

# The Effectiveness of Plyometric Training and Core Stability Training on Dynamic Balance and Lower Body Power in Badminton Players

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## Abstract

**Background:** Dynamic balance refers to the ability to maintain stability while performing actions, repositioning, or moving. Badminton players require exceptional dynamic balance due to the need for rapid movements across the court to execute actions effectively and maintain injury-free performance. Additionally, explosive strength is essential for achieving high-level performance in badminton.

**Objective:** The aim of the study is to evaluate the effects of plyometric training (PT) and core stability training (CST) on dynamic balance and lower body power in badminton players, using my jump lab application for precise performance measurements.

**Methodology:** A total of 46 players were initially screened for this experimental study, and based on inclusion and exclusion criteria, 40 badminton players were selected. Outcome measures included the Y Balance Test (YBT) and Vertical Jump Test (VJT). The subjects were split into two groups, each consisting of 20 players. For six weeks, one group underwent plyometric training, while the other focused in core stability training.

**Results:** In within-group analysis revealed statistically significant improvements in both the Y Balance Test and Vertical Jump Test for both groups. However, between-group analysis showed that the plyometric training group achieved significantly greater improvements compared to the core stability group in all measured outcomes.

**Conclusion:** Plyometric training proved to be more effective than core stability training in enhancing lower body power, as measured by My jump Lab and dynamic balance in badminton players. These findings suggest that incorporating plyometric exercises can lead to greater performance improvements for recreational badminton players.

**Keywords:** Badminton players, plyometric training, core stability training, dynamic balance, my jump lab application

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## Introduction

Badminton is a high-intensity racket sport that involves rapid intervals of play.<sup>1</sup> It involves repeated, high-speed movements of short duration within an 80-square-meter court.<sup>2</sup> The sport demands not only upper and lower body strength but also core strength to execute powerful smashes. Agility, balance, and coordination are equally critical for managing quick, dynamic postural adjustments on the court.<sup>3</sup> Overhead strokes, such as smashes or clear shots, often lead to single-limb landings, making them a primary cause of injuries in badminton. Another common injury risk arises from sudden deceleration followed by directional changes (plant-and-cut movements). Therefore, developing robust dynamic balance is essential for badminton players to enhance performance and lesser risk of injury during rapid on-court movements.<sup>4</sup>

The ability of the human body to maintain balance and centre of gravity (COG) over a base of support depends on effective neuromuscular responses to continuous vestibular, somatosensory, and visual stimuli.<sup>5</sup> Players use balance not only to protect themselves from injuries but also to enhance their sporting performance.<sup>6</sup> The Y Balance Test (YBT) is a reliable tool designed to standardize the revised Star Excursion Balance Test (SEBT). It focuses on three specific reach directions out of the original eight in the SEBT: anterior (ANT), posterolateral (PL), and posteromedial (PM). The revised SEBT, including the YBT, was developed to improve the efficiency of dynamic balance assessments.<sup>7</sup>

Lower-body power plays a crucial role in athletic performance, influencing jumping, sprinting, and agility.<sup>8</sup> Jump tests are commonly used to measure lower-body power, which is the result of the combination of force and velocity.<sup>9</sup> Leg strength, especially the ability to perform vertical jumps (VJ), is often a key factor in determining sports performance. Numerous studies have focused on enhancing vertical jump performance, with experts agreeing that plyometric training (PT) is the most effective method for boosting leg muscle power and improving vertical jump height.<sup>10</sup> A modern method

for measuring vertical jump height involves the use of mobile applications. My Jump, an app available on both iOS and Android devices, uses frame-by-frame video analysis to determine flight time and jump height. This app provides an affordable and portable alternative to traditional vertical jump assessment tools. Additionally, My Jump has demonstrated high reliability and accuracy, closely matching the results of highest standard for vertical jump measurement, the force plate.<sup>11</sup>

Plyometrics is a training technique that involves explosive exercises typically seen in track and field.<sup>12</sup> It includes movements such as jumping, hopping, and bounding, which are classified as plyometric training (PT). This method effectively stretches the muscles and tendons through an eccentric contraction, followed by a concentric contraction, referred to as the stretch-shortening cycle (SSC).<sup>13</sup> After the concentric phase, the muscle utilizes the elastic energy accumulated during the stretching phase to produce greater force. During eccentric loading, rapid stretching and shortening of the muscle can result in desensitization of the Golgi tendon organs and enhanced responsiveness of the muscle spindles. Consequently, Plyometric Jump Training enhances muscle strength, power, and balance.<sup>14</sup>

