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Evaluating the Efficacy of Four Week Core Stabilization Training versus Balance Training Program on Static and Dynamic Balance in Young Females from Urban Areas of Ahemedabad - A Comparative Study

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Abstract: ***Background**: Balance and core stabilization training are essential for maintaining postural stability and preventing injuries. **Objectives**: To compare the efficacy of four-week core stabilization training and balance training on static and dynamic balance in young females. **Methods**: 40 young females were randomly assigned to either CST(n=20) or BT(n=20) groups. The training programs were conducted for four weeks, with three sessions per week. The CST group performed exercises targeting core muscles, including tuck in, planks, bird dog, dead bug and deep lunges. The BT group performed balance exercises, including tandem walking, retro walking, one leg standing with ball catch and throw and one leg standing. Outcome measures included stork balance test for static balance and star excursion balance test for dynamic balance were assessed pre- and post-training. **Results**: The present study suggests that both static balance and dynamic balance showed improvement, with significant gains in specific aspects. Notably, the balance group demonstrated greater improvement in static balance compared to dynamic balance. **Conclusion**: The present study concludes that both balance training and core stabilization exercises are effective in improving static and dynamic balance in young adult females. However, the balance training showing greater improvement in static balance.*

Keywords: Balance Training, Core Stabilization, Static Balance, Dynamic Balance, Postural Stability.

1. Introduction

Balance is a key component of normal daily activities, defined as the ability to maintain the body's centre of gravity within the limits of stability as determined by the base of support [1]. It is a complex motor skill describing the dynamics of body posture to prevent falls and can be classified as either static or dynamic. Core-stability training (CST) and balance training (BT) are popular methods to improve balance and posture [1]. Static balance refers to the ability to maintain the centre of gravity (COG) within the base of support (BOS), keeping the centre of pressure (COP) as immobile as possible during standing or sitting. Dynamic balance, by contrast, involves moving the COP in a given direction within the limits of stability, maintaining a stable BOS while completing a prescribed movement, often requiring balance on a single limb while manipulating the other [3]. Maintaining balance requires optimal interaction of proprioceptive, vestibular, and visual mechanisms integrated by the nervous system [4]. The human body employs three primary movement strategies for restabilization in response to perturbation: the ankle strategy, hip strategy, and stepping strategy [5, 6].

The core muscle is defined as the basis of proximal stability for distal mobility, allowing transfer of energy from large to small muscles during everyday movements [7]. Core muscles are divided into two groups:

- Deep core muscles (local stabilizers): transversus abdominis (TrA), lumbar multifidus (LM), internal oblique, and quadratus lumborum primarily responsible for spinal stability.
- Shallow core muscles (global stabilizers): rectus abdominis, internal and external obliques, erector spinae, quadratus lumborum, and hip muscle groups responsible for additional spinal control and connecting pelvis to thoracic ribs or leg joints [8]. Core stability is defined as the ability to control motion of the lumbar spine and pelvis relative to a neutral position [9]. The transversus abdominis and multifidi have been shown to contract 30 ms before shoulder movement and 110 ms before leg movement, theoretically stabilizing the lumbar spine prior to limb action [10,11].

Rapid technological advancement has led to reduced physical activity and increased sedentariness, weakening core muscles and compromising posture. Young females in particular may develop balance deficits due to anatomical and physiological factors, increasing their risk of injury [12].

The study will investigate the effects of CST and BT on balance, strength, and flexibility in individuals with poor core strength or posture. The results will provide insights into the most effective method for improving balance and reducing injury risk.

2. Materials & Methods

2.1 Method

a) **Source of data:** Ahmedabad, most of population from the department of physiotherapy and nursing college from Vahelal
b) **Study design:** Comparative study
c) **Duration of study**: 6 months
d) **Sample size:** 40
e) **Sample design**: convenient sampling

2.2 Materials

1) Data collection form/ assessment form
2) Pen
3) Paper
4) Stop watch
5) Measure tape
6) Chalk
7) Plinth
8) Ball

3. Procedure

- After obtaining Institutional Ethical Committee clearance, subjects were selected based on inclusion criteria, which included age 18-30 years, no history of major injuries or surgeries, Level 1, 2 and 3 in Sahrmann's core stability test and free from any history of Neuromuscular, Orthopaedic and Cardiovascular pathology, and exclusion criteria, which included Male population, Strength training or balance training participants, more than level 3 in Sahrmann's core stability test and history of any recent musculoskeletal surgery.
- Informed about the study procedure and provided written consent before being tested for static and dynamic balance by SBT and SEBT.
- Subjects underwent SBT and SEBT before and after the study, and were conveniently divided into two groups: Group A (core stabilization training) and Group B (balance training), receiving interventions for three consecutive days, one session daily for four weeks.

