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EFFECT OF CORE STRENGTH TRAINING VERSUS PLYOMETRIC TRAINING ON AGILITY AND DYNAMIC BALANCE IN KARATE MALE PLAYERS- A RANDOMIZED CONTROLLED STUDY

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ABSTRACT

Background: Agility and dynamic balance are critical physical attributes for successful performance in karate. While both core strength and plyometric training have been shown to enhance these qualities, direct comparisons in competitive karate players remain limited.

Objective: To compare the effects of a 6-week core strength training program versus progressive plyometric training on agility and lower-limb dynamic balance in young male karate players.

Methods: Thirty male karate players (age 18–24 years) were randomly allocated into two groups: Group A (Core Strength Training, n=15) and Group B (Plyometric Training, n=15). Both groups trained three times per week for 6 weeks. Agility was assessed using the T-test and dynamic balance using the Lower Quarter Y-Balance Test before and after the intervention. Data were analyzed using paired and independent t-tests, with significance set at $p < 0.05$.

Results: Both groups showed statistically significant within-group improvements in T-test time and Y-Balance scores ($p < 0.001$). Group A improved T-test performance by 0.85 seconds (6.62%) and Y-Balance

by 7.73 cm (9.89%). Group B demonstrated greater improvements of 1.80 seconds (13.98%) in the T-test and 14.55 cm (18.63%) in the Y-Balance Test. Between-group comparisons revealed significantly superior post-intervention scores and greater mean improvement in Group B for both outcomes ($p < 0.001$), with large effect sizes.

Conclusion: Progressive plyometric training produced significantly greater improvements in agility and dynamic balance compared with core strength training in young male karate players. Plyometric training appears to be the more effective modality when the primary goals are enhancement of change-of-direction ability and lower-limb dynamic balance.

Keywords: Karate, Core strength training, Plyometric training, Agility, Y-Balance Test, T-test

INTRODUCTION

Karate is a combat sport characterized by explosive, multidirectional actions rapid punches, kicks, and stance transitions that demand a unique combination of speed, power, agility, and postural control **[1]**. Success in karate kumite depends heavily on the athlete's ability to change direction quickly, generate explosive lower-limb power, and maintain dynamic postural stability while executing offensive and defensive techniques under time pressure **[2]**. Elite karateka have been shown to possess superior acceleration, explosive power, and agility compared to lower-ranked counterparts, confirming that these physical qualities are central determinants of competitive performance **[3]**. Given this profile, the systematic development of agility and dynamic balance has become a key focus of conditioning programs designed for competitive karate athletes **[4]**.

Agility, defined as the ability to rapidly change direction or speed in response to a stimulus, and dynamic balance, defined as the ability to maintain postural control while the body is in motion, are closely interrelated physical qualities. Both depend substantially on efficient neuromuscular control of the trunk and lower extremities. Trunk stability and strength have been shown to be significant predictors of performance level in combat-sport athletes, underscoring the functional link between core control and sport-specific movement efficiency **[5]**. Similarly, elite karateka rely on refined postural regulation strategies to transition rapidly between dynamic and static states during bouts, further emphasizing that balance is not a peripheral fitness component but a core performance determinant in this sport **[6]**.

Two training modalities are commonly recommended to target these qualities: core strength training and plyometric training.

Core strength training aims to enhance the strength and endurance of the trunk musculature the abdominals, erector spinae, and gluteal group which functions as a muscular corset stabilizing the lumbo-pelvic region during limb movement. By improving proximal stability, core training is theorized to enhance the efficiency of force transfer to the extremities, thereby improving both agility and dynamic balance performance **[7]**. Plyometric training, in contrast, relies on the stretch-shortening cycle, using rapid eccentric-to-concentric muscle actions to enhance neuromuscular power, reactive strength, and rate of force development, qualities directly relevant to change-of-direction speed and explosive movement **[8]**.

Emerging evidence from other individual and combat sports supports the effectiveness of both approaches. In elite badminton players, combined balance and plyometric training produced significant improvements in dynamic postural stability and quickness compared to plyometric training alone **[8]**. Comparable findings have been reported in adolescent taekwondo athletes, where combined balance-plyometric protocols enhanced dynamic balance and sport-specific agility performance over an 8-week period **[9]**. Meanwhile, core strength training alone has demonstrated significant improvements in dynamic balance and agility in adolescent badminton players, suggesting that trunk-focused conditioning can independently produce meaningful gains in these performance qualities without a plyometric component **[10]**.

