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Short-Term Plyometric Mesocycle Improves Vertical Jump Performance in Competitive Taekwondo Athletes: A Single-Group Pre-Post Study with Concurrent Coach-Prescribed Strength Training

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Abstract

Using a single-group pre-post design, this study examined the short-term effects of a mesocycle focused on plyometrics conducted alongside the team's usual strength training on squat jump (SJ), countermovement jump (CMJ), and drop jump (DJ) performance in competitive taekwondo athletes. Ten male athletes (19.57 ± 0.98 years) completed an 8-week program during the general preparation phase; strength work proceeded as part of the team routine and was not investigator-controlled or logged. Pre-post testing quantified jump height in SJ, CMJ, and DJ using a validated optical system. Reactive metrics (ground contact time [GCT] and the reactive strength index [RSI]) were obtained for the DJ only. Paired-samples analyses showed short-term improvements in jump height across tests: SJ (pre: 38.13 ± 4.69 cm; post: 41.97 ± 5.01 cm; +10.1%), CMJ (pre: 40.93 ± 5.86 cm; post: 44.50 ± 6.25 cm; +8.7%), and DJ (pre: 32.77 ± 4.96 cm; post: 36.21 ± 4.00 cm; +10.5%). In the DJ, improvements included greater jump height and shorter GCT, which together yielded a higher RSI, indicating enhanced fast stretch-shortening cycle (SSC) execution. These findings suggest that, within an ecologically valid combined-practice context, a short plyometric mesocycle may support near-term gains in jump performance, with reactive strength benefits evident in the DJ. Causal inference is limited because strength training occurred concurrently and was not controlled.

Keywords

Taekwondo, Plyometric Training, Combined Practice, Short-Term Effects, Squat Jump (SJ), Countermovement Jump (CMJ), Drop Jump (DJ), Reactive Strength Index (RSI), Ground Contact Time (GCT)

1. Introduction

Taekwondo is a Korean martial art that has evolved from a military combat system into a modern competitive sport. After World War II, techniques from traditional styles were consolidated into a unified method, forming the basis of the contemporary sport. Since the 1950s, Taekwondo has undergone steady modernization, culminating in official Olympic recognition in 1994 and inclusion in the Olympic Games from 2000 (Pieter & Heijmans, 2000).

As a competitive sport, Taekwondo is characterized by frequent high-velocity kicking, rapid decision-making, and repeated explosive actions under time pressure. Performance hinges on lower limb power, inter-limb coordination, and dynamic control, and World Taekwondo (WT, formerly WTF) competition emphasizes technology-assisted scoring and sport performance, a feature that distinguishes modern WT competition formats from many other combat sports contexts (Heller et al., 1998). These neuromechanical demands motivate the use of standardized jump assessments, particularly the drop jump (DJ) and the reactive strength index (RSI), for performance profiling.

Lower limb strength is a primary determinant of performance in Taekwondo, supporting rapid kicking, quick jumping actions, and stance stability (Fong & Ng, 2011; Kim et al., 2011). In practice, performance depends on integrating strength and speed with technical and tactical skills, so explosive strength and jump-based drills are common in high-level preparation. Accordingly, short, repeated exchanges in Taekwondo rely on the alactic anaerobic (ATP-PCr) system to provide immediate power and enable rapid recovery between efforts (Campos et al., 2002; Casolino et al., 2012; Ojeda-Aravena et al., 2022; Tornello et al., 2013).

