study.

Results and Discuss

Results
Descriptive statistics for the pretest and posttest straight punch speed scores are displayed in Table 2. The average straight punch rate went up 7.67 punches as a result of the intervention. Moreover, the standard deviation of the scores decreased from pretest to posttest, indicating lower dispersion in the dataset. This descriptive observation was tested formally rather than assumed: the Pitman-Morgan test for correlated variances confirmed that the reduction in between-athlete variability was statistically significant, t(10) = 2.67, p = 0.024 (variance ratio F = 2.75; pretest-posttest r = 0.78).

Table 2. Descriptive Statistics of Straight Punch Speed Before and After the Resistance Training Program

Variable	n	Minimum	Maximum	Mean	SD
Pretest (punches/10 s)	12	38	56	46.33	5.84
Posttest (punches/10 s)	12	46	60	54.00	3.52

Table 2. Descriptive statistics for straight punch speed before and after the four-week resistance training program.

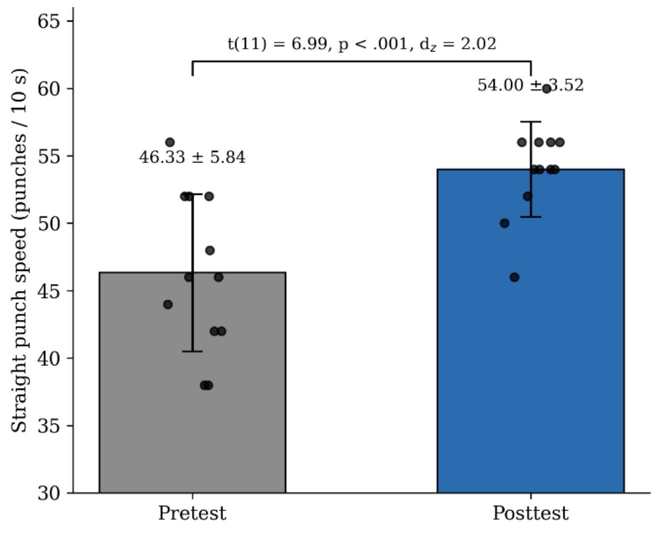

Figure 1. Changes in Straight Punch Speed from Pretest to Posttest Following the Resistance Training Program

Figure 1. Mean (± SD) straight punch speed at pretest and posttest. Black dots represent individual athletes (n = 12, jittered horizontally for visibility). The bracket denotes the result of the paired-samples t test.

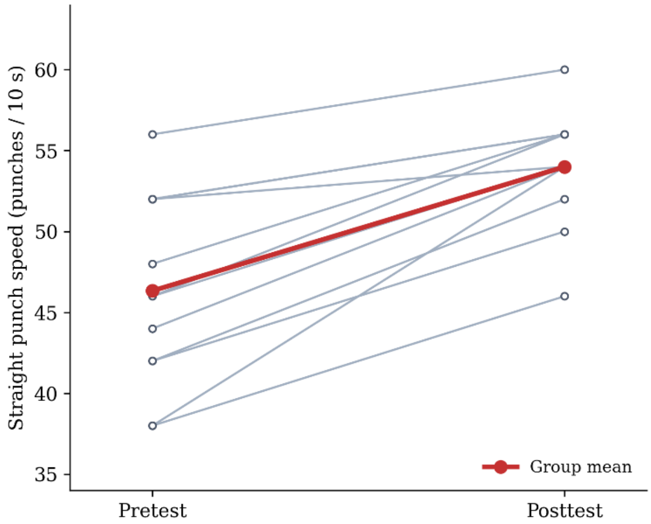

Figure 2. Individual and Group-Mean Changes in Straight Punch Speed from Pretest to Posttest

Figure 2. Individual (grey) and group-mean (red) change in straight punch speed from pretest to posttest for each of the 12 athletes, illustrating that all athletes improved and that between-athlete spread narrowed after training.