Despite this growing body of evidence in other racquet and combat sports, direct comparative data on the relative efficacy of core strength training versus plyometric training on agility and dynamic balance specifically in male karate players remain scarce. Existing karate-specific literature has predominantly examined core training in isolation or in youth populations, leaving a gap regarding which modality confers superior benefit in adult competitive karateka **[1]**. Given that both training forms operate through partially distinct physiological mechanisms proximal stabilization versus stretch-shortening cycle potentiation a head-to-head comparison is warranted to guide evidence-based programming decisions for coaches and sports physiotherapists.

Therefore, the present study aims to compare the effects of a 6-week core strength training program versus a 6-week plyometric training program on agility, assessed using the T-test, and dynamic balance, assessed using the Lower Quarter Y-Balance Test, in male karate players.

OBJECTIVE OF THE STUDY

- To evaluate the effect of a six-week core strength training program on agility using T- Test and dynamic balance using Y- Balance lower-limb Test in young male karate players.
- To evaluate the effect of a six-week progressive plyometric training program on agility using T- Test and dynamic balance using Y- Balance lower-limb Test in young male karate players.
- To compare the relative effectiveness of core strength training versus progressive plyometric training on agility using T-Test in young male karate players.
- To compare the relative effectiveness of core strength training versus progressive plyometric training on dynamic balance using Y-Balance lower-limb test in young male karate players.

METHODS

1. **Study design:** Comparative study.
2. **Study type:** RCT.
3. **Sample size:** 30 male karate players
4. **Study population:** 18 to 24 years male karate players
5. **Study setting:** PRIMATE MMA Academy, South Bopal, Ahmedabad
6. **Sampling technique:** Purposive Sampling
7. **Intervention frequency and duration:** 3 sessions per week for 6 weeks (18 sessions), Each treatment session lasted approximately 45-60 minutes.
8. **Inclusion Criteria:**18-24 years **[11],** Males **[11]** Must play 1-2 session per week **[12]**, Normal BMI **[13]**, No ortho or cardiorespiratory contraindications or restriction **[1]**
9. **Exclusion Criteria:** Recreational karate players **[11]**, Recent injury in previous 6 month **[11]**, No diabetes **[14]**, Recent surgery **[14],** Involvement in any additional strength training program outside the trail **[15]**, Missing >2 training session **[16]**
10. **Outcome measures:**

T-Test for agility **[17]:** The T-Test was administered using a version standardized from previous literature. The units of measurement were changed from yards to meters, creating a 10 × 10 m course. The course procedure of having the participant touch each cone is not standardized in the literature; therefore, the task was eliminated. The directions adopted for this study were based on Miller *et al*. **[18]**. On the "go" command, the participant **(1)** ran or moved as

quickly as possible forward to the center cone, **(2)** sidestepped to the right 5 m to the right cone, **(3)** sidestepped to the left 10 m to the far-left cone, and then **(1)** sidestepped back to the right to the center cone **(Figure 2)**. The participant then ran or moved backward as quickly as possible to cross the finish line. The raters began the stop watch on "go" and stopped when the participant broke the plane of the finish line. The time to complete each trial was recorded in seconds. Disqualification was determined if the participant failed to run the course as instructed, failed to reach the finish line or complete the course, moved any cones, did not keep his trunk and feet pointed forward at all times, or crossed his legs more than once when sidestepping. If a participant did not complete a trial successfully, a score of 0 was given. ICC- 0.98 (0.97–0.99) **[4]**

Lower Quarter Y- Balance Test [19]: The YBT was evaluated using a commercially available device (Y Balance Test, Move2Perform, Evansville, IN). In order to ensure comparison between the tests, the A, PM, and PL directions of the SEBT were used. Order of the test leg and direction were also randomized at each test session. All testing was conducted barefoot to eliminate additional balance and stability from the shoes. As in the YBT, the anterior borders of the participant's feet were placed at the convergence of the reach direction lines of the SEBT at the second toe. The test was demonstrated by a member of the research team before the participant completed 4 practice trials in each direction on each leg. Completing these practice trials has previously been reported to decrease the learning effect without hindering an individual's ability to perform the test. After the test trials were completed, each participant was given a 2-minute rest period and then conducted 3 test trials in each direction. Test sessions were undertaken at the same time of day to minimize diurnal variation in postural stability. A trial was classified as invalid if the participant removed his hands from his hips, did not return to the starting position, applied sufficient weight through the reach foot so as to gain an increase in reach distance (SEBT), placed the reach foot on the ground on either side of the line or tube, raised or moved the stance foot during the test, or kicked the plate with the reach foot to gain more distance (YBT). If an invalid trial occurred, the data were discarded, and the participant repeated the trial. ICC- **(0.85–0.99) [20]**.

