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Effects of a Unilateral Plyometric Training Program and the Association of Training Motivation with Take-Off Power in Long-Jump Athletes

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Abstract

Objectives: This study examined changes in take-off power following a unilateral plyometric training program and tested whether training motivation was associated with the magnitude of improvement among long-jump athletes from the Kuda Terbang Athletics Club, Bima City.

Materials and Methods: A one-group pretest–posttest quasi-experimental design was used. Ten active long-jump athletes aged 16–18 years were recruited through total sampling. The four-week intervention comprised three weekly sessions of single-leg hops, single-leg bounds, and single-leg box jumps. Take-off power was assessed with the Single-Leg Vertical Jump Test, and training motivation was measured with a 20-item Likert questionnaire (Cronbach's $\alpha = 0.82$). Data were analyzed using descriptive statistics, Shapiro–Wilk tests, a paired-samples t-test, and simple linear regression at $\alpha = 0.05$.

Results: Mean single-leg vertical-jump height increased from 27.50 ± 3.02 cm to 28.30 ± 2.62 cm. The mean improvement was 0.80 cm (95% CI: 0.35–1.25), $t(9) = 4.00$, $p = 0.003$, with a large within-participant effect (d_v = 1.26). Motivation explained 56.2% of the variance in gain scores, $F(1,8) = 10.264$, $p = 0.013$; however, the association was negative ($B = -0.099$, $\beta = -0.750$), indicating smaller gains among athletes with higher motivation scores in this sample.

Conclusions: Four weeks of unilateral plyometric training were associated with a statistically significant improvement in take-off power. The negative motivation–gain association should not be interpreted causally because the study had only 10 participants, no control group, and restricted motivation scores. Larger controlled studies are required before drawing conclusions about motivation as a predictor of adaptation.

Keywords: long jump; unilateral plyometrics; take-off power; training motivation; vertical jump

Introduction

Long-jump performance depends on the athlete's ability to preserve horizontal velocity during the approach and rapidly generate an appropriately directed impulse during take-off. This phase is executed from one leg and requires substantial lower-limb strength, rate of force development, neuromuscular coordination, and efficient use of the stretch–shortening cycle. Muscular strength is a foundational quality for power production and sport-specific performance (Suchomel et al., 2016), while plyometric training is widely used to improve explosive actions by coupling rapid eccentric loading with an immediate concentric response.

Evidence from systematic reviews indicates that plyometric training can improve vertical-jump height, sprint performance, and lower-body strength (Markovic, 2007; Oxfeldt et al., 2019; Stojanović et al., 2017). Neuromuscular adaptations may include improved motor-unit recruitment, tendon behavior, intermuscular coordination, and use of stored elastic energy (Ramírez-delaCruz et al., 2022). These adaptations are relevant to long jump because the take-off must be forceful, rapid, and technically coordinated.

Exercise specificity provides a rationale for emphasizing unilateral drills. Compared with bilateral tasks, unilateral exercises more closely resemble the single-leg take-off and impose additional requirements for balance and frontal-plane control. Drouzas et al. (2020) reported superior improvements in selected strength, speed, and power outcomes after volume-matched unilateral plyometric training, while broader syntheses have found task-specific advantages of unilateral training for unilateral and horizontally oriented performance (Moran et al., 2021; Zhang et al., 2023). Unilateral plyometrics may also reduce lower-limb asymmetry (Sun et al., 2025), although the transfer of these adaptations depends on the athlete, exercise selection, dose, and performance test.

Training adaptation is not solely physiological. Motivation influences persistence, effort, attendance, and engagement with coaching tasks. Self-determination theory proposes that higher-quality, more autonomous motivation is supported when athletes experience autonomy, competence, and relatedness (Ryan & Deci, 2020). Autonomy-supportive coaching has been linked to self-determined motivation and sport performance (Gillet et al., 2010). However, the statistical association between a motivation score and short-term physical improvement may be complex, especially in small samples where ceiling effects, baseline differences, and measurement error can strongly affect regression estimates.

At the Kuda Terbang Athletics Club in Bima City, preliminary observations suggested that athletes' take-off power was moderate to low, training was dominated by general and bilateral exercises, and training motivation varied. Evidence specifically integrating a unilateral plyometric intervention with analysis of motivation and take-off-power change among Indonesian long-jump athletes remains limited. Therefore, this study aimed (1) to determine whether take-off power changed after a four-week unilateral plyometric program and (2) to examine the association between training motivation and individual gain in take-off power.