Core stabilization training group [13]
Table 1 shows the structured exercise protocol focused on voluntary activation of TrA and lumbar multifidi (LM). Program duration: 4 weeks, 3 sessions/week (12 total sessions).

Table 1: Core stabilization training protocol

Week	Exercise	Parameters
1week	Tuck in	10 reps × 3 sets, 5-sec hold
	Prone bridge	10 reps × 3 sets, 5-sec hold
2week	Tuck In	20 reps × 1 set, 10-sec hold
	Bird Dog	10 reps each leg × 1 set, 10-sec hold
3week	Tuck In	20 reps × 1 set, 10-sec hold
	Dead Bug	10 reps each leg × 1 set
4week	Tuck In	20 reps × 1 set, 10-sec hold
	Deep Forward Lunges	10 reps each leg × 2 sets

Balance training group [13]
Table 2 shows the structured exercise protocol targeted ankle muscle strategies (Weeks 1–2) and progressed to practical single-leg balance tasks (Weeks 3–4). Program duration: 4 weeks, 3 sessions/week (12 total sessions).

Table 2: Balance training protocol

Week	Exercise	Parameters
1 & 2 week	Retro-walking	11m straight line, 3 repetitions
	Tandem Walking	11 m heel-to-toe, 3 repetitions
3 & 4 week	One-Leg Standing with Ball Catch & Throw	15 catches each leg
	One-Leg Standing with Leg Swing	30 sec each leg, 10 reps, 30-sec rest intervals

Pre- Intervention Test

Stork Balance Test [14]:
The Stork Balance Test is designed to assess an individual's ability to maintain balance on one leg, which was essential for performance and daily activities. This test helps monitor the development of an equilibrium and proprioception skills, which were crucial for injury prevention and overall coordination.

Participants stood barefoot, hands-on hips, non-supporting foot against the inside knee. The heel was raised and time was recorded until one of four failure criteria occurred.

The stopwatch was stopped if any of the follow occur:
1) The hand(s) come off the hips
2) The supporting foot swivels or moves (hops) in any direction
3) The non-supporting foot loses contact with the knee.
4) The heel of the supporting foot touches the floor.

Star Excursion Balance Test [15]:
Star Excursion Balance Test (SEBT) was a functional measure of Dynamic balance. The SEBT was initially described with the individual standing in the center of eight lines forming an eight-pointed star with 45°between each of them. Several studies revealed that this procedure could be simplified with only three lines (or directions, named according to the stance foot): anterior (ANT), posteromedial (PM), and posterolateral (PL).

Participants stood barefoot at the center of a grid and reached maximally in three directions: Anterior (ANT), Posteromedial (PM), and Posterolateral (PL) with each foot, while maintaining single-leg stance. Distance recorded in centimetres.

Statistical Analysis
Data were analyzed using SPSS version 16. The Shapiro-Wilk test confirmed non-normal distribution, so non-parametric tests were used. The Wilcoxon signed-rank test compared pre- and post-intervention values within each group. The Mann-Whitney U test compared between-group differences. Cohen's d was calculated for effect size interpretation.

4. Result

After conducting 56 evaluations, 50 subjects started the study, in which completed 40 subjects. While follow-up dropout subjects were 5 in Group A core stabilization training group and 5 in Group B balance training group respectively. The CONSORT flow diagram can be seen in Fig. 1. The demographic data of the participants, including their age, was descriptively summarized and compared using mean values for both groups, as presented in Table 1.

