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Combined plyometric and target kick-drill training and straight-kick speed in female Pencak Silat athletes

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ABSTRACT

This study investigated the effect of combined plyometric and target kick-drill training on straight-kick speed in female pencak silat athletes. A single-group pretest–posttest design involved 10 female athletes aged ≥15 years. Participants completed 16 supervised training sessions over four weeks. Straight-kick speed was assessed using a standardized 10-second straight-kick frequency test. Data were analyzed using a paired-samples t-test and Hedges' g. Straight-kick performance increased from 10.30 to 16.40 repetitions per 10 seconds, representing a 59.2% improvement ($t(9) = 22.03$, $p < .001$; Hedges' $g = 3.10$). Combined plyometric and target kick-drill training was associated with substantial improvement in straight-kick speed; however, controlled randomized studies are required to confirm the training-specific effect.

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Introduction

Victory in pencak silat, the officially sanctioned martial art of Indonesia that is nowadays internationally contested, rests upon the skill of delivering scoring strikes faster than the opponent can defend themselves. Tanding sparring, the points are determined by kicking and punching that do not knock an adversary down but are directed accurately on specific parts of his body; in other words, one who is able to rapidly and accurately deliver strikes gains a tactical and strategic advantage at the time of the game. Kicks mainly account for a major proportion of all the attempts that score a point, and therefore, the strength and speed of a kick are directly proportional the explosive capacity in the lower limb (Oláh et al., 2025; Wu et al., 2025). Of all the kicks, straight kick (tendangan lurus) is an initial attacking mode that can lead to the opponent's loss: it reaches either the chest or abdominal area in a very short and directly, and when delivered fast, is barely noticeable, thus, extremely tough to counter. Therefore, improving the kick speed should be top of coaching agendas, even with all the uncertainty surrounding which methods would best support such a goal compared to what has already proven to be quite effective in training the roundhouse kicks through which most of the references are compiled.

Pencak silat athletes endure special and repetitive physical activities as required by the game. For instance, a competition segment features intense offensive phases alternating with defensive actions, so the neuromuscular components need to consistently produce the highest possible strength in an instance of the millisecond but still remain in balance and posture control (Sudirman et al., 2022). Women, as the participants of the competition grow bigger, go through identical kinds of requirements but are significantly less engaged in the realm of training studies. That lack of involvement hinders the sharing of scientific knowledge to this population so the main question is to see if a particular training method can speed up straight kicks of ladies. The idea is to help coaches by providing them practical advice and also fill in the descriptive literature gap.

The speed of a straight kick is important in that it directly affects scoring efficiency. A fast kick reduces the block or evasion period to which an opponent is given, raises the chance of making contact on target, and also the athlete is able to retreat to a safer position quicker afterwards and thus remain in a better defensive posture. Pencak silat prior literature has been frequently linking kicking quality with both the explosive power of thigh muscles and also the fine timing of the hip and foot action (Lubis et al., 2022; Febrianta et al., 2025). Therefore, interventions that not only increase explosive power but also improve the pattern of kicking movements are likely to increase straight-kick performance.

Mechanistically, kick speed is basically determined by two factors: the speed at which the lower-limb musculature can create force as well as the degree to which that force is transmitted through the kinetic chain. Very quick and forceful movements are, to a large degree, the result of the so-called stretch, shortening cycle (SSC). In this process, a short, fast-paced eccentric pre-stretch helps to poteniate a concentric action by the use of stored elastic energy, reflexive facilitation, and more motor-unit recruitment (Markovic & Mikulic, 2010). Studies have demonstrated that combat athletes who achieve better results are better characterised by two things: rate of force development (RFD) and utilisation of the SSC (Ojeda-Aravena et al., 2022). The link between jumping capacity and kick force, which is already established in the literature, further supports the idea that lower-limb power is a common factor or substrate of these actions (Olah et al., 2025). Therefore, to improve the straight-kick speed one needs not only to activate leg extenders effectively at a neural level but also to increase the mechanical stiffness of the muscle, tendon unit.

Plyometric training seems to be the conditioning modality which meets these demands most directly. Repeatedly loading the SSC by jumping and bounding during plyometric exercises results in neural adaptations greater motor-unit recruitment, faster rate coding, and lower antagonist co-contraction as well as muscle-tendon adaptations that lead to increased explosive power and rate of force development (Markovic & Mikulic, 2010). Findings from a meta-analysis confirm that plyometric exercises effectively increase jumps height and strength in various populations whereas maximal effects can only be achieved if different jump types are combined and if the session volume is sufficient (Sáez de Villarreal et al., 2009; Sáez de Villarreal et al., 2010, 2015). Another very important point is the principle of training specificity: adaptation happens more when movements are transferred to the trained pattern. Target kick drills can be used as exploitation of this principle as they involve athlete performing the exact kick at the target multiple times. As a result, trajectory hip drive inter-segmental coordination get refined so that recently developed power is used towards faster technique rather than just a stronger leg.