Materials and Methods

Study Design

This study used a quantitative one-group pretest–posttest quasi-experimental design. All participants completed baseline testing, undertook the same four-week unilateral plyometric program, and repeated the take-off-power test after the intervention. Because there was no control group, the design estimates within-participant change but cannot isolate the intervention from maturation, concurrent training, repeated-testing effects, or other time-related influences.

Study Participants

The study was conducted at the Kuda Terbang Athletics Club, Bima City, Indonesia, from April to May 2026. The population consisted of all active long-jump athletes registered with the club. Total sampling produced 10 male and female participants aged 16–18 years, each with approximately 2–4 years of training experience and active participation in the club's routine program. The source manuscript did not report the sex distribution or provide participant-level baseline characteristics.

Study Organization

Take-off power was operationalized as single-leg vertical-jump height and assessed using the Single-Leg Vertical Jump Test. Training motivation was measured once using a 20-item Likert questionnaire covering persistence, interest, enthusiasm, and discipline. The questionnaire was evaluated using product–moment item correlations and demonstrated internal consistency of Cronbach's α = 0.82. The reported instrument information did not include the response range, total-score range, item-validity coefficients, or timing of questionnaire administration relative to the intervention.

The intervention was conducted three times per week for four weeks. Each session included a 10–15-minute warm-up, 30–40 minutes of primary training, and a 10-minute cool-down. Exercise complexity and volume progressed across the program (Table 1). All testing used the same procedure before and after the intervention.

Table 1. Four-week unilateral plyometric training program

Week	Primary exercise	Volume	Training emphasis
1	Single-leg hops	3 × 8 repetitions	Moderate intensity; landing control
2	Single-leg bounds	3 × 10 repetitions	Horizontal force and rhythm
3	Single-leg box jumps	4 × 8 repetitions	High-intensity vertical impulse
4	Combined unilateral drills	Progressive volume	Integrated and progressive loading

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Statistical Analysis

Descriptive statistics were calculated using SPSS. Because the sample was small (n = 10), normality was evaluated with the Shapiro–Wilk test. Pretest and posttest jump heights were compared using a paired-samples t-test. The within-participant effect size was calculated as Cohen's d_v (mean change divided by the standard deviation of change scores). Simple linear regression was used to examine whether training motivation predicted the gain score in take-off power. Statistical significance was set at $p < 0.05$. No adjustment for covariates or multiple testing was reported.

Results

All Shapiro–Wilk tests were nonsignificant ($p > 0.05$), providing no evidence against normality for motivation, pretest scores, or posttest scores (Table 2). Given the very small sample, these tests have limited power and were considered together with the study design.

Table 2. Shapiro–Wilk normality tests

Variable	W	df	p
Training motivation	0.910	10	0.283
Vertical jump—pretest	0.936	10	0.504
Vertical jump—posttest	0.949	10	0.656

Mean jump height increased from 27.50 cm at pretest to 28.30 cm at posttest (Table 3). The mean increase was 0.80 cm, with a 95% confidence interval from 0.35 to 1.25 cm. The paired-samples test was statistically significant, $t(9) = 4.00$, $p = 0.003$. The standardized within-participant effect was large ($d_v = 1.26$).

Table 3. Pretest–posttest comparison of take-off power

Measure	Mean (cm)	SD	Mean gain	95% CI of gain	t (df)	p
Pretest	27.50	3.02				
Posttest	28.30	2.62	0.80	0.35–1.25	4.00 (9)	0.003

Simple regression indicated that motivation accounted for 56.2% of the variance in take-off-power gain scores, $F(1,8) = 10.264$, $p = 0.013$ (Table 4). The unstandardized coefficient was negative ($B = -0.099$, $SE = 0.031$), as was the standardized coefficient ($\beta = -0.750$). Within this sample, each one-unit increase in the motivation score was associated with an estimated 0.099-cm smaller gain. This is an association and does not establish that motivation reduced training adaptation.

Table 4. Regression of take-off-power gain on training motivation

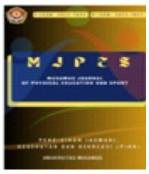
Predictor	B	SE B	β	t	p	R^2
Constant	7.441	2.078	—	3.581	0.007	
Training motivation	−0.099	0.031	−0.750	−3.204	0.013	0.562

Discussion

The main finding was a statistically significant 0.80-cm increase in single-leg vertical-jump height after four weeks of unilateral plyometric training. Although the absolute improvement was modest, the low variability of individual change scores produced a large standardized within-participant effect. This direction agrees with meta-analytic evidence that plyometric training improves jump performance across different athlete populations (Markovic, 2007; Oxfeldt et al., 2019; Stojanović et al., 2017). It is also physiologically plausible because repeated stretch–shortening-cycle actions can improve rapid force production, coordination, and the use of elastic energy (Ramírez-delaCruz et al., 2022).