The normality of the pretest and posttest distributions was ascertained by means of the Shapiro-Wilk test (Table 3) and therefore the use of a parametric paired-samples t test for the main hypothesis testing was confirmed.

Table 3. Shapiro–Wilk Test of Normality for Pretest and Posttest Straight Punch Speed Scores

Variable	Shapiro-Wilk statistic	df	p
Pretest	0.945	12	0.561
Posttest	0.906	12	0.190

Table 3. Shapiro-Wilk test of normality for pretest and posttest scores. $p > 0.05$ indicates no significant departure from a normal distribution.

The paired-samples t test showed a statistically significant increase in straight punch speed after the intervention (Table 4). The 95% confidence interval for the mean difference did not include zero. Furthermore, the within-subject effect size was calculated as Cohen's dz = 2.02, which is more than a large effect size, revealing both the strength and the practical size of the change in this sample. This value was obtained by dividing the mean difference (7.67 punches/10 s) by the standard deviation of the difference scores (3.80), following Lakens (2013); its 95% confidence interval, derived from the non-central t distribution, ranged from 1.00 to 3.01, so even the lower bound of that interval corresponds to a large effect.

Table 4. Paired-Samples t-Test Results Comparing Pretest and Posttest Straight Punch Speed

Pair	Mean difference	SD of difference	95% CI (lower, upper)	t	df	p	dz
Pretest − Posttest	−7.67	3.80	−10.08, −5.25	−6.99	11	< 0.001	2.02

Table 4. Paired-samples t test comparing pretest and posttest straight punch speed. The negative sign reflects the pretest-minus-posttest ordering of scores; the posttest mean was higher than the pretest mean. dz = Cohen's d for repeated measures (mean difference / SD of the difference scores).

In general, straight punch speed rose from an average of 46.33 punches per 10 seconds to 54.00 punches per 10 seconds, which was an improvement of 16.6% over baseline (95% CI 5.25 to 10.08 punches/10 s). Furthermore, it seems that a training effect was the cause of this increase and was rather consistent across all the participants because both the size of the mean change and the decreasing level of standard deviation indicate that the posttest results are quite homogeneous.

Additionally, a norm-referenced secondary performance classification (five-level benchmarking scale) was used to get an understanding of how athletes' actual performance levels have changed at an individual level. In the beginning, most athletes were in either Fair or Poor levels (33.3% each), 25% were Good, and 8.3% were Very Good, and there was no Very Poor level athlete. After the training period, the majority of the distribution was centered around the Fair category (66.7%), with the share of the Poor category athletes dropping to 16.7%. Additionally, 8.3% of the athletes were classified as Good, and even though the majority of the groups improved it turned up that one athlete (8.3%) had gone to the Very Poor category at the posttest (see Fig. 3) which is an example of variability of different individual outcomes that are primarily, but not completely, positive.

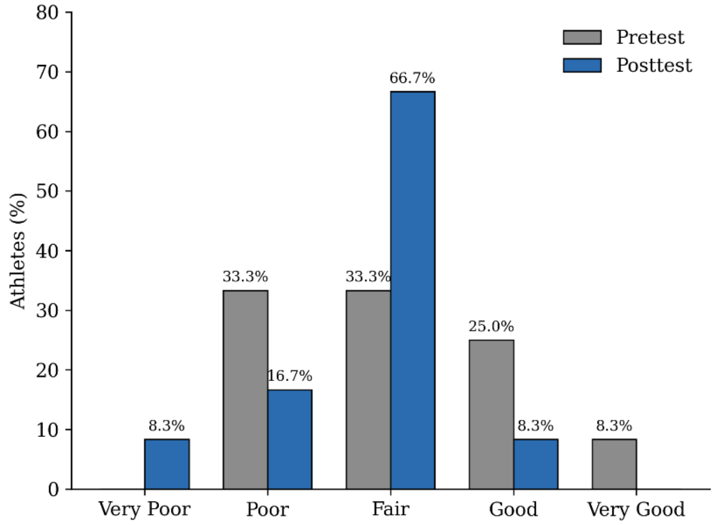

Figure 3. Distribution of Athletes Across Performance Categories at Pretest and Posttest

Figure 3. Distribution of athletes across norm-referenced performance categories at pretest and posttest, based on a standard-deviation-based five-category benchmarking scale.