Studies with a practical focus back up the intervention, outcome connection across different combat sports, for example, a training exercise that involves a certain kind of jump will help a person in general kick more often with a straight kick and also help that person kick with a stronger leg and kick the ball/box faster. In pencak silat, a combination of different types of jump training, like plyometrics, was able to significantly increase the number of times a straight kick was thrown and also to significantly improve leg power and kick velocity (Sudiana et al., 2023; Febrianta et al., 2025). Moreover, a combination of different training approaches raised the overall level of kicking skill (Sudirman et al., 2022).In taekwondo, plyometric vertical jumps and box training drills were reported to give higher quality performance in kick momtong dollyo chagi

(Susianti et al., 2022) and specialized methods aimed exclusively at leg-power training significantly improved the athletes' ability to perform explosive movements (Liu et al., 2020). In karate, the plyometric work was found to lead to the development of the lower-limb power and at the same time reduce inter-limb asymmetry (Soñén et al., 2021). A study with meta-analysis also showed that, in general, the training methods involving a kind of jump (plyometric-jump) were responsible for enhancing various physical-fitness abilities of the combat-sport athletes such as taekwondo, silat, wrestling, judo, fencing, and karate (Ojedaa-Aravena et al., 2023).

Apart from the fact that the evidence may have a scientific backing, there are some aspects which remain unresolved. For one thing, the meta-analysis cited earlier noted a very big difference in the studies it covered with effects mostly at an intermediate-to-large level not at an extreme level when the controlled comparison was pooled (Ojeda-Aravena et al., 2023). Secondly, even with these post-inhibition approaches being applied for several weeks, sometimes, it did not result in a kicking increase for the taekwondo players as Castro-Gatrido et al. (2020), who worked with these post-inhibition techniques, noted. In the literature, the contrast- or complex-training formats are said to have been associated with strength and power differences among martial arts artists (Chen et al., 2025) as a result such different responses are a common theme in literature these days. It therefore seems likely that the outcome of plyometric training methods is dependent on characteristics and abilities of the training subjects as well as the measurement tools and techniques used by the researchers, apart from being very much dependent on the study design that was applied to evaluate the results.

Three major lacunae have been identified in this body of work. firstly, the majority of joint plyometric-technical training methods have been tested in the disciplines of taekwondo and karate, and pencak silat as a whole and even the straight kick as a technique seem to have been given limited attention. Secondly, female pencak silat athletes have, at best, very seldom been the subject of study. Therefore the sensitivity of this population to explosive-training stimuli is not well understood. Thirdly, the kind of brief, field-deliverable programmes that mix plyometrics with kick-drills tailored to a target-the way most clubs actually would implement it-have, in most cases, not been measured by modern effect-size reporting. Filling up the gaps has scientific as well as applied implications: it will tell us, in the context of an under-studied group, if a low-cost four-week combined stimulus could bring a significant change to a skill that matters in a competition setting.

To address the identified gaps, the present study employed a single-group pretest–posttest design (Campbell–Stanley $O_1 - X - O_2$ notation), often termed a pre-experimental or within-subjects design. An RCT or quasi-experimental design with a parallel control group would have provided stronger causal inference; however, the eligible female participants -those meeting all four inclusion criteria -constituted a single intact club (n = 10), making parallel randomisation or an equivalent control-group recruitment practically and ethically unfeasible within the club's existing training schedule. The pre-experimental design was therefore the pragmatically appropriate choice for characterising the within-athlete change following the intervention in this population and setting. The intervention comprised a deliberate combination of lower-body plyometric training and target-specific straight-kick drills rather than either modality in isolation. This design choice is theoretically justified by the principle of training specificity: plyometric loading of the stretch-shortening cycle (SSC) develops the explosive physical capacity underlying fast limb movements, while target-kick drills ensure that the new capacity is expressed through the competition technique rather than as generic leg power (Markovic & Mikulic, 2010). Combining the two modalities in sequence within each session is therefore hypothesised to produce a more complete adaptation than either component alone -a rationale supported by the transfer-of-training logic underpinning complex and combined training methods across combat sports (Chen et al., 2025; Sudirman et al., 2022). Because the study was conducted in a real club setting with an intact athlete group, an a priori power analysis was not available to inform participant recruitment; the sensitivity analysis reported in the Method section confirms post hoc that the design was adequately powered only for large effects.