Table 1: Baseline Data Comparison

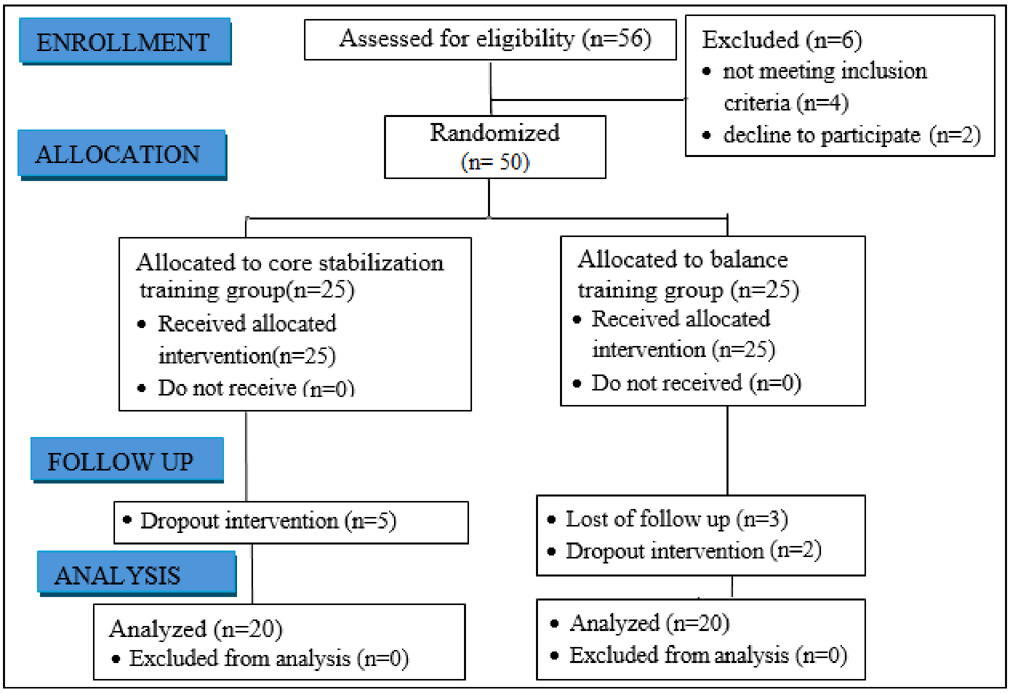
Variables	Group A Mean ± SD	Group B Mean ± SD
Age	20.10±2.12	21.05±3.36

The Wilcoxon signed-rank test was used to compare the pre- and post-intervention outcomes of stork balance test and SEBT within the group which is presented in Table 2 & 3. Within group analysis (Table 2) both Group A and Group B showed significant improvements in static balance in stork balance test score after the training program, as evidenced by the p-values (<0.001) and z-values (3.83 and 3.92, respectively). Within-group analysis (Table 3) revealed significant improvements in dynamic balance in both Group A (CSTG) and Group B (BTG) in the reach distance of the Star Excursion Balance Test (SEBT) in all three directions (anterior, posterior-medial, and posterior-lateral). Notably, the posterior-lateral reach distance improved significantly more in CSTG.

The Mann-Whitney U test was used to compare the post intervention between core stabilization training group (CSTG) and balance training group (BTG) which is presented in Table 4, 5 & 6.

Between group analysis (Table 4) shows The CSTG group has a mean difference score of 12.1, while the BTG group has a slightly higher mean difference score of 14.05. The large effect size (Cohen's d=0.9) indicates a substantial difference between the groups, suggesting Group B's intervention was more effective in improving balance.

The (Table 5) results show no significant difference between the groups in the ANT direction (p=0.221). However, significant differences were found in the PM direction (p=0.018), where Group A (9.9±0.81) achieved better scores than Group B (7.75±3.36), and in the PL direction (p=0.021), where Group B (10.2±2.81) scored slightly higher than Group A (9.85±4.9). The Cohen's d values indicate small to moderate effect sizes for the significant differences (0.1 for PM and 0.3 for PL), suggesting that the interventions had varying effects on balance in different directions.



Flow Chart 1: CONSORT Diagram

Table 2: Within Group Comparison of Stork Balance Test

Group	Outcome	Pre / Post	Mean ± SD	Z Value	P Value	Significance
Group A	Stork Balance Test	PRE	6.10±3.90	3.830	<0.001	Significant
		POST	18.20±11.70			
Group B	Stork Balance Test	PRE	7.80±4.38	3.922	<0.001	Significant
		POST	21.85±9.81			

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Table 3: Within Group Comparison of Star Excursion Balance Test

Group	Direction	Pre/Post	Mean ± SD	Z Value	P Value	Significance
GROUP A	ANT RT	PRE	58.15±6.19	3.730	<0.001	Significant
		POST	68.45±10.58			
	PM RT	PRE	63.95±9.063	3.624	<0.001	Significant
		POST	73.85±9.874			
	PL RT	PRE	72.60±6.20	3.220	0.001	Significant
		POST	82.45±11.10			
	ANT LT	PRE	58.05±5.73	3.362	<0.001	Significant
		POST	67.95±10.65			
	PM LT	PRE	66.20±9.86	3.361	<0.001	Significant
		POST	75.90±10.96			
	PL LT	PRE	71.35±8.94	3.868	<0.001	Significant
		POST	83.40±11.38			
GROUP B	ANT RT	PRE	56.10±8.87	3.826	<0.001	Significant
		POST	67.35±9.28			
	PM RT	PRE	63.65±6.35	3.848	<0.001	Significant
		POST	71.40±9.98			
	PL RT	PRE	72.65±6.27	3.867	<0.001	Significant
		POST	82.85±9.08			
	ANT LT	PRE	60.25 5.61	3.830	<0.001	Significant
		POST	69.10 6.53			
	PM LT	PRE	67.10 9.61	3.178	0.001	Significant
		POST	74.75 7.63			
	PL LT	PRE	74.95 7.30	3.699	<0.001	Significant
		POST	85.25 8.18			

