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EFFECTS OF AN EIGHT-WEEK HYPERTROPHY-PHASE TRAINING PROGRAM ON LOWER-LIMB EXPLOSIVE STRENGTH IN HIGH-SCHOOL TARUNG DERAJAT PARTICIPANTS

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Keywords:
Tarung Derajat, hypertrophy phase, resistance training, vertical jump, lower-limb explosive strength, adolescent athletes

Abstract
This study examined the effect of an eight-week hypertrophy-phase program on lower-limb explosive strength in 22 high-school Tarung Derajat participants. A one-group pretest-posttest design was used. Participants trained three times per week for eight weeks using supervised lower-limb resistance exercises with progressive overload. Vertical-jump performance was measured before and after the intervention and analyzed using Shapiro-Wilk and paired-samples t-test. Vertical-jump performance increased from 47.73 +/- 12.17 cm to 53.77 +/- 12.37 cm; the mean gain was 6.05 cm or 12.67%, $t(21) = 12.34$, $p < .001$, Cohen's dz = 2.63. The program significantly improved lower-limb explosive strength.

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Authors' contribution:
A - Conception and design of the study; B - Acquisition of data; C - Analysis and interpretation of data; D - Manuscript preparation; E - Obtaining funding

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INTRODUCTION

Tarung Derajat is an Indonesian combat sport that requires fast lower-limb force production for kicking, blocking, stance changes, and short-distance displacement. Local Tarung Derajat studies have reported that core endurance, body composition, aerobic fitness, leg strength, and achievement-related motivation are associated with physical readiness and kicking outcomes (Aldani et al., 2025; Febriza et al., 2025; Setiawan, 2021; Utami & Sungkowo, 2025). Similar evidence from Pencak Silat also emphasizes the role of lower-limb explosive power and flexibility in kick performance, indicating that combat-sport techniques depend on a coordinated interaction between technical skill and neuromuscular capacity (Ihsan et al., 2022). In school extracurricular environments, however, physical conditioning is often conducted as general practice rather than as a periodized program with measurable loading, progressive overload, and objective performance evaluation.

Recent resistance-training evidence supports the use of systematic loading to improve strength, hypertrophy, and neuromuscular performance. Systematic reviews and meta-analyses show that training load, volume, weekly dose, proximity to failure, and inter-set rest are relevant variables for strength and hypertrophy adaptations (Carvalho et al., 2022; Currier et al., 2023; Pelland et al., 2025; Refalo et al., 2021, 2023; Robinson et al., 2024; Singer et al., 2024; Swinton et al., 2024). Although the present intervention was not designed as a maximal-strength or plyometric phase, a hypertrophy phase can build tissue tolerance, work capacity, and foundational force-production capacity that may support later conversion into power-oriented movements.

Youth and adolescent training literature further indicates that supervised strength, plyometric, complex, eccentric, and functional training can improve sprinting, jumping, change-of-direction ability, and lower-limb strength when programs are age-appropriate and well supervised (Bright et al., 2023; Deng et al., 2023, 2024; Gao et al., 2025; Hu et al., 2025; Lin et al., 2025; Liu et al., 2025; Luo et al., 2025; Ma et al., 2025; Moreno-Torres et al., 2025; Pinho et al., 2024; Shen et al., 2025; Sun et al., 2025; Xu et al., 2025; Zheng et al., 2025; Zhou et al., 2024; Zhu et al., 2025). Martial-arts and combat-sport studies also show that plyometric-jump training and French contrast training can improve strength and power in combat athletes, although optimal doses vary across age, sex, training status, and sport demands (Chen, H., et al., 2025; Chen, L., et al., 2023, 2025; Jiang et al., 2025; Morris et al., 2022; Ojeda-Aravena et al., 2023; Yuan et al., 2025; Zhang et al., 2025).

Measurement is also a practical issue. Vertical-jump performance is widely used as a field indicator of lower-limb explosive strength because it is inexpensive, simple, and relevant to high-force, rapid-extension tasks. The validity and reliability of vertical-jump assessment devices and smartphone applications have been supported in recent studies, while youth-athlete research highlights the need to consider age, specialization, inter-limb asymmetry, and movement-screen reliability when interpreting jump outcomes (Balsalobre-Fernandez et al., 2024; Kalata et al., 2025; Kozinc et al., 2021; Lindblom et al., 2021; Montalvo et al., 2021; Silva et al., 2024; Stafylidis et al., 2025; Wirtz et al., 2023). Therefore, vertical jump is suitable for school-based monitoring, provided that procedures are standardized and repeated consistently.

