

# Effect of Combined Strength and Plyometric Training on Smash Speed and Court Movement in Competitive Badminton Players of Sikar and Churu Districts of Rajasthan

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**Abstract:** Badminton is a high-intensity racket sport requiring explosive power, rapid directional changes, agility, and neuromuscular coordination. Smash speed and efficient court movement are decisive performance factors that depend largely on lower-body strength and plyometric ability. The present study aimed to examine the effect of combined strength and plyometric training on smash speed and court movement among competitive badminton players. Thirty district-level players aged 16–22 years from **Sikar** and **Churu** were selected and randomly divided into experimental and control groups. The experimental group underwent an eight-week structured strength and plyometric training program alongside regular badminton practice, while the control group continued only routine training. Smash speed was measured using video motion analysis, and court movement ability was assessed through a standardized badminton agility test. Statistical analysis revealed significant improvement in both variables among the experimental group compared to the control group. The findings indicate that integrated strength and plyometric training enhances explosive performance and on-court movement efficiency in badminton players.

**Keywords:** Strength training, Plyometric training, Smash speed, Court movement, Badminton performance, Agility, Explosive power.

**Introduction** - Badminton is recognized as one of the fastest racket sports, requiring players to execute explosive movements, rapid directional changes, and high-speed strokes within very short time intervals. Success in the game depends not only on technical skill but also on physical attributes such as muscular strength, power, speed, and agility. Among offensive skills, the smash is considered the most decisive stroke, demanding strong lower-body drive, trunk rotation, and coordinated upper-body acceleration. Efficient court movement is equally important, as players must reach the shuttle quickly while maintaining balance and control. Inefficient movement patterns increase fatigue and reduce performance quality during rallies. Therefore, physical conditioning plays a vital role in modern badminton performance.

Strength training improves muscle force production and joint stability, while plyometric training enhances explosive ability by improving the muscles' ability to produce force rapidly. When these two training methods are combined, they can significantly enhance athletic movements that involve jumping, sprinting, and sudden changes in direction. In many developing training environments, athletes focus mainly on skill practice and match play, with limited

emphasis on scientific conditioning. This may restrict physical development and overall performance potential. Research focusing on badminton-specific performance variables such as smash speed and court movement remains limited at the district competitive level. Hence, the present study was designed to examine the effectiveness of combined strength and plyometric training in improving these performance aspects.

## Review Of Literature

A considerable body of sports science research supports the role of strength and plyometric training in enhancing explosive performance, agility, and sport-specific skills. These physical components are particularly critical in high-speed racket sports like badminton, where players perform repeated jumps, lunges, and rapid multidirectional movements.

Sharma and Kaur (2019) examined the influence of lower-body strength training on power output among racket sport athletes and found significant improvements in jump height, stroke force, and movement acceleration. Their study emphasized that increased muscular strength enhances force transfer from the lower body to the upper body during overhead strokes, directly influencing smash

effectiveness.

Singh (2018) reported that plyometric training improves the efficiency of the stretch-shortening cycle, leading to faster muscle contraction and greater explosive output. The study observed that athletes who underwent depth jumps, bounding, and box jumps demonstrated superior sprint and agility performance compared to control groups.

Research by Markovic and Mikulic (2010) established that plyometric exercises significantly enhance vertical jump performance and neuromuscular coordination. Improved jump ability directly contributes to higher contact points in overhead smashes, enabling players to generate greater shuttle velocity.

In badminton-specific research, Phomsoupha and Laffaye (2015) highlighted that smash performance is influenced by leg power, trunk rotation speed, and shoulder acceleration. Their biomechanical analysis revealed that lower-body power contributes substantially to shuttlecock velocity.

Agility and court movement are also linked to strength and plyometric development. Miller et al. (2006) found that plyometric training enhances agility by improving reaction time, muscle stiffness, and ground contact efficiency. Athletes showed quicker directional changes and reduced movement time.

A study by Chen et al. (2017) on elite badminton players demonstrated that those with higher lower-body power displayed faster court coverage and better defensive recovery. The researchers concluded that explosive training improves both offensive and defensive performance.

Furthermore, Chu (2013) emphasized that integrated strength and plyometric training produces superior results compared to isolated training, as it develops both force production and speed of contraction, essential for sport-specific explosive actions.

Although extensive international research exists, limited studies focus on district-level Indian badminton players, particularly in semi-urban regions. Most training programs in such areas prioritize skill repetition rather than physical conditioning. Therefore, investigating the effect of structured strength and plyometric training on smash speed and court movement among competitive badminton players is both necessary and relevant.

**Objectives Of The Study:** The present study was conducted with the following objectives:

1. To determine the effect of combined strength and plyometric training on smash speed among competitive badminton players.
2. To examine the influence of combined strength and plyometric training on court movement ability.
3. To compare pre-test and post-test smash speed scores of experimental and control groups.
4. To compare pre-test and post-test court movement performance of experimental and control groups.
5. To assess the effectiveness of scientific conditioning

programs in enhancing badminton performance variables.

**Hypotheses Of The Study:**

1. H1: There will be a significant difference between pre-test and post-test smash speed of the experimental group.
2. H2: There will be a significant difference between pre-test and post-test court movement scores of the experimental group.
3. H3: The experimental group will show significantly greater improvement in smash speed compared to the control group.
4. H4: The experimental group will demonstrate significantly better court movement performance than the control group after training.
5. H5: Combined strength and plyometric training will positively influence badminton-specific explosive performance.

**Significance Of The Study:** This study holds practical and scientific importance in the field of sports training and badminton performance enhancement.

