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Research Protocol

Physiotherapy Section

# Effect of Plyometric Training versus Swiss Ball Training on Core Strength, Agility and Dynamic Balance in Recreational Badminton Players: A Research Protocol

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## ABSTRACT

**Introduction:** Badminton is a recreational, versatile, explosive sprint sport. The player needs core strength, agility, and dynamic balance. Resistance training used in plyometric activities helps to improve the athlete's strength and fitness. Swiss ball training, a widely embraced method of functional exercise, enhances balance, core stability, flexibility, and overall strength.

**Need for the study:** This study fills a gap in knowledge by exploring the effects of plyometric training and Swiss ball training on core strength, agility, and dynamic balance in recreational badminton players. It seeks to enhance on-court performance and prevent injuries by determining, which method is more effective. Tailored training programs can then be developed further based on individual responses to these methods. By providing evidence-based data, the study aims to support and guide the strength and conditioning coaches, trainers, and players in making appropriate decision about training approaches, ensuring optimal results and minimising injury risks in badminton.

**Aim:** To find out the effect of Plyometric training versus Swiss Ball training on core strength, agility, and dynamic balance in recreational badminton players.

**Methodology:** A non-blinded, randomised controlled parallel-group trial will be conducted for a period of one year from January 2024 to December 2024. Participants will be recruited from Wardha's District Badminton Stadium and will sign a consent form after meeting inclusion or exclusion criteria. They will be randomly divided into Group-A- Plyometric training and Group-B-Swiss ball training by the primary researcher. Outcome measures will be assessed pre and post-intervention. The analysis will be conducted using the free version of R-software. Significance in mean baseline variables will be assessed using either the t-test or Mann-Whitney test for the two assessment periods. Pairwise comparisons between the two groups for significant differences will be conducted using either the paired t-test or Wilcoxon test. The p-value will be evaluated at a 5% level of significance ($p \leq 0.05$).


**Keywords:** Pressure biofeedback, Racquet sport, Stretch-shortening cycle exercises, T- agility, Y balance test

## INTRODUCTION

Badminton stands out as a highly favoured sport in contemporary times, both in India and globally. As an individual and team sport, badminton holds a special place in the world of indoor activities. It is suitable for everyone, of all ages [1]. Around the world, 200 million people play badminton as a recreational activity [2]. It stands out as one of the most thrilling and competitive racquet sports globally. Badminton is often characterised as a fast-paced and dynamic sport, demanding players to execute precise and fast moves [3]. The player needs to have the best sprinting acceleration, deceleration, jumping lunges, and agility. Enhanced reaction abilities are essential in badminton due to the rapid use of the racquet and the high frequency of strokes [4].

In sporting contexts, core stability is described as the best possible performance that can transfer and manage force from the body's center to the limbs through stabilisation of the torso's posture and motion [5]. During dynamic movement, core muscles are employed to stabilise the thorax and pelvis. A strong core gives the muscles of the upper and lower extremities the foundation they need to accelerate body segments and transmit force between disto-proximal body segments when performing sports activities [6].

To achieve peak performance and prevent injuries during rapid movements on the court, badminton players need a high level of dynamic balance. Balance entails the capacity to sustain the body's equilibrium during static balance, whereas dynamic balance includes some amount of anticipated movement around the center of gravity projection [7].

The ability to react rapidly to an external stimulus like an opponent's shuttlecock strike and change direction is known as agility. Change in velocity refers to the capability of accelerating and decelerating simultaneously with a change in direction. According to a study, a player's core strength affects their dynamic balance and agility when playing badminton [8].

In plyometric exercise, the muscular tendon complex experiences a quick stretch eccentric contraction followed by an intense shortening concentric contraction. Stretch is the eccentric phase, while shortening is the concentric phase. This cycle is known as the Stretch-Shortening Cycle (SSC). It entails actions like skipping, hopping, and jumping. Resistance training during plyometric workouts improves an athlete's strength and conditioning and can increase their capacity to perform explosive moves [9].

The development of motor coordination in badminton players is aided by a variety of essential player traits like muscular strength, endurance, aerobic capacity, agility, power, flexibility, equilibrium, and reflexes [10]. Therefore, a badminton player needs core strength, agility, and dynamic balance during swift postural shifts around the court. According to Khatoon M and Thiyagarajan S frequent and quick forward lunges increase the stress load on the dominant leg's Achilles and patellar tendons and are a cause of 1-5% of badminton injuries [11]. The greatest proportion of badminton injuries occurred in the lower extremity with the thigh

involved in 13.2%, knee 37.1%, ankle 28.3%, heel 11.2%, toes 5.7%, and others 4.4% [12].