All in all, the group-level, individual-level, and categorical findings agree with the same result: straight punch speed went up continuously after the 4 weeks of resistance training among most of the athletes. The effect sizes within the same subject were quite big.

Discussion

The purpose of this experiment was to check if a short-term, gradually increasing, upper-limb exercise intervention could enhance straight punch speed in pencak silat athletes who have training at the club level. We found statistically significant, and in addition a very huge change in the number of straight punches delivered within 10 seconds. After 4 weeks of training, the average score increased by 16.6% while the differences between the players at each testing stage became smaller. The findings of this study add empirical, sport-specific evidence to a literature in combat-sports that is more concerned with punch force or punch kinetic impact in boxing over punch frequency-speed in pencak silat. It is worth being explicit about why this is a distinct contribution rather than a restatement of the boxing findings. Punch force and impact power are single-effort kinetic outputs that depend chiefly on the effective mass and velocity of the striking limb at contact, whereas punch frequency-speed in tanding is a repeated-effort capacity constrained by the rate of force development, the speed of the return to guard and the alactic energy supply. The two constructs are related but not interchangeable, and evidence that resistance training raises the former does not by itself establish that it raises the latter. Making that inferential step is precisely what the present study contributes.

The observed magnitude of change here (dz = 2.02) is at the top of the scale; it aligns with the directions of effect sizes that have been found in resistance-training interventions on short periods of punch performance in boxing. For illustration, an eight-week BFR regimen brought huge to very-large boosts of peak punch force over several punch types (Awana et al. 2025), a six-week variable-resistance complex-training program led to very large increments in single-punch speed, force, and power in top female boxers (Liu et al., 2024), and eight weeks of contrasting types resistance training linear- vs. rotational-produced significant punch impact power improvements which were especially noticeable in punches that had the same biomechanics as the trained movements (Pinto et al., 2026). Also, an intensive, four-week contrast-training program was demonstrated to boost punch-related physical skills at the level of professional boxers, who were just about to participate in a competition (Finlay, 2025), suggesting the probability of achieving notable adaptation within the same period of four weeks that the current research has used. This pattern is also consistent with the broader boxing punching-force literature, which identifies both maximal and explosive strength qualities of the upper and lower body as the physical determinants most closely associated with punch impact (Beattie & Ruddock, 2022; Loturco et al., 2016) and traces those determinants back to the same leg-driven, proximal-to-distal force pathway (Lenetsky et al., 2013). The present combined loading-plus-transfer approach also stands in useful contrast to at least one boxing trial in which four weeks of plyometric training with external weights alone did not significantly change maximal punching movement frequency, even though it improved punching power endurance (Bruzas et al., 2018), suggesting that the addition of progressively loaded strength work, rather than explosive work alone, may be what drove the frequency-speed gain observed here.

It has been suggested that the change in the performance at the initial stage is most probably due to neural adaptation rather than physical enlargement because of the shortness of intervention. Brief resistance training has been reported numerous times that the muscle force can be increased through an increased number of motor units and the rate of firing of the nerves at a level that would take weeks even before the first hypertrophy would be achieved (Del Vecchio et al., 2019). On the other hand, a study of closely related phenomena has shown that the increment in maximal force after a brief period ofstrength training may come from changes purely in the nervous system rather than in muscles, and the exact type of change in the system will depend on the kind of training which, for instance, may be a quick or a slow contraction (Del Vecchio et al., 2022). This velocity sensitivity helps in understanding the results we have here: since the program first used slower, technique-oriented lifts and gradually moved towards explosive medicine ball and plyometric actions which were to be performed at a very high speed, it might have aimed for both the original neural drive which was associated with maximal strength and also the fast twitch recruitment and rate of force development that is needed for rapid repeated strikes, rather than relying only on heavy, slow lifting. Rate of force development itself is understood to be governed largely by early-phase motor unit discharge rate and can be enhanced by both heavy-resistance and explosive-type training, which supports combining the two modes within a single short block rather than relying on either alone (Maffiuletti et al., 2016).