From a neuromechanical perspective, lower limb actions in competition commonly reflect three transition types between muscle contraction modes: 1) isometric to concentric, 2) controlled eccentric braking followed by a fast concentric action with a longer eccentric to concentric coupling time (a slower SSC), and 3) rapid eccentric braking followed by a fast concentric action with minimal coupling time (a fast SSC) (Komi, 1984; Nicol et al., 2006; Turner & Jeffreys, 2010). In high-performance sports science, three jump assessments are frequently used to profile these qualities: squat jump (SJ), countermovement jump (CMJ), and drop jump (DJ). These tests are widely employed in Taekwondo training and periodic evaluations (Ojeda-Aravena et al., 2021; Ouergui et al., 2020). Interventions reported in the literature have typically been short with a limited number of sessions, and elite athletes generally outperform recreational counterparts in jump metrics (Bridge et al., 2014). Mechanistically, CMJ and DJ emphasize reactive strength via the fast SSC, whereas SJ starts from an isometric squat and minimizes SSC contribution, thereby isolating concentric force production (Castagna & Castellini, 2013; McGuigan et al., 2006; Suchomel et al., 2016). Prior research has shown associations between SJ/CMJ performance and speed/change-of-direction ability in Taekwondo, karate, fencing, and across elite athletes in agility-dominant sports (Chaabene et al., 2017; Chtara et al., 2020; Herrera-Valenzuela et al., 2021). A DJ entails stepping off a box from a known height, contacting the ground, and immediately performing a maximal vertical rebound while minimizing ground-contact time (GCT) (Byrne et al., 2016; González-García et al., 2024). The DJ is commonly evaluated alongside the RSI, calculated as jump height divided by GCT. RSI reflects an athlete's capacity to transition rapidly from eccentric braking to concentric propulsion within a fast SSC. Because RSI is technique sensitive, valid comparisons require standardized and explicitly reported testing procedures, including drop height, hand position, arm swing, the chosen strategy (bounce or countermovement), trunk posture, footwear, surface, and timing method (Struzik et al., 2016). Using several drop heights in DJ testing helps determine each athlete's optimal height, where RSI is highest. When the testing procedures are standardized, the results are acceptably consistent across different days (Byrne et al., 2016). Recent work also shows acceptable within- and between-day reliability for CMJ and DJ outcomes when familiarization, warm-up, and consistent cueing are provided, and recommends reporting indices such as the coefficient of variation and the minimal detectable change for applied monitoring (González-García et al., 2024). Moreover, a systematic review and meta-analysis indicate that plyometric jump training improves RSI compared with controls, underscoring RSI's value for performance tracking (Ramirez-Campillo et al., 2023).

To date, the scientific literature has not documented a short-term training program that integrates all three jump modalities (SJ, CMJ, and DJ) within a single combined jump and strength regimen for competitive Taekwondo. Accordingly, this study presents an eight-week program and quantifies short-term changes in SJ, CMJ, and DJ performance among elite competitive taekwondo athletes during the general preparation period. We hypothesized significant improvements from pre-post across all three tests, including an increase in DJ RSI that would reflect higher jump height and/or reduced GCT.

2. Materials and Methods

2.1. Study Design

The study used a single-group pre-post design in competitive Taekwondo athletes. Performance in three jump tests (SJ, CMJ, DJ) was assessed at two time points (pre-intervention and post-intervention) to evaluate the short-term effects of a plyometric-focused mesocycle with concurrent usual strength training on jump performance.

2.2. Participants

Thirteen competitive male Taekwondo athletes initially enrolled. Three athletes withdrew during the mesocycle due to a viral illness and an injury sustained during combat practice. This left a final analytic sample of ten athletes (age 19.57 ± 0.98 years; height 1.77 ± 0.06 m; body mass 71.14 ± 5.83 kg; BMI 21.84 ± 1.68) with 5 - 14 years of Taekwondo experience, all training within the same team structure (six days per week with one rest day). Athletes with a history of lower-limb joint injury involving the ankle, knee, or hip were excluded, and at screening, all enrolled participants reported no pain or functional limitations and were cleared for full participation. The study was approved by the Institutional Ethics Committee of the affiliated academic center. All participants provided written informed consent for the use of their training and testing data, and were asked to refrain from non-scheduled physical activity outside the team program.

2.3. Concurrent Training Context

Throughout the intervention, athletes continued routine, coach-prescribed strength training as part of team practice. These sessions were not investigator-controlled or logged, so detailed load and volume data were unavailable, including set-rep structures, rest intervals, perceived exertion, or changes in maximal strength. All participants had prior experience with structured strength training in the team program.

2.4. Procedures

The study spanned ten weeks. Baseline jump testing (pre) was conducted in Week 1. The intervention lasted eight weeks during Weeks 2 to 9. Post-intervention testing (post) occurred in Week 10. During the intervention, athletes trained three days per week with two same-day sessions on each training day: a coach-led jump session combined with the team's usual free-weight work, and a routine technical and tactical Taekwondo session. Strength work was part of the regular team schedule and was individualized by the coaching staff. The investigators did not plan, manage, supervise, or execute these training sessions.