This study fills these three gaps by implementing a combined training scheme of plyometric plus target-kick-drills with female pencak silat practitioners and further, by reporting changes in straight-kick speed using both effect size and confidence interval estimates rather than just significance testing, thus going beyond the traditional approach. Therefore, the paper offers two aspects of contribution to the field: it broadens the evidence on the effectiveness of combined training to a population and technique that have been little explored until now, as well as, through its results, providing an example of statistical reporting that is transparent, fits the design, and can easily be applied to a single-group field study. We believed that the speed of straight kick after the training would be significantly higher than before (H_1). On the other hand, we acknowledge that this lack of control may well limit the extent of the inference one can make causally and we also highlight that fact very clearly in the Discussion section of the paper.

Method

Study Design

A single-group pretest–posttest design was used. In the Campbell–Stanley taxonomy this is a pre-experimental (one-group) design, and it is frequently classified within the quasi-experimental family because assignment is non-randomised ($O_1 - X - O_2$). It was chosen for pragmatic reasons: the participants were members of a single, intact martial-arts club, so neither random allocation nor the recruitment of an equivalent control group was feasible within the club's training schedule. The design allows the within-athlete change following a defined intervention to be quantified, but-as detailed in the Limitations-it does not control for maturation, repeated-testing, or learning effects, and causal attribution is therefore necessarily cautious. Reporting follows APA (7th edition) conventions throughout.

Participants and Sampling

Participants were athletes of the SMI Lampasi pencak silat club in Limapuluh Kota Regency, West Sumatra, Indonesia. The club membership (the study population) comprised 41 athletes (14 male, 27 female). A purposive sampling strategy was applied against pre-specified eligibility criteria, yielding a final sample of 10 female athletes. Restricting the sample to female athletes who met all criteria produced a homogeneous group aligned with the study aim of characterising the response in this under-studied population. Inclusion criteria were: (a) active participation in routine club training; (b) at least one year of pencak silat training experience; (c) prior participation in at least one competition; and (d) age ≥ 15 years. Athletes who did not meet all four criteria were not sampled. All ten sampled athletes completed the intervention and both testing sessions (no attrition). The study was conducted as part of an undergraduate research programme at Universitas Negeri Padang. Athletes (and, for minors, their parents or guardians) were informed of the procedures and provided consent to participate. Formal institutional ethics-approval details were not recorded in the source document.

Intervention Protocol

The intervention combined lower-body plyometric training with target-specific straight-kick drills and was delivered over 16 supervised sessions across four weeks at a frequency of four sessions per week. Each session lasted approximately 75–90 minutes and followed a fixed structure: a standardised warm-up, a plyometric block, a target-kick-drill block, and a cool-down. The plyometric block emphasised short-contact, SSC-based jumping actions performed with maximal intent and full recovery between sets, with volume progressed across the four weeks in line with the overload principle. The target-kick-drill block required athletes to execute the straight kick repeatedly against a defined pad/target, cueing a direct trajectory, active hip drive, and rapid return to stance so that the developing explosive capacity was expressed through the competition technique. The combined format operationalises the specificity principle: the plyometric block builds the physical capacity, and the target-drill block channels it into the trained movement.

Outcome Measure and Testing Procedures

The outcome was straight-kick speed, operationalised as the number of valid straight kicks completed in 10 seconds using the standardised Indonesian pencak silat kicking-speed test (Lubis, 2016). This test is the reference normative instrument for pencak silat kick-speed assessment in Indonesia; published female-athlete norms divide performance into five bands: "very poor" (< 12 repetitions), "poor" (13–15), "fair" (16–18), "good" (19–23), and "very good" (> 24 repetitions). The test has been applied across several published intervention studies in pencak silat athletes (Sudiana et al., 2023; Febrianta et al., 2025), providing ecologically consistent precedent for its use in the present sample. The instrument procedure specifies: (a) a target pad set at 75 cm height for female athletes; (b) a support foot starting position 50 cm behind a marked line; (c) execution on the auditory command "go," with the athlete performing straight kicks and returning the foot to contact the floor behind the line between repetitions; (d) bilateral alternating kicking across the 10-second trial; and (e) three trials administered with the best (highest) kick count retained as the score. Kick counting was performed by trained officials under a structured multi-role protocol: one official monitored target height conformity, one operated the stopwatch and whistle, and one stabilised the target pad; a fourth official recorded the count. This multi-official structure constitutes procedural reliability control. A study-specific intraclass correlation coefficient (ICC) for test-retest reliability was not computed, which is acknowledged as a limitation (see Limitations section). Future replications are recommended to include a familiarisation session and a separate test-retest reliability session prior to the intervention baseline measurement to generate an ICC for this specific test in this population. Raw counts were interpreted against the published female reference norms. Identical equipment, procedures, and personnel were used at O_1 (pretest, week 0) and O_2 (posttest, week 4) to minimise systematic measurement error across time points.