Considering the perspective of a biomechanist, straight punch speed is more determined by the efficient chain of transfer of force along a proximal-to-distal sequence of the joints in the body than by the simple strength of the arm. The design of the training plan emphasized the development of pectoralis major, anterior deltoid, and triceps brachii, the primary muscle groups for punch extension in the upper limbs. To make sure that the results achieved in the strength exercises (bench press, shoulder press and triceps extension), would be a factor in developing a faster and a more explosive expression of force, we have included medicine-ball throws and plyometric push-ups in the sessions. Different training methodologies (e.g. complex and contrast sets) which boxers use effectively, were mentioned together with their underlying training-transfer principle by Liu et al. (2024) and Pinto et al. (2026), as the means of explanation for these training strategies. Broader literature of velocity-based and periodized resistance exercises shows that systematically progressive overload plans can reliably increase strength as well as high-speed muscular actions, such as sprint and jump (Loaiza-Betancur et al., 2026; Baena-Marín et al., 2022), thus giving a good reason for the adoption of the percentage-of-1RM method of progression for strength/power development.

These observations also match with the wider scope of conditioning work on pencak silat, which has mainly focussing on lower-limb explosive power and kicking speed, Structured plyometric and functional training programs have been demonstrated improving kicking speed and power in university-level pencak silat athletes over comparable four-to-six-week timeframes (Lubis et al., 2024), and leg-muscle explosive power together with balance have been shown to account for a substantial proportion of the variance in sickle-kick speed (Ahmad et al., 2026). The present results shift the focus from leg to arm movements and it looks as if that the same general principle-- that resistance training when specific to the resistance training can be paired with explosion exercises to make the striking movements at a higher speed -- is valid for all the striking movements of pencak silat and is not exclusive of kicking techniques.

It is also of interest that the reduction of the standard deviation from the pretest stage (5.84) to the posttest stage (3.52) took place. The training profile of an athlete greatly influences their physical preparedness at the baseline. Resistance training programmes standardised by design could be such physical activities which "level the field" as they offer more significant advantages to athletes initially at relatively smaller levels of physical condition. This finding is largely aligned with the conclusions drawn from several reviews highlighting rapid and uniform early strength gains in less experienced or "lower status" athletes compared to very well trained athletes (Aslam et al., 2025). Assuming a confirmation of this in larger sample sizes, a practical point might follow which coaching at the perguruan level would consider this a short, unified resistance-training block could be a way to raise the basic standard of punching speed of the whole team even without individualised programming prior to a major championship.

Because the design was uncontrolled, plausible rival explanations for the 16.6% gain have to be considered explicitly rather than dismissed. First, a test-retest learning or familiarisation effect is possible, since each athlete performed the 10 s test twice; it is unlikely to account for the whole change, because the task is a maximal-effort execution of a technique the participants had already trained for at least one year, but it cannot be excluded and would be expected to inflate the estimate. Second, regression to the mean may contribute, although its influence is limited here because participants were not selected on the basis of extreme pretest scores, a phenomenon that generally becomes more pronounced precisely when, as here, follow-up measurement is taken on a sample selected from a wider population (Barnett et al., 2005). Third, maturation is relevant given that the sample included adolescents, although four weeks is short relative to the timescale over which growth-related changes in punching capacity accumulate. Fourth, motivational and Hawthorne effects arising from participation in a supervised study are plausible and cannot be separated from the training stimulus in this design; systematic review evidence confirms that awareness of being studied can measurably alter participant behaviour, although the size and consistency of that effect vary widely across settings (McCambridge et al., 2014). Finally, technical training continued throughout the block; although its content and volume were unchanged, its interaction with the conditioning stimulus remains unresolved. Taken together, these alternatives mean that the present estimate is best read as an upper bound on the true training effect, and that attributing the change to resistance training alone would not be warranted.