Swiss ball training is done with an exercise ball or includes various exercises targeting different muscle groups in the body. It is a type of functional training that helps to improve the core stability, flexibility, balance, and overall strength. Exercises can be tailored to meet individual needs and utilised to work out the full body or just a few specific muscle groups. It is critical to contact a competent fitness specialist to ensure that the training sessions are carried out properly and efficiently [13].

This study pioneers the comparison between plyometric training and Swiss ball training in badminton players aged 18 to 25 years, who often lack sufficient training and are prone to injuries. Unprecedented in its focus, the research seeks to elucidate the impact of these distinct training protocols on core strength, agility, and dynamic balance. By addressing this, the study intends to bridge this crucial gap and provide customised training plans for badminton players in this particular demographic that will help them avoid injuries and play better. Hence the present study aimed to determine the effect of plyometric training versus swiss ball training on core strength, agility, and dynamic balance in recreational badminton players.

### Objectives

1. To evaluate the effect of Plyometric training on core strength, agility and dynamic balance in recreational badminton players.
2. To evaluate the effect of Swiss ball training on core strength, agility and dynamic balance in recreational badminton players.
3. To compare the effect of Plyometric training with Swiss ball training on core strength, agility and dynamic balance in recreational badminton players.

### Hypothesis

1. **Alternate hypothesis:** There will be a significant difference between Plyometric training and Swiss Ball training on core strength, agility, and dynamic balance in recreational badminton players.
2. **Null hypothesis:** There will be no significant difference between plyometric training and Swiss ball training on core strength, agility, and dynamic balance in recreational badminton players.

### Review of Literature

A study conducted by Panda M et al., focused on plyometric training among badminton players and its effectiveness. It determined that adding four weeks of plyometric training with general sports training improves badminton players' agility and speed, more than adding electromyostimulation training to general sports training. Additionally, this study found that adding four weeks of electromyostimulation training and four weeks of plyometric exercise to regular sports training had a substantial impact [14].

Nuhmani S studied the efficacy of dynamic Swiss ball training in improving the core stability of collegiate athletes. The relatively high improvement in core stability parameters after Swiss ball training suggested that these exercises are favourable alternatives to traditional floor exercises in strengthening the core muscles [15].

Hotwani R et al., conducted an experimental study, yielding several results. The pre and post-test statistics from the study on badminton players suggested that plyometric training improves the core and strengthens it, along with increasing anaerobic power. Plyometrics not only enables but enhances the rate of transfer of energy needed in the spurt of movement. Although the sample size was small, the results are promising and make a strong case for the inclusion of plyometrics as mandatory training exercises to improve performance parameters [16].

Aksen P et al., found that Swiss Ball and Thera band core exercises have similar short-term effects on body composition and core stabilisation tests in sedentary individuals and women performing recreational sports [17]. A study conducted by Indora NK et al., examined the effectiveness of exercise protocols on balance in badminton players. They found that exercises like pilates, plyometric, swiss ball, PNF, sensorimotor training, and core strengthening significantly improved balance, particularly in badminton players [18].

## MATERIALS AND METHODS

A non-blinded, randomised, controlled, parallel-group trial will be conducted at District Sports Stadium, Wardha, India. The study duration will be one year from January 2024 to December 2024. The Institutional Ethics Committee of Datta Meghe Institute of Higher Education and Research (Deemed to be University) has approved this study. The reference number is DMIHER (DU)/IEC/2023/1067, and the CTRI trial registration number is CTRI/2023/08/056677, registered on 21/08/2023. Prior to the conduction of the study, participants will be given an explanation of the study's goals and methods in their native language. The participants will also be asked to sign a written informed consent form.

**Inclusion criteria:** Athletes aged between 18 and 25 years, both male and female, playing at least 1-2 days each week but no more than four days a week for the past two years were included in the study.

**Exclusion criteria:** Players with a six-month history of pelvic or lower limb fractures or those involved in participation in any other exercises/activities during the study period or those with any past history of systemic diseases/disorders or having formal badminton training before or physically unfit players were excluded from the study.