Statistical Analysis

Analyses were performed in SPSS with the significance level set at $\alpha = .05$. Descriptive statistics are reported as mean ± standard deviation with the range. The distributional assumption for the paired test was examined with the Shapiro–Wilk test (appropriate for $n < 50$) applied to the pretest and posttest scores. Because the design compares two related measurements on the same athletes, the primary inferential test was a paired-samples t-test on the pretest–posttest difference; this is the design-appropriate choice for a single group measured on two occasions. A repeated-measures ANOVA, mixed ANOVA, or ANCOVA was not indicated because there was neither a third time point nor a comparison group. The equality-of-variance (Levene) result reported in the source is retained for completeness in Table 3, but homogeneity of variance between the pretest and posttest is not a formal assumption of the paired t-test and was not used to gate the analysis.

To move beyond significance testing, standardised effect sizes were computed from the reported summary statistics. Two complementary indices are presented: Cohen's d_r (the mean difference divided by the standard deviation of the difference scores; equal to $t/\sqrt{n}$), which reflects the within-athlete consistency of change, and Cohen's d_{av} (the mean difference divided by the average of the pretest and posttest standard deviations), which is more comparable with between-group effect sizes in the wider literature. Cohen's d_{av} was small-sample corrected to Hedges' g_{av} using the factor $J = 1 - 3/(4 \cdot df - 1)$. The pretest–posttest correlation implied by the difference SD was recovered to contextualise the within-subject index, and the percentage change relative to baseline was calculated. A sensitivity analysis of statistical power was conducted for the paired design ($n = 10$, $\alpha = .05$, two-tailed). Confidence intervals for the raw mean difference are exact; intervals for the standardised effects were obtained by scaling the mean-difference interval (for g_{av}) and by the Borenstein approximation (for d_r) and are labelled as approximate.

Results and Discussions

Participant Characteristics

Ten female pencak silat athletes met all eligibility criteria and completed the study with no attrition (100% retention). Group descriptors that were available are summarised in Table 1.

Table 1. Characteristics of the study sample

Characteristic	Value
Sport / discipline	Pencak Silat (Fighting)
Sex	Female
Analysed sample, n	10
Population screened, N	41 (14 male, 27 female)
Age	≥ 15 y (17.6 ± 2.2)
Training experience	≥ 1 year
Competitive experience	≥ 1 competition
Stature / body mass	158.4 ± 2.7

Descriptive Statistics

Straight-kick frequency rose from a pretest mean of 10.30 ± 1.70 repetitions·10 s^{-1} (range 8-13) to a posttest mean of 16.40 ± 1.90 repetitions·10 s^{-1} (range 13-19). Both the minimum and the maximum increased, indicating an upward shift across the whole group rather than a change confined to the lowest or highest performers (Table 2). Relative to the female reference norms, the group mean moved from the "very poor" band at baseline to the "fair" band after the intervention (Figure 3).

Table 2. Descriptive statistics for straight-kick frequency (repetitions·10 s^{-1})

Time Point	n	M	SD	Min	Max	Range	95% CI of M
Pretest	10	10.30	1.70	8	13	5	[9.08, 11.52]
Posttest	10	16.40	1.90	13	19	6	[15.04, 17.76]

Note. M = mean; SD = standard deviation; CI = confidence interval. The 95% CI of each mean was derived from the reported SD and n.

Assumption checks

Both distributions satisfied the normality assumption: Shapiro-Wilk W = .904 (p = .245) for the pretest and W = .942 (p = .573) for the posttest, with all p-values exceeding .05 (Table 3). The equality-of-variance test reported in the source (Levene, based on the mean) was also non-significant. Because the pretest and posttest scores were normally distributed and the design is a paired comparison, the parametric paired-samples *t*-test was appropriate.

Table 3. Assumption Checks for The Paired Analysis

Check	Statistic	df	Sig. (p)	Decision
Shapiro-Wilk (pretest)	W = .904	10	.245	Normal
Shapiro-Wilk (posttest)	W = .942	10	.573	Normal
Levene (based on mean) *	F = .009	1, 18	.925	Variances equal

*Note. * The Levene test is reported for completeness; equality of variance between the two time points is not a formal assumption of the paired-samples t-test.*

Inferential Test and Effect Size

The paired-samples *t*-test confirmed a statistically significant increase in straight-kick frequency from pretest to posttest. The mean gain was 6.10 repetitions·10 s^{-1} (95% CI 5.47-6.73), $t(9) = 22.03$, $p < .001$ (Table 4). The magnitude of the effect was very large on both the within- and between-subject scales: Hedges' $g_{av} = 3.10$ (95% CI 2.78-3.42) and Cohen's $d_r = 6.96$ (approximate 95% CI 3.85-10.08). The two indices diverge because the pretest-posttest scores were strongly correlated (recovered r ≈ .89), which shrinks the standard deviation of the difference scores and consequently inflates d_r; g_{av} is the more transferable estimate for comparison with the wider literature. In relative terms the gain corresponds to a +59.2% change from baseline (Figures 4 and 5).