2.5. Training Protocol

To evaluate short-term effects, athletes followed a weekly microcycle with three combined training days (Sunday, Tuesday, Thursday). Each of these days included two same-day sessions: morning 10:00 - 11:30 (jump training plus free-weight strength) and afternoon 16:00 - 17:30 (technical/tactical Taekwondo). On Monday, Wednesday, and Friday, only technical/tactical practice was conducted. Saturday was a rest day. All sessions were held indoors under typical environmental conditions (ambient temperature ≈ 18˚C - 22˚C).

Free-weight strength targeted multi-joint patterns of the upper, mid, and lower body using an Olympic barbell and plates: 1) bench press, 2) back squat, 3) deadlift. Each exercise was performed for three sets—one at 10 RM (maximum load for 10 repetitions with proper technique) followed by two at 5 RM—with ~1 min rest between exercises and ~2 min between sets as per team routine (Baechle & Earle, 2008). Each training session followed a fixed jump sequence: hurdle jumps at 40 cm (3 sets), then the three jump modalities assessed in this study (SJ, CMJ, DJ). Each jump modality was performed for three sets of five repetitions. A standardized order was maintained across sessions, with ~2 min rest between sets and brief passive rest between jump modalities.

2.6. Measurement Instruments

Jump height (cm) was recorded using an optical system (Optojump Next, Microgate, Bolzano, Italy) in the affiliated physiology laboratory under standardized conditions following a structured warm-up. The system consisted of two parallel optical bars placed on the floor, and data were processed with the manufacturer's software. For drop jumps (DJ), ground-contact time (GCT) was recorded in milliseconds, and the reactive strength index (RSI) in centimeters per millisecond was computed as jump height in centimeters divided by GCT in milliseconds. Each assessment session included: 1) a 16-min general warm-up consisting of approximately 6 min of joint mobility for all major joints in multiple planes, 5 min of light jogging, and 5 min of specific stretching for the back and lower extremities. 2) specific rehearsal for the three jump tasks (SJ, CMJ, DJ). 3) 5 min of seated rest before testing. The tests were administered in a fixed order across the three jump types (SJ, CMJ, DJ). Within each type, athletes completed three trials with approximately 1 min of passive rest between trials and approximately 3 min between jump types. The best trial for each type was retained for analysis. To isolate lower-limb power and neutralize the influence of arm swing, all jumps were performed with hands on the hips and the trunk upright, and verbal instructions were standardized across athletes. Attempts were repeated if an arm swing occurred or if the hands left the hips. Prior to testing, the measurement system was calibrated in accordance with the manufacturer's instructions. All testing and measurements were performed and evaluated by the investigator, with laboratory staff assisting in test administration or evaluations, in accordance with the laboratory's standard operating procedures. Raw data were exported for analysis.

2.7. Jump Assessment Procedures

SJ testing. The squat jump was initiated from a static isometric position with the thighs parallel to the ground, approximately 90˚ of knee flexion. A brief pause eliminated any countermovement. Participants were instructed to jump from a complete standstill as high as possible. After each attempt, participants returned to the standardized starting position. General procedures (number of trials, rest intervals, order of tests) followed by measurement instruments.

CMJ testing. From an upright starting position with feet shoulder-width apart and hands on the hips (no arm swing), athletes performed a rapid countermovement to a self-selected depth that optimized jump performance. The action comprised an eccentric action of the knee and hip extensors followed immediately by a forceful concentric push-off, emphasizing a swift transition consistent with the

SSC. Jump height (cm) was recorded, and the best trial was retained for analysis. General procedures (number of trials, rest intervals, order of tests) followed by measurement instruments.

DJ testing. Athletes performed drop jumps from a 40 cm platform. They stepped off to land with feet shoulder-width apart, hands on the hips, trunk upright, and with minimized knee flexion so the knees remained relatively extended. Upon ground contact, they executed a maximal vertical rebound, aiming to minimize GCT and to achieve the highest possible jump. Coaching cues emphasized a brisk SSC characterized by a brief eccentric landing followed immediately by an explosive concentric take-off. At the ankle joint, the landing involved a short dorsiflexion phase followed by rapid plantarflexion at push-off. The primary plantarflexors were the triceps surae (gastrocnemius and soleus), with stabilizing contributions from peroneus longus, peroneus brevis, and tibialis posterior, while proximal extensors at the knee and hip supported vertical propulsion. General procedures and outcomes were as described in Measurement instruments (DJ height in cm, GCT in ms, RSI (cm/ms), computed as jump height in centimeters divided by GCT in milliseconds. DJ-specific validity criteria included no pre-tension step or hop before the drop, no exaggerated countermovement after contact in order to maintain a quick transition, and no loss of balance at landing or take-off. Trials that violated these criteria were repeated.