Research gap. Most available evidence focuses on plyometric training, general resistance training, team sports, or elite combat-sport athletes. There is limited school-based evidence examining a structured hypertrophy-phase program among high-school Tarung Derajat extracurricular participants using a simple pretest-posttest vertical-jump assessment. Moreover, previous local work has mainly described physical fitness or correlated physical capacities with technique, rather than testing whether a short-periodized training phase improves lower-limb explosive output in a school extracurricular setting.

Novelty and objective. The novelty of this study lies in applying an eight-week hypertrophy-phase conditioning program to a high-school Tarung Derajat extracurricular group and reporting objective pre-post vertical-jump outcomes with effect size and confidence intervals. This approach links a practical school-training model with contemporary resistance-training evidence and a field-friendly performance test. The objective was to determine whether the eight-week hypertrophy-phase program improved lower-limb explosive strength among Tarung Derajat extracurricular participants.

RESEARCH METHODS

Study design

This study used a quantitative pre-experimental one-group pretest-posttest design. The design followed the structure O1-X-O2, where O1 represents the baseline vertical-jump assessment, X represents the eight-week hypertrophy-phase training program, and O2 represents the post-intervention assessment. This design was selected because the intervention was implemented in one intact extracurricular group. The absence of a control group is acknowledged as a methodological limitation.

Participants

The participants were 22 active members of the Tarung Derajat extracurricular program at SMAN 1 Cilaku. The sample consisted of 11 males and 11 females aged 15-18 years (mean = 16.18 +/- 1.05 years). Total sampling was used because all active members were included. For publication ethics and privacy, individual names from the raw data file were anonymized as P01-P22 in this manuscript.

Table 1.
Participant characteristics.

Characteristic	Category / statistic	Value
Sample size	Total participants	22
Sex	Male	11 (50.00%)
Sex	Female	11 (50.00%)
Age	Mean +/- SD	16.18 +/- 1.05 years
Age	Median (range)	16 (15-18) years
Age distribution	15 years	6 (27.27%)
Age distribution	16 years	10 (45.45%)
Age distribution	17 years	2 (9.09%)
Age distribution	18 years	4 (18.18%)

Note. Percentages are calculated from the full sample (N = 22).

Intervention: eight-week hypertrophy-phase training program

The intervention was conducted for eight weeks with three sessions per week. Each session consisted of dynamic warm-up, hypertrophy-phase lower-limb strengthening, Tarung Derajat technical practice, and cooldown. The training emphasized progressive overload, exercise technique, safety, and individual adjustment. The core exercises included squat variations, lunges, step-ups, calf raises, hip thrusts, and functional lower-limb movements. Exercise volume was generally maintained at 3-4 sets of 8-12 repetitions with 60-90 seconds of rest between sets. Loads were adjusted according to each student's technical capacity and readiness.

Table 2.
Overview of the eight-week hypertrophy-phase program

Weeks	Main training emphasis	Loading guideline	Technical and safety focus
1-2	Familiarization and movement quality	2-3 sets x 10-12 reps; low to moderate intensity	Squat/lunge mechanics, landing control, breathing, posture
3-4	Hypertrophy volume accumulation	3 sets x 8-12 reps; moderate intensity	Consistent range of motion, tempo control, progressive overload
5-6	Progressive lower-limb strengthening	3-4 sets x 8-12 reps; moderate to moderately high intensity	Technique under fatigue, balanced unilateral work, adequate recovery
7-8	Consolidation and readiness for power transfer	3-4 sets x 8-10 reps; moderate intensity with controlled intent	Maintain movement quality, avoid excessive fatigue before posttest

Note. The table summarizes the intervention model prepared for reporting. Loads should be individualized and supervised for adolescent participants.

Instrument and testing procedure

Lower-limb explosive strength was measured using a vertical-jump test. Scores were recorded in centimeters as the difference between standing reach and maximal jump reach. Testing was conducted after a standardized warm-up. Participants performed familiarization attempts, and the best valid trial was recorded. The same testing procedure was used at pretest and posttest to reduce measurement bias.