Table 4: Between Group Comparison of Mean Difference of Stork Balance Test

Outcome	Group A Mean Difference ± SD	Group B Mean Difference ± SD	U Value	P Value Significance	Cohen's d
Stork Balance Test	12.1±7.8	14.05±5.43	1.00	0.01 Significant	0.9

Table 5: Between Group Comparison of Mean Difference of Right-Side Star Excursion Balance Test

Outcome	Direction (Right)	Group A Mean Difference ± SD	Group B Mean Difference ± SD	U Value	P Value Significance	Cohen's d
SEBT	ANT	10.3 ± 4.39	11.25 ± 0.41	26	0.221 Not significant	0.7
	PM	9.9 ± 0.81	7.75 ± 3.36	46.5	0.018 Significant	0.1
	PL	9.85 ± 4.9	10.2 ± 2.81	1	0.021 Significant	0.3

Table 6: Between Group Comparison of Mean Difference of Left Side Star Excursion Balance Test

Outcome	Direction (Left)	Group A Mean Difference ± SD	Group B Mean Difference ± SD	U Value	P Value Significance	Cohen's d
SEBT	ANT	9.9±4.92	8.85±0,92	36	0.42 Not significant	0.3
	PM	9.7±1.1	7.65±1.98	6	0.12 Not significant	0.1
	PL	12.05±2.44	10.3±0.88	28	0.34 Not significant	0.5

5. Discussion

This study compared the effects of core stabilization training (CSTG) and balance training (BTG) on static and dynamic balance in 40 young adult females. Both interventions produced significant improvements within groups. However, between-group analysis revealed that BTG had a more pronounced effect on static balance, leading to acceptance of the H2 hypothesis.

BTG demonstrated superior improvement in the Stork Balance Test (mean difference: 14.05 vs. 12.1; Cohen's d=0.9). This is attributed to the balance training program specifically targeting proprioceptive feedback, neuromuscular control, and muscle activation patterns around the ankle and hip joints, systems directly involved in maintaining a stationary posture. Training stimuli such as retrowalking, tandem walking, and one-leg standing with perturbation (ball-catching) challenged these systems in ecologically relevant ways.

CSTG also showed meaningful improvement in static balance (mean score: 6.10 to 18.20), which can be attributed to strengthened core muscles providing a stable base of support, improved proprioception, increased muscle stiffness, and enhanced postural control of the lumbo-pelvic region [16].

Both groups significantly improved dynamic balance across all SEBT directions. Notably, CSTG performed better in the right posteromedial direction, while BTG performed slightly better in the right posterolateral direction. No significant differences existed in the anterior direction or any left-side directions.

The CSTG's advantage in the PM direction may reflect improved lumbo-pelvic control and deep muscle co-contraction, which optimize the body's centre of gravity during medially-directed weight shifts. BTG's broader reach in the PL direction may stem from enhanced ankle-hip proprioceptive coordination and neuromuscular reaction time.

Left-side non-significance may be explained by individual laterality differences, strength asymmetries between limbs, or insufficient training volume to elicit changes in lateral-dominant movement patterns.

Core stabilization improved balance by enhancing spinal segment control and deep stabilizer contraction, enabling better COG management and optimal lumbo-pelvic stability. **Herrington L, Davies R** found that even asymptomatic individuals may have endurance deficits in TrA and multifidus, and that specific training of these muscles augments core stability performance. The position of the spine significantly determines body COG, which in turn regulates balance [17].

A combined program of core stabilization and balance training may offer the most comprehensive benefit for static and dynamic postural control, as each approach targets different aspects of the neuromuscular system. Balance training appears especially valuable for improving static upright stability, while core training contributes to directional dynamic control and spinal stability during movement.

6. Conclusion

The present study concludes that both balance training and core stabilization exercises are effective in improving static and dynamic balance in young adult females. However, the balance training showing greater improvement in static balance. These findings suggest that specific training programs can be tailored to target balance abilities, and that balance training may be particularly beneficial for improving static balance.

Declaration by Authors

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