Core stability or strengthening (CS) has become a prominent fitness trend and is increasingly integrated into sports medicine.<sup>15</sup> Core stability training (CST) is crucial for athletes in all racket sports, especially badminton players, who regularly perform explosive actions such as smashing the shuttlecock. In badminton, landing from jump shots after overhead smashes can lead to knee injuries, often caused by insufficient strength or poor balance. Proper core stability training not only boosts performance but also helps prevent injuries associated with dynamic movements in badminton and other racket sports.<sup>16</sup> In athletic activities, core stability refers to the capacity to efficiently produce, transmit, and regulate force and movement to the limbs while maintaining the proper position and movement of the trunk relative to the pelvis. It serves as a muscular support system, stabilizing the torso and spine, whether or not the limbs are in motion.<sup>17</sup>

Few studies have explored how plyometric and core stability training impact power and dynamic balance in badminton players. Therefore, this study focused on investigating the impact of different training approaches on dynamic balance and lower-limb power in this population.

## Methodology

This experimental study was conducted at TLK Sports Academy in Chennai from March 2024 to June 2024. Initially, 46 badminton players were screened for eligibility, and 40 players who met the inclusion and exclusion criteria were chosen to take part. A power analysis was performed to determine the appropriate sample size, confirming that 20 participants per group were sufficient to detect significant differences with a 5% margin of error. After selection, participants were randomly divided into two groups: Group A (Plyometric Training) and Group B (Core Stability Training), with 20 participants in each group

### Inclusion Criteria

The study included male recreational badminton players aged between 18 to 25 who consented to complete a six-week intervention. Participants were required to be free of any current injuries to qualify for the study.

### Exclusion Criteria

Players who had been regularly engaging in plyometric or abdominal exercises prior to the study were excluded. Additionally, individuals with recent lower-extremity injuries, such as hamstring, meniscus, ankle, or ACL tears were not included. Those with any neurological deficits were also excluded from participation in the study.

### Procedure

Participants were randomly allocated to two groups (Group A = Plyometric Training, Group B = Core Stability Training), with each group consisting of 20 players. Both groups underwent training sessions three times a week for six weeks, with each session lasting 30 minutes. The outcome measures for this study included the Y-Balance Test (YBT) and

Vertical Jump Test (VJT) using the My Jump Lab application. These tests were selected due to their relevance to key performance aspects in badminton and their ability to assess improvements resulting from the interventions.

The **Y-Balance Test (YBT)** was used to a dynamic balance, a crucial skill for badminton players who require stability during rapid movements and directional changes. The test measures balance in three directions— anterior, posterolateral, and posteromedial— which are important for movements such as lunges, shuffles, and quick stops. The YBT provides valuable insights into a player's stability, which is directly linked to both performance and injury prevention.

The **My Jump Lab application** was used to measure vertical jump height, an important indicator of lower-body power, which is essential for badminton actions such as smashes and quick jumps. The app uses frame-by-frame video analysis to accurately calculate jump height and flight time, offering a portable and reliable alternative to traditional methods like force plates. The app tracks improvements in vertical jump performance, reflecting changes in lower-body strength.

The training program was initially demonstrated and explained to the participants and the PT protocol was structured into three phases beginner, intermediate, and advanced; Phase 1: Squat jumps (1set,15reps), Bounding (1set,15 reps), Side/side jumps (1set, 15reps), Broad jumps (1set, 5reps), Scissor jumps (1set, 5reps), Box jumps (1set, 5 reps). Phase 2: Squat jumps (1set,15reps), 180° jump (1set,15 reps), Side/side jumps (1set, 15reps), Broad jumps stick (1set, 6reps), Hop, hop, hop and Stick (2set,6reps), Scissor jumps (1set, 6reps), Box jumps (2set, 6reps), Box drop (2set,6reps). Phase 3: Tuck jump (1set,15reps), Triple broad-vertical (2set,5reps), Crossover hop hop & stick (2set,6reps), X-hops(2set,6reps), Box jump(2set,6reps), Depth jump (2set,6reps), Depth jump 180° Turn (1set,6reps).