Statistical analysis

Descriptive statistics were reported as mean, standard deviation (SD), median, minimum, maximum, and 95% confidence interval (CI). Normality was examined using the Shapiro-Wilk test because the sample size was below 50. Because pretest, posttest, and change scores were normally distributed, the main pre-post comparison used a paired-samples t-test. A Wilcoxon signed-rank test was also reported as a non-parametric sensitivity analysis. Effect size was calculated as Cohen's dz using the mean difference divided by the SD of the difference scores. The alpha level was set at .05.

RESULTS AND DISCUSSION

Descriptive statistics and normality

Pretest vertical-jump performance averaged 47.73 +/- 12.17 cm, whereas posttest performance averaged 53.77 +/- 12.37 cm. The average pre-post gain was 6.05 +/- 2.30 cm. Shapiro-Wilk tests indicated that the pretest, posttest, and change scores did not significantly deviate from normality (all $p > .05$).

Table 3.

Descriptive statistics of vertical-jump performance.

Variable	N	Mean	SD	Median	Min	Max	95% CI for mean
Pretest (cm)	22	47.73	12.17	46.00	30	69	42.33 to 53.12
Posttest (cm)	22	53.77	12.37	52.00	36	76	48.29 to 59.26
Change (cm)	22	6.05	2.30	6.00	2	11	5.03 to 7.06

Note. Change score = posttest minus pretest.

Table 4.
Normality test results.

Variable	Shapiro-Wilk W	p value	Decision
Pretest	0.928	0.110	Normal
Posttest	0.921	0.080	Normal
Change	0.962	0.533	Normal

Note. Normality was interpreted at alpha = .05.

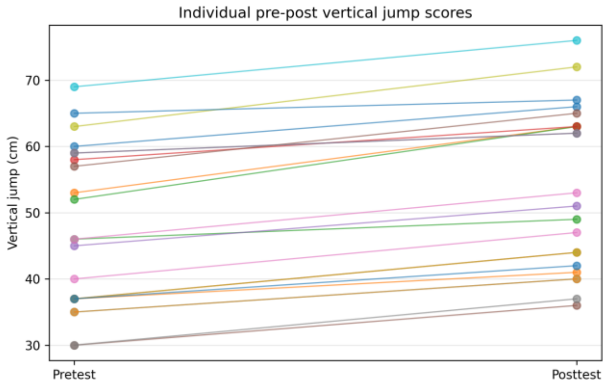

Figure 1.
Individual pre-post vertical-jump scores.

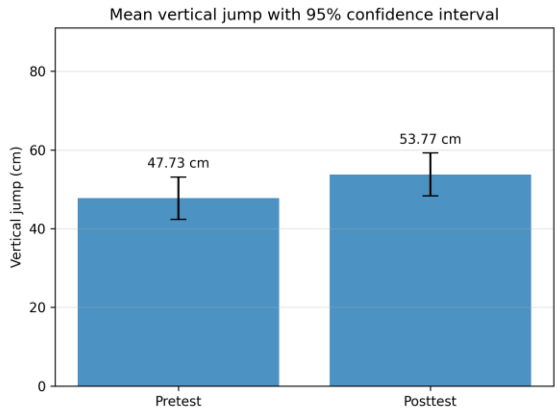

Figure 2.
Mean vertical-jump scores with 95% confidence intervals.

Main pre-post comparison

The paired-samples t-test showed a significant improvement from pretest to posttest, $t(21) = 12.34$, $p < .001$. The mean difference was 6.05 cm with a 95% CI of 5.03 to 7.06 cm. The percentage improvement was 12.67%, and the effect size was very large (Cohen's dz = 2.63; Hedges-corrected paired effect = 2.53). The Wilcoxon signed-rank sensitivity analysis confirmed the same conclusion ($W = 253$, $p < .001$).

Table 5.

Paired-samples t-test and effect size.

Comparison	**Mean difference**	**95% CI**	**t**	**df**	**p**	**Cohen's dz**	**Interpretation**
Posttest - pretest	6.05 cm	5.03 to 7.06	12.34	21	< .001	2.63	Very large

Note. Cohen's dz was calculated as mean paired difference divided by the standard deviation of paired differences.