Table 4. Paired-Samples t-test and Effect Size for The Change in Straight-kick Frequency

Comparison	Mean diff.	SD diff.	SE	95% CI	t	df	p	g_{av} [95% CI]
Posttest − Pretest	6.10	0.88	0.28	[5.47, 6.73]	22.03	9	< .001	3.10 [2.78, 3.42]

Note. The source reports the difference as pretest − posttest = −6.10; it is presented here as posttest − pretest = +6.10 so that the positive sign reflects improvement. p is two-tailed; the exact value is ≈ 3.9 × 10^{-9}. g_{av} = Hedges' corrected d_{av}.

Statistical power (sensitivity)
Because no a priori power calculation was reported, a sensitivity analysis was conducted for the paired design. With n = 10 and α = .05 (two-tailed), the study had 80% power to detect a within-subject effect of $d_r \approx 1.00$ or larger; that is, it was adequately powered only for large effects. Given the very large observed effect, the achieved (post-hoc) power approached 1.00. This confirms that the statistical decision is secure for an effect of this size, while underscoring that the design could not have reliably detected the smaller effects typical of controlled combat-sport trials.

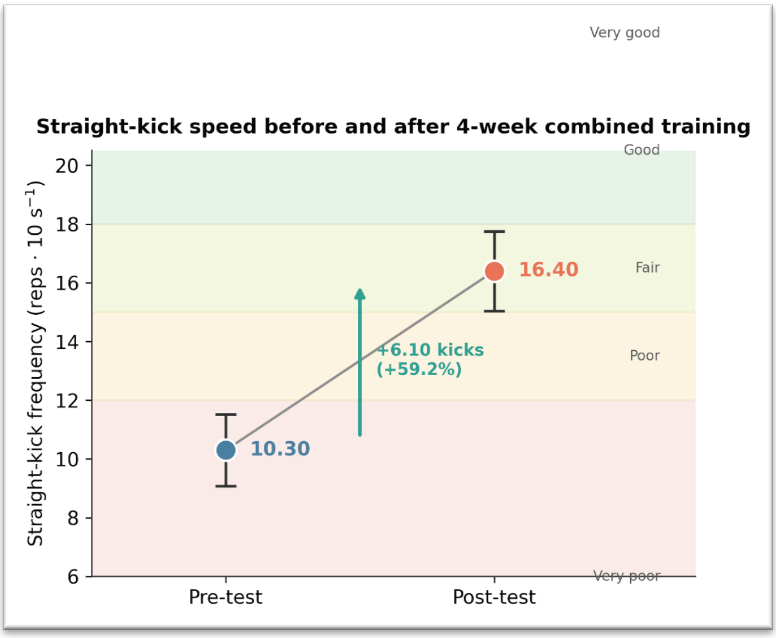

Figure 3. *Mean straight-kick frequency at pretest and posttest with 95% confidence intervals, overlaid on the female reference-norm bands. The group mean shifts from the "very poor" band to the "fair" band, a change of +6.10 repetitions (+59.2%). Non-overlapping intervals indicate a clear separation between the two time points; the categorical shift shows the change is meaningful against the test's own standards.*

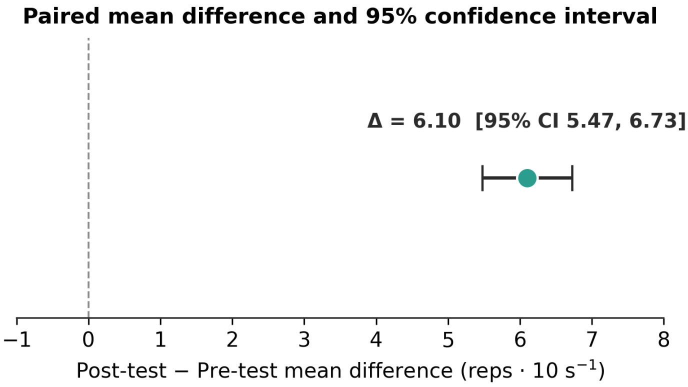

Figure 4. Paired mean difference (posttest − pretest) with its 95% confidence interval. The interval lies well above zero (5.47-6.73 repetitions), so the direction and precision of the estimated improvement are unambiguous within this sample. The estimation view complements the significance test by expressing the result on the original measurement scale.