2.8. Statistical Analysis

Normality of the pre-post difference scores was assessed with the Shapiro-Wilk test. Given the small sample and the robustness of parametric procedures, paired-samples t tests were conducted for pre-post comparisons. The mean pre-post difference with its 95% confidence interval, t, df, two-sided tests were used, Cohen's d_z for paired designs ($d_z = t/\sqrt{n}$), and the equivalent F-statistic ($F(1, 9) = t^2$) are reported. For interpretation, higher values indicate improvement for jump height and RSI, whereas for GCT, a negative percent change reflects improvement. Percent change was computed as (Post − Pre)/Pre × 100.

3. Results

Descriptive and inferential outcomes for SJ, CMJ, and DJ are summarized in **Table 1**. All jump modalities showed increased height, while DJ GCT decreased (i.e., shorter/faster ground-contact time, indicating improvement), and RSI (cm/ms) increased. Test statistics and effect sizes appear in **Table 1**; graphical summaries are provided in **Figures 1-4**. Most athletes shifted toward higher iso-RSI bands, reflecting greater jump height, shorter ground-contact time, or both (**Figure 3**).

Across the cohort, SJ, CMJ, and DJ height increased significantly (all $p < 0.001$), whereas DJ GCT decreased ($p = 0.040$), indicating faster ground contact; consequently, DJ RSI improved markedly ($p < 0.001$). Effect sizes (Cohen's d_z) were large for SJ (1.964), CMJ (2.858), DJ height (1.596), and DJ RSI (1.932), and moderate for DJ GCT (−0.757), consistent with the directionality that lower GCT reflects improvement.

Table 1. Jump outcomes pre-post ($n = 10$). Values are mean ± SD. Absolute change = Post − Pre; Percent change = (Post − Pre)/Pre × 100. Lower GCT indicates faster contact. RSI (cm/ms) was computed as height in centimeters divided by GCT in milliseconds. Two-tailed paired tests. Effect sizes are Cohen's $d_z = t/\sqrt{n}$.

Outcome	Pre (mean ± SD)	Post (mean ± SD)	Absolute change	Percent change	$F(1, 9)$	p	Cohen's d_z
SJ (cm)	38.13 ± 4.69	41.97 ± 5.01	3.84***	10.1	38.574	<0.001	1.964
CMJ (cm)	40.93 ± 5.86	44.50 ± 6.25	3.57***	8.7	81.692	<0.001	2.858
DJ height (cm)	32.77 ± 4.96	36.21 ± 4.00	3.44***	10.5	25.464	<0.001	1.596
DJ GCT (lower is better) (ms)	182.98 ± 21.54	176.11 ± 13.20	−6.87*	-3.8	5.738	0.040	−0.757
DJ RSI (cm/ms)	0.181 ± 0.034	0.207 ± 0.029	0.026***	14.1	37.321	<0.001	1.932

Abbreviations: SJ = squat jump; CMJ = countermovement jump; DJ = drop jump; GCT = ground-contact time; RSI = reactive strength index. *$p < 0.05$ and ***$p < 0.001$ indicate statistically significant pre-post differences (two-tailed paired tests; $\alpha = 0.05$).