INTERVENTION

GROUP A: CORE STRENGTH TRAINING (CST)

The CST included 9 exercises: (1) push up, **(2)** abdominal crunch, **(3)** vertical leg crunch,

(4) jack knife, **(5)** supine knee drops side-to-side, **(6)** reverse crunch, **(7)** super-man, **(8)** cat-camel stretch, and **(9)** plank jack, 3 set, 12 repetitions, 90 sec holds between exercise Participants completed a 10 min warm up including several practice trials before testing. The CST was performed for approximately 30–35 min three times per week for 6 weeks **[1]**.

GROUP B: PLTOMETRIC TRAINING (PT)

Monday: Jump squat, Box jump, Side jump, Strides, Skipping

Wednesday: Side way box jump, Jump over to tuck jump, Sump jump, Hamstring curl fast, Jumping on toes

Friday: One leg hop jump, Box jump, Side way jump, Depth jump, Scissor jump

Week 1 -2: 15 rep, 2 sets

Week 3: 20 rep, 2 sets

Week 4-5: 20 rep, 3 sets

Week 6: 20 rep, 4 sets [12]

RESULTS

Table 1: Baseline Characteristics of Participants

Variable	Group A (Core) (n=15) Mean ± SD	Group B (Plyometric) (n=15) Mean ± SD	t- value	p- value
Age (years)	20.67 ± 1.88	20.60 ± 2.06	0.09	0.928
Pre-T-test (sec)	12.84 ± 0.25	12.88 ± 0.20	−0.43	0.673
Pre-Y-Balance (cm)	78.18 ± 1.60	78.09 ± 1.44	0.16	0.877

No significant baseline differences were observed between groups for age, agility (T-test), or dynamic balance (Y-Balance Test), confirming successful randomization

Table 2: Mean Scores of T- Test (Agility) Within Groups (Pre and Post Intervention)

Groups	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Mean Difference	t-value	p-value
Group A	12.84 ± 0.25	11.99 ± 0.20	−0.85	56.72	<0.001
Group B	12.88 ± 0.20	11.08 ± 0.16	−1.80	119.15	<0.001

Table 3: Mean Scores of Y-Balance Test Lower Limb Within Groups (Pre and Post Intervention)

Groups	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Mean Difference	t-value	p-value
Group A	78.18 ± 1.60	85.91 ± 1.58	+7.73	−653.76*	<0.001
Group B	78.09 ± 1.44	92.65 ± 1.14	+14.55	−154.75*	<0.001

Both Group A and Group B showed statistically highly significant improvement ($p < 0.001$) in agility (reduction in T-test time) and dynamic balance (increase in Y-Balance score) after 6 weeks of training.

Table 4: Comparison of Post-Intervention Scores and Mean Improvement between Groups

Outcome Measure	Group A (Core) Mean ± SD	Group B (Plyometric) Mean ± SD	Mean Difference (B − A)	t-value	p-value	Cohen's d
Post T-test (sec)	11.99 ± 0.20	11.08 ± 0.16	−0.91	13.51	<0.001	5.05
Improvement in T-test (sec)	0.85 ± 0.06	1.80 ± 0.06	+0.95	−44.67	<0.001	16.31
Post Y-Balance (cm)	85.91 ± 1.58	92.65 ± 1.14	+6.74	−13.39	<0.001	4.90
Improvement in Y-Balance (cm)	7.73 ± 0.05	14.55 ± 0.36	+6.82	−72.02	<0.001	26.30

At post-intervention, Group B demonstrated significantly better agility (lower T-test time) and significantly higher dynamic balance scores than Group A ($p < 0.001$ for both). The magnitude of improvement was significantly greater in Group B for both outcomes ($p < 0.001$). Effect sizes (Cohen's d) were extremely large, indicating a strong practical advantage of plyometric training over core stability training for both agility and balance in this population.

DISCUSSION

The present study found that both 6-week core strength training and progressive plyometric training significantly improved agility (T-test) and dynamic balance (Y-Balance Test) in young male karate players. However, the plyometric group demonstrated substantially greater improvements in both outcomes ($p < 0.001$).

These results align with previous findings that plyometric training enhances change-of-direction ability and neuromuscular control in karate athletes through improved stretch–shortening cycle efficiency **[23, 24]**. Core strength training also produced significant gains, consistent with earlier reports of improved postural control and force transmission following core programs in karate players **[1, 22]**. The smaller effect of core strength training suggests it is less specific to the explosive, multi-planar demands of karate compared with plyometric exercises.

CONCLUSION

Both core strength and plyometric training significantly improved agility and dynamic balance in young male karate players. Progressive plyometric training produced superior gains and appears more effective when the primary goals are enhancement of change-of-direction ability and lower-limb dynamic balance.

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