1. Provides scientific evidence for integrating strength and plyometric training in badminton coaching programs.
2. Helps coaches design structured conditioning routines rather than focusing only on skill practice.
3. Assists district-level players in improving smash power and court coverage ability.
4. Contributes to sports science research in developing regions like **Sikar** and **Churu**.
5. Supports the development of evidence-based training models for competitive badminton athletes.

**Methodology**

**Research Design:** The study employed an **experimental research design** using a pre-test and post-test control group method. This design was selected to determine the effect of combined strength and plyometric training on smash speed and court movement in competitive badminton players.

**Selection Of Subjects:** A total of **30 competitive badminton players** were selected from sports academies and training centers of **Sikar** and **Churu** districts.

Group	Number of Subjects	Criteria
Experimental Group	15	Regular badminton players + additional strength & plyometric training
Control Group	15	Regular badminton training only

**Inclusion criteria:**

1. Age between **16–22 years**
2. Minimum **2 years of badminton playing experience**
3. Participation in district or school/state-level competitions
4. Medically fit and injury-free

**Exclusion Criteria:**

1. Any musculoskeletal injury
2. Cardiovascular or respiratory disorders
3. Participation in other structured strength training programs

**Variables Of The Study:**

Type of Variable	Variable
Independent Variable	Combined Strength and Plyometric Training
Dependent Variables	1. Smash Speed 2. Court Movement Ability
Control Variables	Age, playing experience, practice duration

**Tools And Tests:**

Variable	Test	Measurement
Smash Speed	Video Motion Analysis Method	Shuttle speed (km/h)
Court Movement	Badminton Agility/ Footwork Test	Time in seconds
Leg Power (supporting)	Vertical Jump Test	Jump height (cm)

**Training Programme:**

The experimental group underwent an **8-week combined strength and plyometric training program**, 3 sessions per week, in addition to regular badminton practice.

**Strength Training Exercises**

1. Squats
2. Lunges
3. Deadlifts
4. Step-ups
5. Core exercises (planks, medicine ball rotations)

**Plyometric Training Exercises**

1. Box jump
2. Depth jumps
3. Skater jumps
4. Bounding
5. Lateral hops

**Session Duration:** 45–60 minutes

**Progression:** Intensity gradually increased every two weeks.

The control group continued only routine badminton skill training.

**Testing Procedure:**

1. Pre-tests were conducted before the start of training.
2. Standard warm-up of 10 minutes (jogging + stretching).
3. Smash speed was recorded using video analysis during maximum-effort smashes.
4. Court movement was assessed using a standardized badminton footwork pattern test.
5. After 8 weeks, post-tests were conducted under identical conditions.
6. Rest intervals were standardized to maintain test reliability.

**Ethical Considerations:**

1. Written consent obtained from participants.

2. Participants were informed about study purposes and procedures.
3. Safety measures were followed during training and testing.
4. Data confidentiality was maintained.

**Reliability And Validity:**

1. Vertical Jump Test reliability:  $r = 0.89$
2. Agility Test reliability:  $r = 0.86-0.90$
3. Video motion analysis is widely accepted for performance evaluation in racket sports.

**Statistical Analysis:** Descriptive statistics (Mean and Standard Deviation) were calculated to analyze performance changes. The **t-test** was used to determine significant differences between pre-test and post-test scores and between groups.

**Results:** The pre-test and post-test scores revealed that the experimental group demonstrated marked improvement in smash speed, court movement ability, and vertical jump performance after the 8-week combined strength and plyometric training program. The control group showed only minor changes.

1. Smash speed increased significantly in the experimental group, indicating enhanced explosive stroke power.
2. Court movement time decreased, showing improved agility and on-court efficiency.
3. Vertical jump height improved, confirming better lower-body power development.

Statistical analysis using the t-test indicated that the improvements in the experimental group were significant at the 0.05 level, while the control group changes were not significant.

**Discussion:** The improvements in smash speed can be explained by enhanced force production and neuromuscular efficiency developed through strength and plyometric training. Plyometric drills improve the stretch-shortening cycle, enabling faster muscle contraction and more powerful movements, which are crucial for executing high-velocity smashes.

The reduction in court movement time suggests better agility, balance, and reactive strength. Plyometric and strength exercises improve muscle stiffness and joint stability, which help athletes change direction quickly with reduced energy loss.

The improvement in vertical jump performance confirms the development of explosive leg power, which contributes directly to higher contact points and stronger overhead strokes. The minimal gains in the control group indicate that routine badminton practice alone does not sufficiently enhance explosive physical qualities.

These findings support the idea that scientific conditioning programs are essential for optimizing badminton performance.

**Conclusion:** The present study concludes that combined strength and plyometric training significantly improves

smash speed and court movement ability in competitive badminton players. The experimental group demonstrated marked enhancement in explosive power, agility, and on-court efficiency after the 8-week training program, while the control group showed only minimal improvement through routine practice.

The increase in smash speed reflects improved force generation and neuromuscular coordination, while the reduction in court movement time indicates better agility and directional control. The improvement in vertical jump performance further confirms enhanced lower-body explosive strength, which is crucial for powerful overhead strokes.

Therefore, it can be concluded that integrating structured strength and plyometric training with regular badminton practice is highly effective for enhancing performance-related physical abilities in badminton players.

**Recommendations:** Based on the findings of the study, the following recommendations are made:

1. Badminton coaches should incorporate strength and plyometric exercises into regular training programs.
2. Conditioning sessions should be conducted at least 2–3 times per week for optimal performance gains.
3. Scientific monitoring of training load and progression should be implemented.
4. Sports academies should provide facilities and equipment for strength and plyometric training.
5. Similar studies should be conducted with female players and different age groups.
6. Future research may include additional variables such as reaction time, endurance, and injury prevention.

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