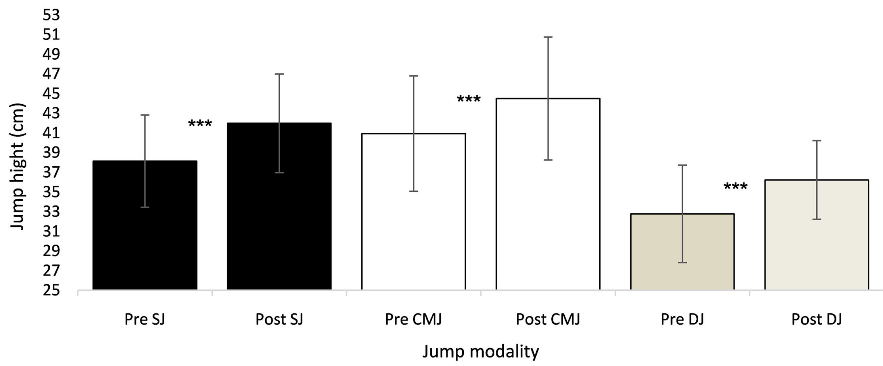

Figure 1. Pre- and post-intervention comparison of jump height (mean ± SD). SJ = squat jump; CMJ = countermovement jump; DJ = drop jump. ***$p < 0.001$, pre-post difference.

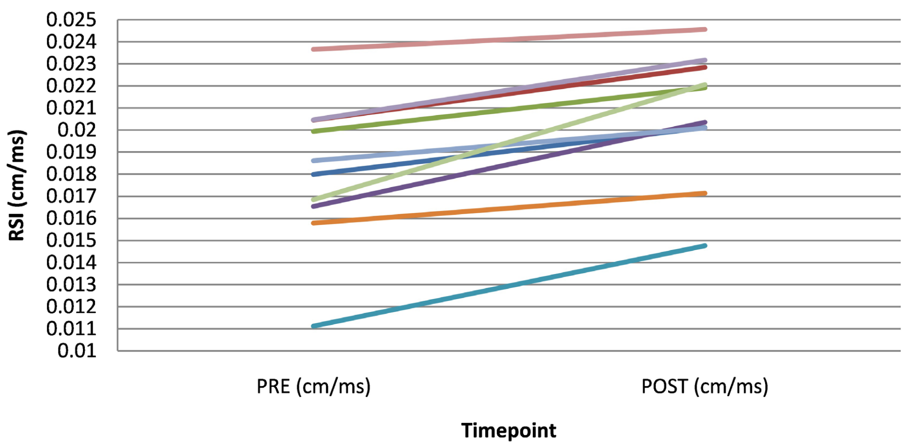

Figure 2. Individual pre-to-post changes in drop jump reactive strength index (RSI, cm/ms); lines connect each athlete ($n = 10$). Individual paired traces show that nearly all athletes improved RSI from pre-post, with modest between-subject variability. The paired-line display emphasizes consistent within-subject gains without relying on subject identifiers.

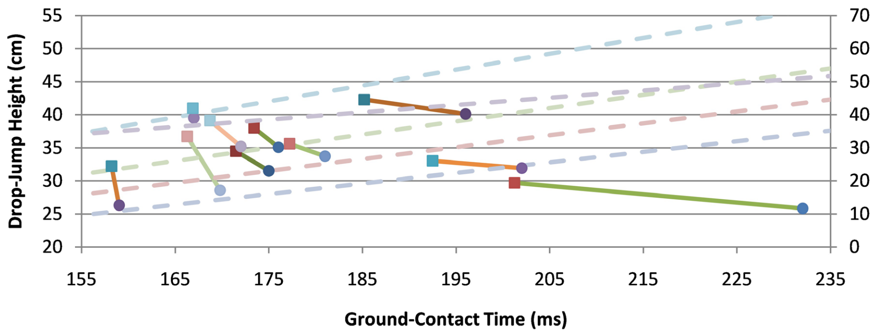

Figure 3. RSI-map showing individual PRE (●) and POST (▪) values with iso-RSI reference lines (e.g., 1.6 - 2.7 cm/ms; higher = better). Lower GCT indicates faster contact; lines connect each athlete from pre-post (n = 10). Legend: Level 1 (≈1.6 cm/ms), Level 2 (≈1.8 cm/ms), Level 3 (≈2.1 cm/ms), Level 4 (≈2.4 cm/ms), Level 5 (≈2.7 cm/ms).