This study's scientific contribution is multifaceted. It not only supplies one of the very few field-based data on alteration in punch speed after resistance training with a specified dose in pencak silat expressed through a simple, coach-oriented result measure (punches per minute) rather than laboratory devices, but also it adds effect sizes and confidence intervals to the standard hypothesis-testing method which enables researchers to contrast the size of the training-induced changes to those reported in the boxing and combat-sport literature. Besides that, it reveals that even a minimal period of four weeks can produce substantial changes in a sport-specific attack outcome if the training is carried out with everyday training equipment (barbells, dumbbells, and medicine balls). This finding is a practical one because many of pencak silat local clubs, besides lacking the resources of the national team clubs, cannot afford to purchase specialized velocity-based training equipment.

Several reservations must also be mentioned regarding these findings as well as pointing to research areas that are yet to be covered. Since the study involved a single group design without an intervention or merely training control, we cannot be sure that the enhancement resulting from these trainings was because of the physical resistances only. It may indeed be that the combined effects of physical exercise with the technical training, testing familiarisation, and motor development throughout these four weeks, led to such an improvement. Therefore, subsequent research needs to include a parallel group, preferably with random assignment, in order to discern what resistance training contributes specifically from its possible explanations. Also, experiments featuring bigger and more differentiated subject groups, covering more different age levels and degrees of competitiveness, including in their methodology direct mechanical or myolectric recording of the punch, would greatly help in understanding the neuromuscular mechanisms proposed herein which now rest solely on the general resistance training literature. On the basis of the variance observed here, a two-group randomised trial would require approximately 26 participants per group to detect a between-group difference of $d = 0.8$ with 80% power at $\alpha = 0.05$, and approximately 45 per group for $d = 0.6$; these figures give a concrete target for the confirmatory work recommended above. Dose-response comparisons (for example two versus four sessions per week, or heavy-slow versus ballistic loading) and comparative-effectiveness trials across striking disciplines are the logical next steps.

Practical Applications

Based on these results, it seems that an upper-limb muscle resistance programme of bench press, overhead press, and triceps extension with increasing weights, explosive medicine ball throws, push-up plyometrics and other similar exercises can lead to a quick and effective enhancement of straight punch speed for pencak silat competitors. It is not the case, after all, that very sophisticated tools and equipment are needed. This is certainly good news as pencak silat is still quite uncommon worldwide and so, most probably, very expensive and complicated gear would be really out of reach especially if one wants to compete against the best. For those coaches who work with athletes from a very diverse set of conditioning backgrounds, it can certainly be said that the programme is very beneficial as it brings the performance levels of the athletes much closer to each other. Therefore, in a sense, the programme is the leveller between very conditioned and very under-conditioned athletes. Those sport scientists who are assisting pencak silat teams would really appreciate it if they could do some basic and easily manageable assessment of the results of training such as how many punches can be thrown in 10 seconds which was adopted here so that the effect of the training will be seen over time. The pencak silat administrators and the national federations can definitely put resistance training as part of the resistance periodization plan for developing the players. They are, however, advised to be cautious until they can make sure with a control group that indeed this training method is effective. Since there was no control group in this study, all the suggested training recommendations should be considered as tentative and therefore, further controlled studies are necessary.

Strengths

The principal strengths of this study include its use of a sport-specific, ecologically valid outcome measure grounded in established exercise-physiology principles regarding the anaerobic alactic energy system; the application of a clearly specified, progressively overloaded training protocol that is fully reported and readily replicable by other coaches and researchers; and the reporting of effect size and confidence interval estimates alongside significance testing, which facilitates comparison with, and future meta-analytic synthesis against, the broader combat-sports strength and conditioning literature.