The unilateral nature of the program is relevant to long jump because competitive take-off occurs from one leg. Drouzas et al. (2020) found that unilateral plyometric training produced favorable lower-limb strength, speed, and power adaptations compared with volume-matched bilateral training in young athletes. Moran et al. (2021) and Zhang et al. (2023) similarly emphasized task specificity when comparing unilateral and bilateral training. In addition, single-leg plyometric work can challenge balance and landing control, outcomes that may support stable force application (Ramachandran et al., 2021; Zhao et al., 2024). The present result therefore supports the practical inclusion of single-leg hops, bounds, and box jumps in long-jump conditioning, provided that loading, surface, technique, and recovery are appropriately managed.

The four-week duration was shorter than many interventions synthesized in previous reviews. Evidence nevertheless indicates that jump training can generate meaningful performance changes when exercise selection, progression, and



adherence are appropriate (Ramirez-Campillo et al., 2021). The combined progression from hops to bounds and box jumps may have provided varied vertical and horizontal stimuli. However, the study did not measure approach velocity, take-off angle, reactive strength, horizontal jump distance, actual long-jump performance, or training load. Consequently, the observed improvement in a single-leg vertical-jump test cannot be assumed to represent an equivalent improvement in competition distance.

The motivation analysis requires substantially more caution. Motivation explained 56.2% of gain-score variance, but its coefficient was negative: athletes with higher motivation scores tended to show smaller improvements. This differs from motivational theory and prior evidence suggesting that autonomy-supportive environments and self-determined motivation can support engagement and performance (Gillet et al., 2010; Ryan & Deci, 2020). The present coefficient should not be interpreted as evidence that motivation is harmful. With only 10 athletes, one or two observations can strongly influence a regression slope. A restricted high range of motivation scores can further destabilize estimates, and athletes with lower initial performance may have had greater scope to improve.

The finding also illustrates the difference between statistical significance and causal explanation. The regression was cross-sectional with respect to motivation and change; it did not manipulate motivation, adjust for baseline jump height, or account for attendance, perceived exertion, sleep, nutrition, sex, biological maturation, or prior plyometric exposure. A more defensible future model would preregister the direction of the association, use a larger sample, report the distribution and reliability of the motivation score, include baseline performance as a covariate, and examine influential observations and confidence intervals. Repeated motivation measures could also determine whether motivation changed during the intervention.

Practically, coaches may use unilateral plyometric exercises as one component of a progressive long-jump program. The results do not justify replacing technical take-off practice, sprint work, bilateral strength development, or recovery management. Because high-intensity unilateral landings increase coordination and stabilization demands, athletes should first demonstrate adequate strength and landing mechanics. Coaches should also cultivate motivation through clear goals, meaningful choice, competence-supportive feedback, and positive relationships rather than treating a single questionnaire score as a direct determinant of adaptation.

This study has important limitations. The one-group design cannot exclude testing, maturation, or concurrent-training effects; the sample was small and drawn from one club; the intervention lasted only four weeks; the sex composition was not reported; and assessor blinding and test reliability were not described. Motivation measurement details were incomplete, while the physical outcome was a proxy rather than actual long-jump distance. The strong negative regression coefficient may reflect sampling instability or a ceiling effect. These limitations reduce external validity and require the results to be regarded as preliminary.

Conclusions

A four-week program of unilateral plyometric variations was associated with a significant increase in single-leg vertical-jump height among 10 long-jump athletes from the Kuda Terbang Athletics Club. Mean performance improved from 27.50 to 28.30 cm, with a mean gain of 0.80 cm. Training motivation significantly predicted gain scores but in a negative direction; therefore, the result does not support a simple claim that greater motivation caused greater physical improvement. Coaches may consider progressive unilateral plyometrics as a specific supplement to long-jump training, while future randomized controlled studies with larger samples, complete participant characteristics, repeated motivation measurement, and sport-specific performance outcomes are needed.

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Author Contributions

Sulistiawati: conceptualization, methodology, investigation, and original draft preparation. Mulyadi, Salahudin, Anhar, and Mardian Adriani: supervision, data interpretation, review, and editing. All authors approved the final manuscript and accept responsibility for the integrity of the work.

Conflict of Interest

The authors declare no conflict of interest.

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