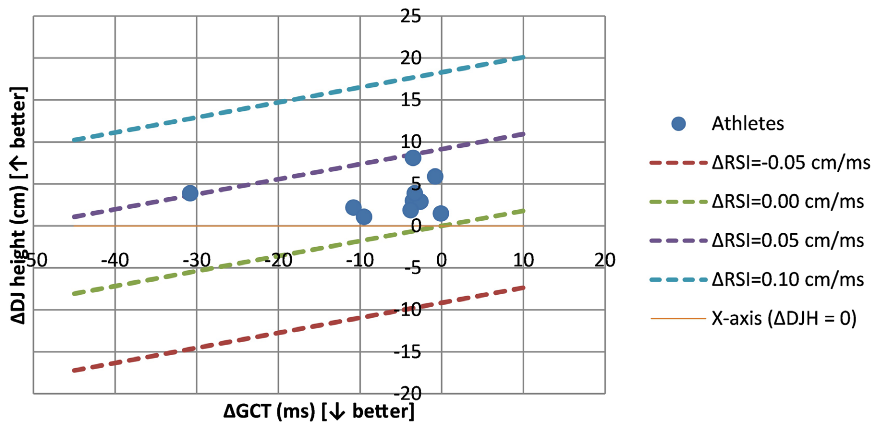

Figure 4. Change-change plot of ΔDJ height (cm) versus ΔGCT (ms) with iso-ΔRSI contours (cm/ms) computed around the cohort PRE mean. Leftward = shorter ground-contact (improvement); upward = higher drop-jump height (improvement). Points farther above the ΔRSI = 0 line indicate greater increases in RSI, whereas points below indicate decreases.

4. Discussion

The present study demonstrated statistically significant short-term improvements in jump performance across all three tests (SJ, CMJ, DJ) in competitive Taekwondo athletes following an eight-week plyometric-focused mesocycle undertaken alongside coach-prescribed strength training. At the group level, SJ, CMJ, and DJ height increased, DJ GCT decreased, and DJ RSI (cm/ms) increased from pre to post, indicating enhanced ability to transition rapidly from eccentric braking to concentric propulsion within the fast SSC. These outcomes are consistent with the intended content and timing of the intervention during the general preparation period. The direction and magnitude of change broadly align with prior reports that integrated strength and plyometric training can improve explosive performance in combat-sport and elite athletic contexts (Boyanmış et al., 2024; Bridge et al., 2014). Given that reactive metrics were available for DJ only, the concurrent increase in DJ RSI alongside shorter GCT indicates improved fast SSC execution characterized by reduced coupling time and maintained take-off intent. Accordingly, and consistent with this mechanism, the ΔDJ height-ΔGCT change-change plot and the RSI-map (**Figure 3** and **Figure 4**) support this interpretation by showing whether athletes improved through shorter contact, greater height, or both. RSI focused interpretation. Beyond increases in jump height per se, the concurrent improvement in DJ RSI alongside a reduction in GCT indicates that athletes not only jumped higher but also did so with quicker GCT, reflecting more efficient exploitation of the fast SSC. The individual paired-line display and RSI-map visualizations (**Figures 2-4**) help clarify the mechanism of change by showing athlete-specific shifts upward (greater height), leftward (shorter GCT), or both, traversing to higher iso-RSI bands. This pattern aligns with meta-analytic evidence that plyometric jump training improves RSI relative to controls (Ramirez-Campillo et al., 2023) and with reports that, under standardized execution and adequate familiarization, CMJ and DJ outcomes are sensitive and reliable for detecting short-term neuromuscular adaptations (González-García et al., 2024). Moreover, monitoring height alone can be misleading because longer contact times may inflate jump height without capturing fast-SSC efficiency. In time-pressured striking and counter-striking exchanges, faster coupling with maintained jump intent is likely performance-relevant. Accordingly, the height-to-time ratio (RSI) is the critical metric in time-pressured tasks (Byrne et al., 2016). Finally, the need to standardize instructions and drop height is consistent with evidence that RSI is technique sensitive and varies with execution strategy (Struzik et al., 2016).

Relative gains across tests. The largest relative improvement was observed for DJ RSI, followed by DJ height, with smaller yet clear gains in CMJ and SJ. This hierarchy is coherent with the test mechanics: CMJ and especially DJ place greater emphasis on fast SSC behavior and reactive strength, whereas SJ minimizes SSC contribution and isolates concentric force production (Castagna & Castellini, 2013; Suchomel et al., 2016). Together, the pattern suggests that the structured plyometric progression preferentially improved fast SSC qualities while still benefiting concentric explosive capacity.