Limitations

This study has several aspects limiting the strength of the causal inference and, more importantly, the generalisability of its results. There are five specific aspects of the study that are discussed in further detail below. Firstly, this is a pilot/feasibility study with a sample size of only 12, which was limited to athletes at a single perguruan who met the eligibility criteria; thus, the statistical power for detecting smaller effects is low and individual data points could disproportionately influence the result. Secondly, the use of a single-group pretest-posttest design means that any changes in technical practice or testing familiarisation, natural growth or development, and other factors, such as the resistance training program, cannot be separated completely. The third limitation, that is, the shortness of the intervention period (i.e. four weeks) was enough to detect neural changes but does not reflect the longer-term, muscular and fat-related changes or the negative effects of physical inactivity (detraining). Fourthly, the study was carried out in single training club and there are no comprehensive anthropometric or training information provided about the final pool of the 12 eligible subjects (excluding the eligibility criteria) which is essential for sample characterisation and comparison with other study populations in terms of their characteristics. Lastly, this study design did not involve blinding of the testers and although testers were the same throughout all experimental procedures and protocol was strictly controlled, some possibility that expectations or testers' influence might have biased the results cannot be ruled out.

Conclusion

Four weeks of progressive upper-body resistance training was associated with a marked increase in straight punch frequency-speed in this sample of pencak silat athletes: mean punch frequency rose by 7.67 punches/10 s, an increase of 16.6% (95% CI 5.25 to 10.08; $t(11) = 6.99$, $p < 0.001$; Cohen's $d_z = 2.02$, 95% CI 1.00 to 3.01), and between-athlete variability was significantly reduced (Pitman-Morgan $t(10) = 2.67$, $p = 0.024$). The most plausible mechanism over this timescale is neural rather than morphological: progressive loading combined with explosive transfer work is expected to raise motor unit recruitment and discharge rates and to shift the force-velocity behaviour of the pectoralis major, anterior deltoid and triceps brachii towards a faster expression of force, which the proximal-to-distal kinetic chain then transmits to the striking hand. These results are nevertheless preliminary observations rather than confirmed effects. Because the study used a single group with no control condition and a small sample, the change cannot be attributed to resistance training alone; practice effects, test familiarisation, maturation and motivational effects remain plausible contributors. Progressively loaded upper-body training may therefore be considered a promising component of pencak silat physical preparation, pending confirmation in randomised controlled trials of approximately 26 participants per group, which would provide 80% power to detect a between-group effect of $d = 0.8$ at $\alpha = 0.05$.

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References

Ahmad, A., Sulfa, M., Prasetyo, Y., Widiyanto, W., Amiruddin, A., & Muhammad, F. (2026). Contribution of leg muscle explosive power and balance to sickle kick speed in pencak silat athletes. Indonesian Journal of Sport Science and Coaching, 8(1), 21-33. https://doi.org/10.22437/ijssc.v8i1.53316

Awana, G., Rizvi, M. R., Sharma, A., Aldalaykeh, M., Zaidi, Z., Makhija, S., Sami, W., & Al-Kuwari, N. F. A. (2025). Blood flow restriction training enhances punching force and upper body strength in elite boxers: A randomized trial. Frontiers in Physiology, 16, Article 1693271. https://doi.org/10.3389/fphys.2025.1693271

Aslam, S., Habyarimana, J. D. D., & Bin, S. Y. (2025). Neuromuscular adaptations to resistance training in elite versus recreational athletes. Frontiers in Physiology, 16, Article 1598149. https://doi.org/10.3389/fphys.2025.1598149