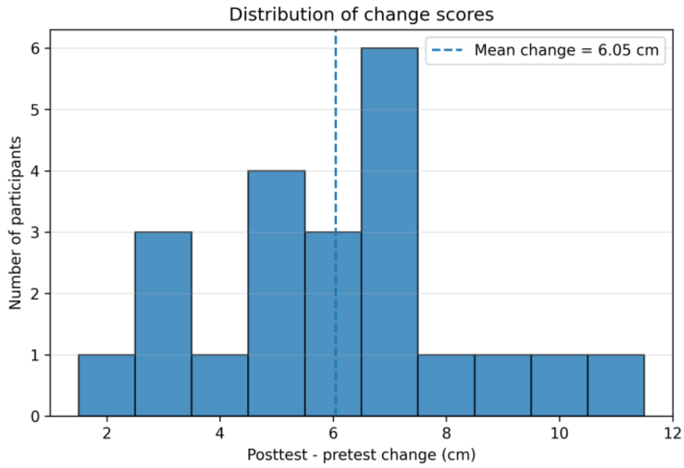

Figure 3.

Distribution of individual change scores.

Exploratory sex-stratified descriptive analysis

An exploratory sex-stratified summary was added to support transparent reporting. Because the study was not powered for between-sex comparisons, these results should be interpreted descriptively rather than inferentially.

Table 6.

Exploratory sex-stratified pre-post summary.

Sex	**N**	**Pretest mean +/- SD**	**Posttest mean +/- SD**	**Change mean +/- SD**	**Paired t**	**p**
Male	11	57.73 +/- 7.66	64.18 +/- 7.22	6.45 +/- 2.98	7.19	< .001
Female	11	37.73 +/- 5.71	43.36 +/- 5.55	5.64 +/- 1.36	13.73	< .001

Note. These subgroup results are descriptive because each subgroup contained only 11 participants.

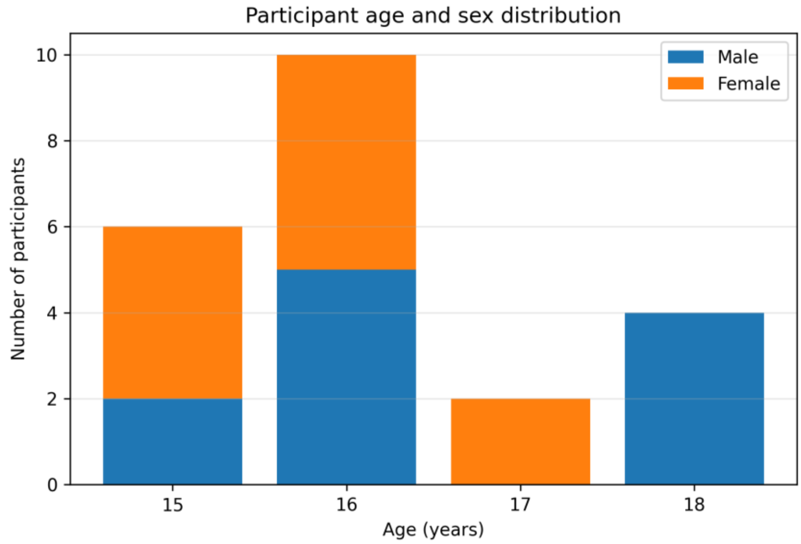

Figure 4.
Participant age and sex distribution.

Discussion

The main finding was that an eight-week hypertrophy-phase training program was associated with a statistically significant and practically meaningful improvement in vertical-jump performance among high-school Tarung Derajat extracurricular participants. The mean gain of 6.05 cm represented a 12.67% improvement from baseline and produced a very large, paired effect size. This improvement is consistent with contemporary evidence showing that resistance-oriented training can enhance muscular strength, power-related outcomes, and functional performance when training variables are organized systematically (Carvalho et al., 2022; Currier et al., 2023; Moda et al., 2023; Morris et al., 2022; Refalo et al., 2023; Swinton et al., 2024).

The result is also consistent with youth-training literature. Supervised strength training in children and adolescents has been shown to improve lower-limb strength, sprinting, and broader physical fitness outcomes, while plyometric and complex training can enhance jumping, sprinting, and change-of-direction performance (Bright et al., 2023; Chen, L., et al., 2023; Gao et al., 2025; Hu et al., 2025; Liu et al., 2025; Luo et al., 2025; Moreno-Torres et al., 2025; Pinho et al., 2024; Shen et al., 2025; Zhu et al., 2025). The present program was not primarily plyometric; nevertheless, the increase in vertical jump may reflect improved force-producing capacity, improved movement confidence, increased tolerance to lower-limb loading, and better coordination through repeated technical practice.