Comparison with prior work. The magnitudes observed here are broadly comparable to improvements reported after short mesocycles in related populations, while recognizing that program length, drill selection, and loading progressions vary across studies (e.g., Bridge et al., 2014; Casolino et al., 2012; Chtara et al., 2020; Ojeda-Aravena et al., 2021). Importantly, RSI has emerged as a practically meaningful indicator sensitive to plyometric training, and our findings of increased RSI with reduced GCT complement meta-analytic evidence that plyometric jump training improves RSI relative to controls. In a Taekwondo-specific context, where repeated explosive actions under time pressure are central, RSI-oriented improvements are especially relevant to performance profiling and monitoring.

For coaches working with competitive Taekwondo athletes, combining a progressive plyometric block with ongoing strength work can support short-term gains in fast SSC function, as reflected by higher DJ RSI and shorter GCT. The RSI-map and change-change plots (**Figure 3** and **Figure 4**) provide actionable diagnostics at the individual level to identify whether an athlete's limiting factor is contact-time reduction, vertical impulse generation, or both, and to tailor technical cues and drill selection accordingly.

Context of concurrent training. Because strength sessions proceeded as part of routine, coach-prescribed practice and were not investigator-controlled, the present results should be interpreted as ecologically valid effects of a real-world plyometric mesocycle conducted alongside usual strength training rather than as isolated effects of plyometrics alone. In practical terms, it is plausible that the concurrent free-weight work increased maximal force capacity and rate of force development, while the plyometric block enhanced fast stretch-shortening cycle (SSC) behavior, yielding additive or even synergistic effects on jump height and RSI (e.g., reduced coupling time with maintained take-off intent). Mechanistically, improved neural drive, inter-muscular coordination, and muscle-tendon unit stiffness from repeated high-velocity SSC exposures can complement strength-induced gains in concentric force production, thereby supporting faster GCT and higher reactive output (Nicol et al., 2006; Suchomel et al., 2016). Accordingly, the post-intervention pattern observed here—shorter DJ GCT with higher RSI—may reflect complementary adaptations from the combined stimulus rather than from plyometrics in isolation. At the same time, because loads, volumes, and progression of the strength sessions were not recorded, the relative contribution of each component cannot be partitioned, and causal inference should be made cautiously within this combined-practice context. This interpretation is consistent with evidence that plyometric programs preferentially improve reactive strength index (Ramirez-Campillo et al., 2023) while resistance training in moderate repetition ranges (≈5 - 10 RM) targets maximal strength qualities pertinent to vertical impulse generation (Campos et al., 2002).

Overall, the integrated assessment of SJ, CMJ, and DJ within a single mesocycle, together with explicit RSI and GCT outcomes, supports the utility of a short-term plyometric block for enhancing reactive-strength qualities in competitive Taekwondo athletes and provides practitioners with interpretable, mechanism-linked metrics for athlete monitoring (Bridge et al., 2014; González-García et al., 2024; Ramirez-Campillo et al., 2023). Neuromuscular mechanisms underlying SSC improvements. The performance gains in DJ (shorter GCT with higher RSI) and the increased SJ/CMJ heights are consistent with adaptations that enhance fast stretch-shortening cycle (SSC) execution. First, increased neural drive and rate of force development (RFD) after high-velocity exposures can elevate early-phase force, aiding rapid force transmission within brief ground-contact windows. Second, improved inter-muscular coordination and motor-unit synchronization can reduce unnecessary co-activation and refine the timing of ankle-knee-hip contributions, supporting efficient energy transfer through the kinetic chain (Nicol et al., 2006). Third, modifications in muscle-tendon unit stiffness—for example, greater tendon stiffness and/or enhanced pre-activation—can improve elastic-energy storage and return, thereby reducing coupling time and elevating reactive output (Nicol et al., 2006). Taken together, these adaptations provide a plausible basis for the observed pattern of faster GCT with higher RSI, especially when plyometric exposures are layered on top of strength-induced increases in maximal concentric force capacity (Suchomel et al., 2016; Campos et al., 2002).