Baena-Marín, M., Rojas-Jaramillo, A., González-Santamaría, J., Rodríguez-Rosell, D., Petro, J. L., Kreider, R. B., & Bonilla, D. A. (2022). Velocity-based resistance training on 1-RM, jump and sprint performance: A systematic review of clinical trials. Sports, 10(1), 8. https://doi.org/10.3390/sports10010008

Barnett, A. G., van der Pols, J. C., & Dobson, A. J. (2005). Regression to the mean: What it is and how to deal with it. International Journal of Epidemiology, 34(1), 215-220. https://doi.org/10.1093/ije/dyh299

Beattie, K., & Ruddock, A. D. (2022). The role of strength on punch impact force in boxing. Journal of Strength and Conditioning Research, 36(10), 2957-2969. https://doi.org/10.1519/JSC.0000000000004252

Bragazzi, N. L., Rouissi, M., Hermassi, S., & Chamari, K. (2020). Resistance training and handball players' isokinetic, isometric and maximal strength, muscle power and throwing ball velocity: A systematic review and meta-analysis. International Journal of Environmental Research and Public Health, 17(8), 2663. https://doi.org/10.3390/ijerph17082663

Bruzas, V., Kamandulis, S., Venckunas, T., Snieckus, A., & Mockus, P. (2018). Effects of plyometric exercise training with external weights on punching ability of experienced amateur boxers. The Journal of Sports Medicine and Physical Fitness, 58(3), 221-226. https://doi.org/10.23736/S0022-4707.16.06674-3

Chaabène, H., Tabben, M., Mkaouer, B., Franchini, E., Negra, Y., Hammami, M., Amara, S., Chaabène, R. B., & Hachana, Y. (2015). Amateur boxing: Physical and physiological attributes. Sports Medicine, 45(3), 337-352. https://doi.org/10.1007/s40279-014-0274-7

Cid-Calfucura, I., Monrroy-Uarac, M., Herrera-Valenzuela, T., & Valdés-Badilla, P. (2023). Effects of strength training on physical fitness of Olympic combat sports athletes: A systematic review. Sports, 11(2), 40. https://doi.org/10.3390/sports11020040

Del Vecchio, A., Casolo, A., Dideriksen, J. L., Aagaard, P., Felici, F., Falla, D., & Farina, D. (2022). Lack of increased rate of force development after strength training is explained by specific neural, not muscular, motor unit adaptations. Journal of Applied Physiology, 132(1), 84-94. https://doi.org/10.1152/japplphysiol.00218.2021

Del Vecchio, A., Casolo, A., Negro, F., Scorcelletti, M., Bazzucchi, I., Enoka, R., Felici, F., & Farina, D. (2019). The increase in muscle force after 4 weeks of strength training is mediated by adaptations in motor unit recruitment and rate coding. The Journal of Physiology, 597(7), 1873-1887. https://doi.org/10.1113/JP277250

Etikan, I., & Bala, K. (2017). Sampling and sampling methods. Biometrics & Biostatistics International Journal, 5(6), 215-217. https://doi.org/10.15406/bbij.2017.05.00149

Finlay, M. (2025). A four weeks contrast training programme enhances punch performance and physical qualities in senior elite amateur boxers: A physical preparation case study for an international tournament. International Journal of Strength and Conditioning, 5(1). https://doi.org/10.47206/ijsc.v5i1.426

Fox, E. L., Bowers, R. W., & Foss, M. L. (1993). The physiological basis for physical education and athletics. Brown & Benchmark.

Hidayat, A., & Sugiharto. (2024). Analisis gerak pukulan lurus pencak silat Perguruan Persaudaraan Setia Hati Terate. Jurnal Keolahragaan.