In combat sports, lower-limb power is relevant because kicking, evasion, and rapid stance changes depend on high-force actions executed within short time windows. Recent meta-analytic evidence in combat and martial arts athletes supports the usefulness of plyometric-jump training for muscle strength and power, while recent French contrast and blood-flow-restriction studies show that targeted lower-limb interventions can improve force development and power (Chen, H., et al., 2025;

Jiang et al., 2025; Ojeda-Aravena et al., 2023; Yuan et al., 2025). Tarung Derajat-specific work also supports the importance of physical capacities for sport-specific performance, including leg strength and kicking outcomes (Aldani et al., 2025; Febriza et al., 2025; Setiawan, 2021; Utami & Sungkowo, 2025).

The magnitude of change should be interpreted with caution because the design did not include a control group. In adolescent participants, improvements can be influenced by biological maturation, school activity, technical familiarization, learning effects, and motivational factors. Recent adolescent evidence indicates that age and maturation can alter responsiveness to plyometric and strength training, which may partly explain heterogeneity in individual responses (Chen, L., et al., 2025; Kalata et al., 2025; Zheng et al., 2025). Therefore, future studies should include a control or comparison group, maturity status, training attendance, perceived exertion, and sport-specific kick tests.

The use of vertical jump as the outcome measure was appropriate for a school-based study because it is low-cost and practical. However, measurement quality depends on standardized warm-up, consistent instructions, repeated attempts, and reliable recording. The literature supports the validity and reliability of vertical-jump devices and smartphone applications, but also warns that device choice, surface, and tester reliability can influence results (Balsalobre-Fernandez et al., 2024; Lindblom et al., 2021; Montalvo et al., 2021; Silva et al., 2024; Stafylidis et al., 2025; Wirtz et al., 2023). Future replications should consider video-based or app-based measurement to increase reproducibility.

The intervention can be positioned as a preparatory phase within a larger periodized training plan. After a hypertrophy phase, coaches may progress toward maximal strength, strength-speed, or plyometric emphasis depending on the competitive calendar and the technical needs of Tarung Derajat participants. Recent evidence suggests that complex training, variable resistance training, high-intensity training, and combined strength-plyometric models may offer additional routes for improving lower-limb power (Ma et al., 2025; Pan et al., 2025; Peng et al., 2025; Sun et al., 2025; Wang et al., 2025; Xu et al., 2025; Zhang et al., 2025; Zhou et al., 2024). For school settings, however, safety, technical supervision, and progressive loading should remain the priority.

Limitations

First, the one-group pretest-posttest design limits causal inference because no non-training or alternative-training control group was available. Second, the sample was small and came from one school extracurricular group, limiting generalizability. Third, biological maturity, attendance, nutrition, sleep, and training load were not quantified in detail. Fourth, vertical jump was the only performance outcome; future studies should add sport-specific kicking, sprinting, change-of-direction, and strength tests. Fifth, the study did not examine retention after detraining or longer-term periodization effects.

Practical implications

For coaches and physical education teachers, an eight-week hypertrophy-phase block can be used as an introductory strength-conditioning phase for Tarung Derajat extracurricular participants when delivered with supervision, appropriate loading, and consistent technique feedback. The program should not replace technical training; rather, it should support technical execution by improving lower-limb force capacity and movement tolerance. Vertical-jump monitoring can be repeated every 4-8 weeks to evaluate adaptation and guide training progression.

CONCLUSION

The eight-week hypertrophy-phase program was associated with a significant improvement in lower-limb explosive strength as measured by vertical jump. Mean performance increased from 47.73 cm to 53.77 cm, with a mean gain of 6.05 cm and a very large, paired effect size. These findings suggest that structured hypertrophy-phase training is a promising and practical conditioning strategy for school-based Tarung Derajat participants. Stronger evidence requires controlled studies with larger samples, maturity assessment, training-load monitoring, and sport-specific performance outcomes.

Data availability and ethics statement

The raw spreadsheet contained identifiable student names. For publication, the dataset was anonymized using participant codes P01-P22. The data used for the analyses in this manuscript are reproduced in Appendix A. The authors should ensure institutional approval, parental/guardian consent where required, and participant assent before journal submission.

Conflict of interest

The authors declare no conflict of interest.

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