After completing the program, post-test data were collected, and both pre-test and post-test scores were recorded and analysed statistically.

**Table 1. Core stability exercise program <sup>(18)</sup>**

Week	Exercises	Duration, reps & sets
1	Abdominal bracing, hollowing	20s Hold
	Prone bridge	
	pelvic bridge	
	Side plank	
2	Bend knee raises	10*2
	Bird dog	
	Glute bridge exercise with alternate leg extension	
	Seated hip march on physio ball	
	Crossover body crunch	
3	Dead bug	10*2
	Glute bridge on physio ball	20s Hold
	Prone bridge on physio ball	20s Hold
	Cobra extension on physio ball	20s Hold
	Superman	10*2
4	Pelvic bridge alternating knee extension with physio ball	10*2
	Med-ball Russian twist	10*2
	Pelvic bridge with shoulder flexion on physio ball	10*2
	Abdominal curl on physio ball	10*2
	Superman on Physio ball	10*2
5	Lunge with med-ball twist	10*2
	Abdominal flexion on physio ball with med-ball	10*2
	Ab wheel rollout	10*2
	Ball bridge with alternate knee extension	10*2
6	Physio ball lunge	10*2
	Thera band-resisted march	10*2
	Side bridge with shoulder abduction	10*2
	Alt-superman on physio ball	10*2

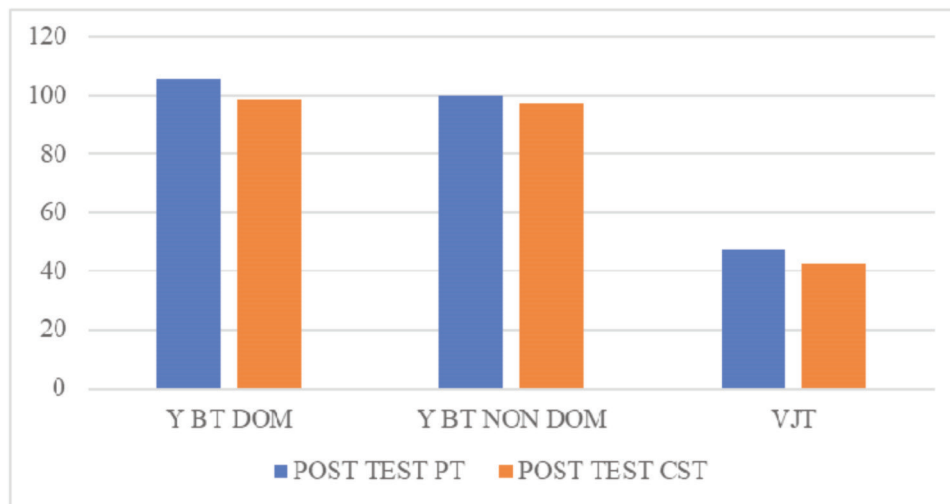
### Statistical Analysis

In this study, SPSS software was applied to analyze the effect of plyometric and core stability training on dynamic balance and lower body power in badminton players. Descriptive statistics, including means and standard deviations for each test (YBT and VJT), were determined for pre- and post-training outcomes in both the Plyometric Training Group and

the Core Stability Training Groups. The Shapiro-Wilk test was utilized to assess normality data and paired t-tests were utilized for comparing pre- and post-training outcomes. Wilcoxon signed-rank tests was used to analyse data that was not regularly distributed. Independent t-tests were employed to compare post-training results between the two groups, whereas Mann-Whitney U tests were used when the data did not have a normal distribution.

**Table 2. Analysis of Post Interventions for PT and CST Group**

Outcome	Test criteria	Total number	Mean	SD	T value	P value
YBT(Dominant)	Post test PT	20	105.48	4.40	4.96	0.001
	Post test CST	20	98.44	4.33		
YBT (non-dominant)	Post test PT	20	99.91	4.08	4.74	0.002
	Post test CST	20	97.27	3.72		
VJT	Post test PT	20	47.5	4.22	2.39	0.001
	Post test CST	20	42.7	2.52		



**Figure 1: Post test value for PT and CST Group**

## Result

### Y-Balance Test (Dominant Leg)

In the PT group, the Mean, Standard deviation in pre-test score was (99.11+2.76), while post-test score is (105.48+4.40). The improvement was highly significant with  $t=5.689$ ,  $P<0.002$ . while the CST group had pre-test Mean, SD (94.98+4.26) and a post-test Mean, SD (98.44+4.33), indicating a substantial increase  $t=2.910$ ,  $P<0.001$ ). When the post-test results of the two groups were compared, the PT group scored considerably better than the CST group, with a  $T=4.966$ ,  $P<0.001$ .