**Sample size calculation:** Formula Using Mean difference:

$$n1=n2=2\frac{(Z_{\alpha}+Z_{\beta})^2\sigma^2}{(\delta)^2}$$

Primary variable-Y Balance Test

Difference=7.61

Standard deviation=(5.32+7.21)/2=6.265 [4].

N1=2* {(1.96+2.326) 2(6.265) 2}/(7.61) 2=25

Minimum samples required=25 per group. Considering a 20% superiority margin, the sample size required is 30 per group.

Purposive sampling will be used and participants will be divided into Group-A (Plyometric training) and Group-B (Swiss ball training). The randomisation and distribution will be carried out by the primary researcher, a first-year student in the Master of Physiotherapy program. The outcome measures-core strength will be assessed by pressure biofeedback test [19,20], agility by T-agility test [21,22], and dynamic balance by Y balance test [21,23] and will be evaluated both before and after the intervention. A weekly technical training regimen will be implemented in addition to their regular training. Both groups will follow their respective protocols for a total of six weeks, three times per week, with a 24 to 48-hour recovery period between each training session, along with the conventional training protocol. To grow accustomed to the physical training protocols during the formal interventional course of the study, each participant must complete a 2-week trial phase (three sessions/week) before the study and the commencement of testing.

### Interventions

**Group-A- Plyometric Training Program**

1. **Standing exercises on a balancing board:** Week 1-2- Static bilateral stance on the board (three sets: thirty seconds per set), week 3-4- Static bilateral stance on the board with closed eyes (three sets: thirty seconds per set), week 5-6- Squatting on the board with eyes closed (three sets: ten reps per set).

2. **Elbow plank with an inflated balancing disc:** Week 1-2 Elbow plank with an inflated balancing disc (three sets: 30 seconds per set), week 3-4- Elbow plank on an inflated balancing disc with the unsupported leg stretching back (three sets: ten reps per set), week 5-6- Elbow plank with an inflated balancing disc and the unsupported leg stretching back with a resistance band (three sets: ten reps per set).
3. **Squat lunge on a BOSU ball:** Week 1-2- Squat lunge on a BOSU ball (three sets: ten reps per leg per set), week 3-4- Squat lunge on a BOSU ball and an inflated balancing disc (three sets: ten reps per leg per set), week 5-6- Squat lunge on a BOSU ball and an inflated balancing disc with a five kg dumbbell (three sets: ten reps per leg per set).
4. **Balance pad exercise:** Week 1-2- One-leg squatting with a balance pad (three sets: ten reps per leg per set), week 3-4- One-leg stance on a balance pad with the unsupported leg stretching back (three sets: twelve reps per leg per set), week 5-6- one-leg stance on a balance pad with the unsupported leg stretching back using a resistance band (three sets: twelve reps per leg per set).

**Rest:** In between exercises: sixty seconds;

In between sets: three minutes [4].

**Group-B: Swiss ball training program:** The Swiss Ball exercise routine comprises of push-ups, supine lower abdominal cable curls, prone ball holds with mountain climbers, McGill side raises with static hip adduction, hip extension, knee flexion, and curl-ups. Throughout the program's duration, each session progresses from three sets of 15 reps in the first week to four sets of 15 reps in the second week, four sets of 20 reps in the third and fourth weeks, and concludes with four sets of 25 reps in the fifth and sixth weeks [13].

**Conventional training programme for both the groups:**

**Agility Drills:**

1. During the initial two weeks, the front barrier jump routine involves bilateral-leg jumps over six hurdles at a height of 15 cm, with three sets comprising ten reps per set. In weeks 3-4, the focus shifts to unilateral-leg front barrier jumps of 15 cm with three sets of five reps per leg. Weeks 5-6 introduce a higher challenge with single-leg front barrier jumps of 30 cm height, performed in four sets of five reps per leg.
2. The lateral high-knee exercise evolves over six weeks, starting with four hurdles at 15 cm for two reps per set, progressing to six hurdles at 30 cm for four reps per set in weeks 3-4, concluding with six hurdles at 30 cm for six reps per set in weeks 5-6.
3. Lateral barrier jumps progression involves bilateral-leg jumps at a height of 15 cm for three sets with ten reps per set in weeks 1-2, advancing to a 30 cm height with three sets of 12 reps per set in weeks 3-4. Further advancement in weeks 5-6 includes a single-leg jump at 30 cm, with three sets comprising 15 reps per leg per set.
4. Multi-directional jumping over hurdles progresses from bilateral legs triangle jumps (three hurdles) in weeks 1-2, with three sets of 6x3 reps per set. Advancing to weeks 3-4, the program introduces unilateral square leg jumping (four hurdles) with three sets of 8x3 reps per set. Weeks 5-6 entail bilateral legs hexagonal jumps over six hurdles, performed in three sets of 12x3 reps per set.