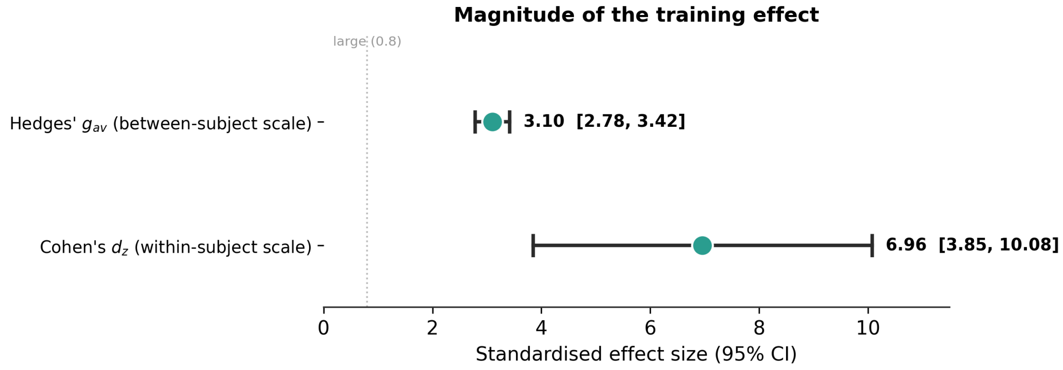

Figure 5. Standardised effect sizes with 95% confidence intervals. Both Hedges' g_{av} (3.10) and Cohen's d_r (6.96) exceed the conventional "large" threshold. The gap between the two indices reflects the high pretest-posttest correlation; g_{av} is the estimate to compare with between-group studies, and its lower bound (2.78) remains very large.

This study examined whether a four-week combined programme of plyometric exercise and target straight-kick drills would improve straight-kick speed in female pencak silat athletes. Following 16 supervised sessions, straight-kick frequency increased from a pretest mean of 10.30 to a posttest mean of 16.40 repetitions·10 s^{-1}, a gain of 6.10 repetitions (+59.2%). This change was statistically significant ($t(9) = 22.03$, $p < .001$) and associated with a very large standardised effect (Hedges' $g_{av} = 3.10$, 95% CI [2.78, 3.42]). Interpreted against the published female reference norms (Lubis, 2016), the group mean shifted from the "very poor" (<12) to the "fair" (16–18) performance band - a categorically meaningful change. The direction of the finding is unambiguous and consistent with the study hypothesis; the remainder of this Discussion interprets the probable mechanisms, situates the result within the broader combat-sport training literature, and appraises the magnitude critically in light of the design's acknowledged constraints.

The combined stimulus targeted two distinct but complementary substrates of kick speed. The plyometric block loaded the stretch-shortening cycle (SSC), and the adaptations most plausibly responsible for faster kicking over a four-week horizon are primarily neural: increased motor-unit recruitment, faster rate coding, reduced antagonist co-contraction, and enhanced reflexive potentiation of the concentric phase (Markovic & Mikulic, 2010). These neural adaptations raise the rate of force development (RFD) of the leg extensors - the physical quality most closely coupled to the speed at which a limb can be accelerated toward a target. The target-kick-drill block then exploited training specificity: by repeatedly performing the straight kick against a defined pad, athletes refined the kick trajectory, hip-drive timing, and return-to-stance speed, so that newly available explosive capacity was expressed as a faster technique rather than as generic leg strength (Sudirman et al., 2022). The combined stimulus → neural/coordinative adaptation → RFD and SSC enhancement → technique coupling → faster straight kick pathway is theoretically well matched to the outcome measure, which requires both power and the efficient re-setting of the kicking mechanism within each 10-second window.

This mechanistic account is consistent with the physiological profile distinguishing higher-performing combat athletes. Ojeda-Aravena et al. (2022) demonstrated that superior SSC utilisation and explosive capacity differentiate performance levels in taekwondo, and Oláh et al. (2025) showed that countermovement jump height and back-squat one-repetition maximum are significantly associated with the peak force of front kicks. Evidence that jumping capacity predicts kick force further supports a common lower-limb power substrate underlying the two movement types. Because the 10-second kick-count test requires both leg power and the efficient re-cycling of the kicking technique, a combined intervention that develops power while simultaneously grooving the movement pattern is theoretically superior to either component alone.

The present direction of effect is consistent with published evidence across three levels of specificity - pencak silat, adjacent striking disciplines, and the broader combat-sport meta-analytic literature - though the magnitude substantially exceeds controlled-design benchmarks and requires careful contextualisation.