### Y-Balance Test (Non-Dominant Leg)

In the PT group, the pre-test Mean=96.81, SD = 2.98, which increased to (99.91+4.08) which showed statistically significance,  $t=3.337$ ,  $P<0.003$ . In contrast, CST group pre-test mean score is (96.96+3.83) and a post-test mean=97.27, SD = 3.72, which is a significant change with  $t=0.265$ ,  $P<0.004$ . post-test results between the two groups revealed that the PT group performed better, with  $t=4.746$ ,  $P<0.002$ .

### Vertical Jump Test (VJT)

Pre-test mean and SD of PT group is (42+3.14) and post-test is (45.45+4.22), reflecting a significant increase in  $t=6.530$  and  $P<0.001$ . The CST group had a pre-test mean=41, SD = 1.87 and post-test (42.7+2.52), with  $t=2.463$ ,  $P<0.002$ . When comparing the post-test results, the PT group demonstrated significantly greater gains than the CST group, with  $t=2.390$ ,  $P<0.001$ .

## Discussion

Dynamic balance is crucial for performance and injury prevention in badminton athletes, given the rapid and agile movements required during play. Studies consistently highlight the efficacy of PT and CST in enhancing dynamic balance among athletes, including those in badminton. This study aimed to evaluate the effects of PT and CST on dynamic balance and lower body power in badminton players, with findings revealing significant improvements in both groups.

Plyometric training demonstrated superior effectiveness in improving dynamic balance, aligning with evidence that emphasizes the role of plyometric exercises in enhancing neuromuscular control and proprioception (Behm et al., 2010).<sup>19</sup> Given the frequent directional changes and sudden stops inherent to badminton, improved dynamic balance directly enhances on-court performance while reducing injury risk. These findings are consistent with Alikhani et al. (2019),<sup>4</sup> who reported that plyometric training improves dynamic balance and knee proprioception in badminton players. Similarly, Chandra et al. (2023)<sup>20</sup> confirmed the benefits of plyometric training across various sports, particularly for enhancing lower body power and dynamic balance.

The significant gains in lower body power following plyometric training align with studies demonstrating the effectiveness of plyometrics in building muscular power and explosiveness (Ramirez-Campillo et al., 2013).<sup>21</sup> While PT emerged as the more effective intervention, the complementary role of CST should not be overlooked. Core stability is essential for preserving posture, facilitating force transfer between the upper and lower body, and minimizing injury risk. (Willardson, 2007).<sup>22</sup>

Although CST improved both dynamic balance and lower body strength, its impact was less pronounced than that of PT. Nevertheless, CST remains essential for skill development and injury prevention.

The My Jump app has proven to be a valid and reliable tool for assessing vertical jump height, providing accuracy comparable to force platforms, which are considered the highest standard for vertical jump evaluation. Previous studies reported minimal differences in vertical jump (VJ) measurements between My Jump and other methods, with deviations averaging approximately 1 mm, even when take-off and landing frames were manually selected. This reliability is particularly noteworthy, given that participants had prior video analysis experience, further showcasing My Jump as an accessible and practical measurement tool.<sup>23</sup>

In conclusion, plyometric training (PT) is more effective than core stability training (CST) for enhancing lower body power and dynamic balance in badminton players. However, combining both training methods may provide optimal benefits for performance and injury prevention. Future studies should explore the long-term impacts of various training approaches on badminton performance and dynamic balance.

### Conclusion

This study found that both plyometric and core stability training improved dynamic balance and lower body power in badminton players. Using My Jump Lab for precise measurements, plyometric training showed greater benefits, particularly in vertical jump height and lower body power, compared to core stability training.

**Ethical Clearance:** ethical guidelines outlined by the study was approved by the Institutional Scientific Review Board on human subjects (01/040/2023/ISRB/PGSR/SCPT). [Date:18/04/2023]."

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**Conflicts of Interest:** No conflicts of interest were associated with this research

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