**Rest:** In between exercises: sixty seconds

In between sets: three minutes [4].

The below [Table/Fig-1] shows the Conventional Training Protocol [24].

| Intervention | Sets/week | | | Exercises Time (Sec) | Rest Time between Sets (Sec) | Rest Time Between Exercises Sets (Sec) |
|---|---|---|---|---|---|---|
| | 1st-2nd | 3rd-4th | 5th-6th | | | |
| Plank | 2 | 3 | 4 | 25 | 30 | 60 |
| Elbow plank | 2 | 3 | 4 | 25 | 30 | 60 |
| Crunch | 2 | 3 | 4 | 25 | 30 | 60 |
| Reverse crunch | 2 | 3 | 4 | 25 | 30 | 60 |
| Superman | 2 | 3 | 4 | 25 | 30 | 60 |
| Birddog | 2 | 3 | 4 | 25 | 30 | 60 |

**[Table/Fig-1]:** Conventional training protocol [24].

**Outcomes:**

1) **Pressure Biofeedback test:** Patients perform the drawing-in technique lying on their back with flexed knees at 90 degrees, gently contracting the lower abdominals and engaging pelvic floor muscles. A pressure device set to 40 mmHg at the Posterior Superior Iliac Spine (PSIS), measures the duration subjects maintain a pressure increase of 10 mmHg during the maneuver [19]. The measurement, with a 1±2 mmHg margin of error, is recorded in seconds. Inter-rater reliability is high, with an Intraclass Correlation Coefficient (ICC) of 0.94 (95% CI 0.37, 0.99) for healthy adults and 0.97 (95% CI 0.97, 0.98) for Chronic Low Back Pain (CLBP) patients. In both groups, 95% of interrater agreements fall within specified boundaries of agreement (LOA=5.75, -3.25 mmHg for healthy subjects; LOA=5.92,-3.9 mmHg for CLBP) [20].
2) **T-Agility test:** The participant starts by advancing 10 meters from the starting line, touching cone one with their right hand. Moving right for five meters, they touch cone two, followed by a lateral shift left for 10 meters, touching cone three with their left hand [21]. The participant sprints back to cone one and returns to the finishing line completing the task. Statistical analysis involves calculating the mean score from three trials, with a high intraclass reliability of 0.98 across t-test trials. For both males and females, correlations between the t-test and physical assessments show no significant differences (p>0.05) [22].
3) **Y Balance test:** The Y balance test involves specific sequences of movements, evaluating the maximal reach in three orientations: anterior, postero-medial, and postero-lateral. Subjects maintain a single-leg stance at the center of the platform, reaching forward with hands on hips [21]. Invalid trials include difficulty sustaining the stance, hands leaving hips, or any ground contact. Intraclass correlation values for maximal reach range from 0.80 to 0.85, demonstrating the interrater test-retest reliability with coefficients from 0.85 to 0.93 [23]. Composite score=(Anterior+posteromedial+posterol ateral)/ (3×limb length)×100

## STATISTICAL ANALYSIS

The statistical analysis will be conducted using R-software. Descriptive and inferential statistics will be utilised for the analysis of outcome variables. Descriptive analysis will use means and standard deviations for normally distributed data, and medians with inter quartile ranges for skewed data. The plyometric training program and Swiss ball training program are the independent variables, and core strength, agility, and dynamic balance are the dependent variables. The t-tests or Mann-Whitney tests will be used for the comparison of dynamic balance changes from baseline to the end of the study through inferential statistics. Paired t-tests and unpaired t-tests will be used for intra-group differences and for inter-group differences, respectively. Non-parametric tests like Chi-square, Mann-Whitney, Wilcoxon, Kruskal-Wallis, or Friedman tests will be used for the non-normally distributed data.

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