Within pencak silat, the closest methodological precedent is Sudiana et al. (2023), who found that plyometric stair-jump and reaction box-jump training significantly improved straight-forward kick frequency in junior athletes using the same 10-second paradigm; Febrianta et al. (2025) likewise reported that plyometric training improved leg-muscle power, kick speed, and agility in pencak silat practitioners. Sudirman et al. (2022) demonstrated that combined and method-comparison training meaningfully enhanced general pencak silat kicking skill. The present result extends this line of evidence to the specific case of the straight kick in female athletes - a combination not previously isolated.

In adjacent striking disciplines, the effect is replicated with consistency. In taekwondo, Susianti et al. (2022) reported that plyometric standing jumps and box drills improved momtong dollyo chagi kick quality in junior athletes; Liu et al. (2020) found that a novel leg-power training method significantly enhanced explosive capacity relevant to kicking in taekwondo athletes; and Ouergui et al. (2022a) demonstrated post-activation performance enhancement effects on kicking performance in young taekwondo practitioners. In karate, Soñén et al. (2021) showed that unilateral and bilateral plyometric training improved lower-limb power and reduced inter-limb asymmetry in karatekas. In mixed martial arts, Chernozub et al. (2022) documented that structured training load variations produced adaptive changes in explosive capacity, and Boobani et al. (2026) examined short-term recovery strategies that attenuate performance decrements between sessions - a complementary finding indicating that managing fatigue allows explosive quality to be maintained across multi-session blocks such as the present four-week programme. In combat-sport nutrition and body composition research, dos Santos et al. (2023) reported that lower body fat percentage is negatively correlated with judo performance, and García-De Frutos et al. (2025) presented a case study of combined physical and nutritional preparation in a professional karate athlete - both studies contextualising the multi-factorial determinants of kicking performance.

At the level of synthesis, the systematic review and meta-analysis of Ojeda-Aravena et al. (2023) - encompassing taekwondo, silat, wrestling, judo, fencing, and karate - concluded that plyometric-jump training produces significant improvements across multiple physical-fitness outcomes in combat-sport athletes, with pooled effects in the moderate-to-large range under controlled conditions. The earlier meta-analyses of Sáez de Villarreal et al. (2009) and Sáez-Sáez de Villarreal et al. (2010) established comparable moderate-to-large effects for plyometric training on jump height and lower-body strength in the general athletic population. Kosynskyi et al. (2023) demonstrated that incorporating elements of national martial arts into specialised physical training of MMA fighters improved specific explosive capacities. However, important null and partial-effect findings exist: Castro-Gatrido et al. (2020) found that post-activation potentiation exercises did not improve kicking frequency in taekwondo athletes in their specific paradigm; Chen et al. (2025) reported variable lower-limb power responses to French Contrast Training in elite martial artists; and Ouergui et al. (2022b) showed that caffeine-conditioning combinations produced discipline-specific rather than universal performance benefits. These heterogeneous outcomes indicate that plyometric and combined training responses are moderated by factors including training status, design specificity, measurement paradigm, and the outcome being assessed.

The observed gain (+59.2%, g_{av} = 3.10) substantially exceeds the moderate-to-large pooled effects typical of controlled plyometric-training trials (Ojeda-Aravena et al., 2023; Sáez de Villarreal et al., 2009). Three design features concur to inflate the apparent effect magnitude and must be considered before the raw estimate is interpreted as a training effect.

First, the outcome is a skill-and-capacity test of the exact movement drilled four times per week. In a single-group design, familiarisation, learning, and technique-refinement gains are completely confounded with conditioning gains, making it impossible to partition the physiological training response from task-specific learning. Second, the high pretest–posttest correlation ($r \approx .89$) compresses the standard deviation of the difference scores and inflates the within-subject index (d_r = 6.96) to an implausibly large value; the between-subject-scaled g_{av} = 3.10 is more defensible but still very large relative to controlled benchmarks. Third, the sample comprised developing athletes with no prior exposure to structured explosive training, a population in which the initial adaptation window is wide and proportionally larger short-term gains are expected relative to trained athletes (Sáez-Sáez de Villarreal et al., 2010) - an established moderator of plyometric responsiveness in the meta-analytic literature.

The most parsimonious interpretation is therefore that a real, coach-relevant improvement occurred, that a meaningful portion is attributable to the combined training stimulus, and that the remainder reflects design-driven inflation from learning, familiarisation, and the absence of a control condition. Presenting the effect sizes transparently with 95% CIs - rather than reporting significance alone - makes this inflation visible and is itself a methodological contribution of the present paper. A realistic expectation for the true conditioning-specific effect, recoverable under a controlled design, would be a moderate-to-large rather than extreme effect size, consistent with the broader combat-sport literature.