Kons, R. L., Ache-Dias, J., Detanico, D., Barth, J., Dal Pupo, J., & Franchini, E. (2021). Physical fitness and match performance in combat sports athletes: A systematic review. Sports Biomechanics, 20(8), 1-16. https://doi.org/10.1080/14763141.2020.1836964

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. Frontiers in Psychology, 4, Article 863. https://doi.org/10.3389/fpsyg.2013.00863

Lenetsky, S., Harris, N., & Brughelli, M. (2013). Assessment and contributors of punching forces in combat sports athletes: Implications for strength and conditioning. Strength and Conditioning Journal, 35(2), 1-7. https://doi.org/10.1519/SSC.0b013e31828b6c12

Liu, Y., Huang, Z., Zhou, Z., Zhang, L., Guo, Y., & Chen, C. (2024). Effects of variable resistance training within complex training on strength and punch performance in elite amateur boxers. Frontiers in Physiology, 15, Article 1472258. https://doi.org/10.3389/fphys.2024.1472258

Loaiza-Betancur, A. F., González-González, C., Díaz-Franco, A., Castaño-Soto, J., Alzate-Toro, A., Areiza-Usuga, E., Zuluaga-M, D. A., Jiménez-Trujillo, J. O., Echavarría-Rodríguez, A. M., Díaz-López, V., Chulvi-Medrano, I., & Iglesias-González, L. E. (2026). A critical appraisal of systematic reviews assessing the effect of chronic velocity-based resistance training on health and athletic performance outcomes: A systematic review. PLOS ONE, 21(2), e0342992. https://doi.org/10.1371/journal.pone.0342992

Loturco, I., Nakamura, F. Y., Artioli, G. G., Kobal, R., Kitamura, K., Cal Abad, C. C., Cruz, I. F., Romano, F., Pereira, L. A., & Franchini, E. (2016). Strength and power qualities are highly associated with punching impact in elite amateur boxers. Journal of Strength and Conditioning Research, 30(1), 109-116. https://doi.org/10.1519/JSC.0000000000001075

Lubis, J., Haqiyah, A., Robianto, A., Ihsani, S. I., Wardoyo, H., Ginanjar, S., Irawan, A. A., Sumartiningsih, S., Setiawan, I., Lubis, R. A., Sanjaya, K. H., & Kusumandari, D. E. (2024). The effect of six-week plyometric, functional, and interval training on body composition, power, and kicking speed in male university pencak silat athletes. International Journal of Disabilities Sports and Health Sciences, 7, 46-53. https://doi.org/10.33438/ijdshs.1371605

Lubis, J., & Wardoyo, H. (2014). Pencak silat. PT RajaGrafindo Persada.

Maffiuletti, N. A., Aagaard, P., Blazevich, A. J., Folland, J., Tillin, N., & Duchateau, J. (2016). Rate of force development: Physiological and methodological considerations. European Journal of Applied Physiology, 116(6), 1091-1116. https://doi.org/10.1007/s00421-016-3346-6

McCambridge, J., Witton, J., & Elbourne, D. R. (2014). Systematic review of the Hawthorne effect: New concepts are needed to study research participation effects. Journal of Clinical Epidemiology, 67(3), 267-277. https://doi.org/10.1016/j.jclinepi.2013.08.015

Ojeda-Aravena, A., Herrera-Valenzuela, T., Valdés-Badilla, P., Báez-San Martín, E., Thapa, R. K., & Ramírez-Campillo, R. (2023). A systematic review with meta-analysis on the effects of plyometric-jump training on the physical fitness of combat-sport athletes. Sports, 11(2), 33. https://doi.org/10.3390/sports11020033

Pinto, M., Crisóstomo, J., Kirk, C., Abián-Vicén, J., & Monteiro, L. (2026). Effects of specific training programs on punch performance. Sports, 14(5), 194. https://doi.org/10.3390/sports14050194

Widiastuti. (2015). Tes dan pengukuran olahraga. PT RajaGrafindo Persada.

Williams, T. D., Tolusso, D. V., Fedewa, M. V., & Esco, M. R. (2017). Comparison of periodized and non-periodized resistance training on maximal strength: A meta-analysis. Sports Medicine, 47(10), 2083-2100. https://doi.org/10.1007/s40279-017-0734-y