Potential learning and novelty effects. Although the athletes were experienced competitors, their limited prior formal practice with the specific jump modalities (SJ/CMJ/DJ) likely introduced a learning component that amplified early gains. Short-term improvements can arise from several task-specific processes: 1) familiarization with test instructions and constraints, which reduces performance variability across trials; 2) refinement of movement strategy, such as optimizing countermovement depth and timing in CMJ or minimizing coupling time in DJ; and 3) improved task-specific coordination and cueing adherence that enhance force transmission during brief ground-contact windows. We attempted to mitigate novelty by using a structured warm-up and specific rehearsal of SJ, CMJ, and DJ before testing, with standardized instructions and repeat trials; however, some portion of the observed change—particularly the larger gains in DJ RSI—may still reflect improved test execution rather than only physiological adaptation. Practically, this emphasizes the need to interpret short-term changes alongside indices of reliability and minimal detectable change and, when feasible, to include multiple baseline sessions or an extended familiarization phase. Future work should also compare athletes with established experience in these jump tasks to quantify the proportion of variance attributable to novelty.

5. Study Limitations

Several limitations should be noted that may have influenced the results.

1) The study lacked a control or comparison group, which limits internal validity and prevents causal attribution to the intervention.

2) Although participants were experienced competitive athletes, they had limited prior formal practice with the specific jump modalities (SJ/CMJ/DJ), so a learning effect likely contributed to part of the short-term improvements. Although we standardized warm-up, instructions, and task rehearsal, we did not include multiple baseline sessions to fully saturate familiarization. Future studies should employ extended familiarization or repeated pre-tests and report reliability-based thresholds (for example, coefficient of variation and minimal detectable change) to better separate learning from true training effects.

3) DJ testing used a single fixed drop height (40 cm), which may not reflect each athlete's optimal RSI height. Future research should employ an individualized drop-height protocol to identify and test at each athlete's RSI-maximizing height, and report whether conclusions are robust across heights.

4) The concurrent, team-prescribed strength training was not investigator-controlled or logged, so working loads, intensity, set and rep structures, and session

RPE were unavailable. This precluded evaluating changes in relative strength or estimating the separate contribution of strength work to outcomes.

5) The analytic sample was small (n = 10) and comprised male athletes only, which constrains statistical power and limits generalizability beyond competitive male Taekwondo athletes.

6) The intervention lasted eight weeks, so long-term effects and retention cannot be inferred.

7) Testing occurred during the general preparation period, which may limit external validity to other phases of the season, such as pre-competition or in-season.

8) There was no systematic nutritional oversight during the training period. Variability in dietary intake and recovery strategies may have contributed to inter-individual differences in adaptation.

6. Practical Implications

This section reflects combined practice: the plyometric mesocycle was implemented alongside coach-prescribed strength that was not investigator-controlled or logged. Therefore, practitioners should interpret the implications in the context of concurrent plyometric and strength training rather than plyometrics in isolation.

1) Emphasize fast SSC mechanics in DJ. Coach for minimal coupling time and brief ground contact to drive RSI up. Use clear cues such as "stiff landing", "quiet feet", and "full intent to jump", and ensure that technical quality is prioritized over adding external load.

2) Use weekly DJ monitoring to guide decisions. Track DJ height, GCT, and RSI once per week under standardized conditions. A weekly cadence aligns with the typical microcycle and balances sensitivity with practicality. Compare each week to an individual rolling baseline (for example, the previous 3 weeks) and to your lab's reliability thresholds (for example, typical error and minimal detectable change).

If RSI drops beyond reliability thresholds and GCT lengthens, treat this as accumulated fatigue: reduce plyometric contacts and/or overall volume for the coming week, increase recovery between sets, and reinforce quick-coupling technique.

If height rises but GCT also rises (RSI unchanged), cue faster coupling (quiet, short contact) and prioritize drills that emphasize brief ground contact rather than adding load.

If RSI improves with shorter GCT, consider a small, planned progression (for example, a modest increase in contacts or a slight rise in box height) while maintaining technical consistency. Log decisions and revisit trends weekly so that adjustments are linked to individual responses rather than group averages.

An 8-week plyometric mesocycle performed with concurrent coach-prescribed strength may therefore improve SJ, CMJ, DJ height, and DJ RSI in competitive Taekwondo athletes, particularly when implemented during the general preparation period and monitored with DJ metrics over time.

Ethics Approval and Consent to Participate

The study was approved by the Institutional Ethics Committee of the affiliated academic center, and all participants provided written informed consent in accordance with the Declaration of Helsinki.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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