Given the pre-experimental design, the following specific threats to internal validity are acknowledged. (1) History: any concurrent training, physical activity, or life events occurring between O_1 and O_2 could plausibly contribute to the observed change. (2) Maturation: over four weeks, natural athletic development and continued club training are uncontrolled and may independently improve kicking performance. (3) Testing effects (practice effects): exposure to the 10-second kick-count test at pretest familiarises athletes with the measurement task, potentially improving performance at posttest through task learning rather than conditioning. (4) Statistical regression: if athletes were selected partly on the basis of low baseline kick scores, regression to the mean could artificially inflate the apparent gain. The present study' baseline mean of 10.30 (in the "very poor" band) is consistent with a lower-ability sample where regression effects may operate. (5) Instrumentation: although equipment and personnel were standardised across testing occasions, a formal test-retest reliability coefficient was not computed, leaving open the possibility of unsystematic measurement variability. (6) Selection bias: purposive sampling from one club limits the generalisability of the recruitment process and cannot exclude the possibility that motivational or historical differences between this club's athletes and other clubs contribute to the result. These threats cannot be eliminated within the single-group design and collectively explain why the true conditioning-specific effect is almost certainly smaller than the raw $g_{av} = 3.10$ estimate.

The present findings should be interpreted within clearly specified generalisability boundaries. Population generalisability is restricted to female pencak silat athletes aged ≥ 15 years with at least one year of training experience at a similar competitive level. The findings may not extend to male athletes (for whom hormonal, morphological, and training-history differences may produce a different response profile), to more highly trained or elite female athletes (whose adaptation window may be narrower), or to older or more experienced practitioners. Ecological generalisability is adequate for community club settings with comparable facilities, coach expertise, and scheduling constraints; the four-session-per-week, four-week structure was demonstrated to be feasible in this context. Temporal generalisability is restricted to the short-term (four-week) horizon: the durability of the gains, dose-response relationships, and the trajectory of continued adaptation beyond this window remain unknown. Technique generalisability is restricted to the straight kick (tendangan lurus); transfer to roundhouse, crescent, or other pencak silat kicking techniques was not examined and cannot be assumed. These boundary conditions should be stated when applying the present results to coaching decisions or to the design of future trials.

Conclusions

A four-week programme combining plyometric exercise and target-specific straight-kick drills - delivered in 16 supervised sessions at four sessions per week - was associated with a statistically significant and very large improvement in straight-kick speed among female pencak silat athletes. The group mean increased from 10.30 to 16.40 repetitions·10 s^{-1} (mean gain = +6.10, 95% CI [5.47, 6.73]; +59.2%), $t(9) = 22.03$, $p < .001$, Hedges' $g_{av} = 3.10$ (95% CI [2.78, 3.42]); the within-subject index was Cohen's $d_r = 6.96$ (approximate 95% CI [3.85, 10.08]), though the divergence between these two indices reflects the high pretest–posttest correlation and the g_{av} estimate is more appropriate for comparison with the between-group effects in the broader literature. Against the published female reference norms (Lubis, 2016), the group moved from the "very poor" (< 12 repetitions) to the "fair" (16–18 repetitions) band - a shift of two normative categories. The study makes two contributions. First, it extends the evidence base for combined explosive-and-technical training to the straight kick in female pencak silat athletes - a population and technique previously understudied. Second, by reporting effect sizes with 95% confidence intervals rather than significance values alone, it provides a transparent, design-appropriate statistical portrait of a single-group field study that can be readily replicated. These contributions must, however, be qualified by the critical limitation of the pre-experimental design: the absence of a control group means that maturation, repeated-testing, technique-familiarisation, and any concurrent training are uncontrolled confounds, and the true training-specific effect is very likely smaller than the raw estimate of $g_{av} = 3.10$. On the applied side, a low-cost protocol combining short-contact plyometrics with technique-specific straight-kick drills appears feasible in a community club context and is accompanied by a clear performance improvement and a categorical rise against test norms, providing coaches with practical evidence to consider when programming for developing female athletes. A randomised controlled trial with an active comparison group is required to establish the conditioning-specific effect independently of learning and maturation. For adequate statistical power, such a trial should recruit a minimum of 26 participants per group ($N \approx 52$) to detect a large between-group effect of $d = 0.80$ ($\alpha = .05$, two-tailed, power = 80%), or approximately 64 per group ($N \approx 128$) if a more conservative moderate effect of $d = 0.50$ is targeted - a sample size realistically achievable across multiple clubs or regencies in a collaborative design.

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