Acta Scientific Orthopaedics (ISSN: 2581-8635)

Volume 8 Issue 3 March 2025

Research Article

Study on the Effectiveness of Sagittal Plane Plyometrics and Frontal Plane Plyometrics on Agility and Jumping Performance Among Young Collegiate Badminton Players

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Received: January 23, 2025

Published: February 28, 2025

Abstract

Background: One of the most well-liked racquet sports worldwide is badminton. For hitting a shuttlecock in a game of badminton, agility and vertical leap are critical motor abilities. Throughout the game, badminton players must quickly and continuously modify their body position in response to the shuttlecock's movement. Rapid direction changes, vertical leaps, forward lunges, and various postural postures are all necessary during a badminton match. The ability to leap vertically and move with agility are crucial motor skills for hitting a shuttlecock at various points on the court.

Methodology: For this investigation, forty volunteers were gathered. Twenty participants in Group A received treatment using sagittal plane plyometrics. Twenty participants in Group B had frontal plane plyometric treatment. The intervention was given to both groups for a period of six weeks. The T-test was utilized to gauge agility, while the Sargeant Jump Test was used to gauge leaping ability. Within each group comparison, the paired "t" test was used, and outside of each group comparison, the unpaired "t" test was used. The results were obtained by the application of statistical methods and statistical software, SPSS

Result: According to the study's findings, among young college badminton players, Sagittal Plane Plyometrics is more successful than Frontal Plane Plyometrics for jumping performance and Frontal Plane Plyometrics is more effective than Sagittal Plane Plyometrics for agility.

Conclusion: This study concluded that in young college badminton players, Sagittal Plane Plyometrics is more successful than Frontal Plane Plyometrics for jumping performance and Frontal Plane Plyometrics is more effective than Sagittal Plane Plyometrics for agility.

Keywords: Sagittal Plane Plyometrics; Frontal Plane Plyometrics; T-Test; Sargeant Jump Test; Badminton

Introduction

The widely popular sport of badminton requires quick reflexes and powerful shots in addition to deft footwork. With smashes up to 30 meters per second, badminton is one of the fastest racquet type sport in the world. To win this sport, athletes must be able to quickly react to the shuttlecock's movements and continuously change their body position. To perform quick and asymmetrical movements of the upper limbs, players must maintain their center of gravity inside the support base [1]. Players in the badminton sport occasionally participate in intense rallies on the court. The game requires quick direction changes, forward lunges, vertical jumps, and a variety of postural postures. [2]. Two or four players can play the racket sport of badminton, which has a temporal structure characterized by quick but forceful movements. Gamers have to exert all of their strength, endurance, flexibility, speed, and agility. The game uses both longer, rallies of moderate to high intensity (aerobic system) and shorter, higher-intense level rallies (anaerobic system). The shuttlecock travels in an irregular path, requiring players to make certain motions, such as lunging and jumping, in addition to strong strokes with a certain motion pattern. [3]. The sport also requires extremely dynamic movements in a small court area. After every shot, quick direction changes become necessary, necessitating quick, accurate technique and good control in all motions. There are many jumps, both vertical and lateral, throughout different parts of the game [4]. The player hits the shuttlecock higher, resulting in a steeper trajectory and shorter travel distance for the shuttlecock. The player's capacity to jump, their spatiotemporal perception, the approaching shuttlecock's flight pattern, and the temporal synchronization of sub-segments all affect the height of the hitting point. [5].

Plyometric exercises enhance explosiveness, elasticity, and eccentric strength by triggering the stretch-shortening cycle with rapid, forceful movements. The four phases of plyometrics are the momentum phase, where body moves using the energy from a previous action; the constant instant phase is characterized by momentum stops due to contact with a surface; the amortization phase, where stored kinetic energy triggers a stretch reflex, resulting in an eccentric contraction then an explosive action; followed by the rebound stage, in which the body releases elastic energy from connective tissue, resulting in an autonomic concentric contraction. [6].

Individuals who participate in dynamic sports frequently use plyometric workouts, and exercises such as bounding, skipping, hopping, and leaping are employed to enhance dynamic muscle performance. Plyometric training program appears to be a useful strategy for increasing strength, agility, and sprinting ability based on available data. Explosive movements featuring abrupt stops, starts, and direction changes are commonly included in plyometric training, and these elements are essential for developing agility [7]. Plyometric exercises include quickly stretching a muscle and then instantly shortening or concentricising the muscle and connective tissue. More force can be produced than is achieved by just a concentric motion by using the muscle's stored elastic energy [8]. Exercises like jumping, bounding, and hopping that take advantage of the muscle units' stretch- shortening cycle are known as plyometric training. Improvements in the production of muscle force and power for subsequent motions have been shown in numerous researches. The stretch reflex and the innately elastic qualities of muscles and tendons are both used to produce this improvement. Plyometric training is a useful step between developing strength and improving speed because it makes the brain and musculotendinous systems more capable of producing maximal force in the quickest time possible. This is because the stretch-shortening cycle (SSC) improves this ability. Reduced sprint and acceleration times are a result of these physiological changes. [9]. To improve athletes' explosive jumping skills, many strengths and conditioning instructors use explosive training like Plyometrics. Furthermore, studies show that a well-crafted plyometric program can help athletes develop positive neuromuscular adaptations, which reduces the incidence of lower extremity injuries like anterior cruciate ligament (ACL) tears in both female and male athletes. [10].

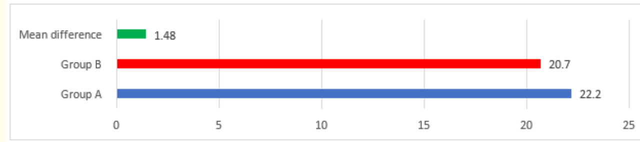
For young athletes to profit significantly and perform better from plyometric training, six weeks should be the minimum required time. [11]. The vertical jump test is a fitness evaluation tool that measures an athlete's maximum vertical jump height to assess their lower body explosive power. This test was selected as a measure of outcome to evaluate upward leap height in the present shuttle player-focused study. In this test, participants stand sideways to a wall and raise their nearest hand to it. The height of the fingertips, or standing reach height, is indicated with chalk. After taking one step back from the wall, the athlete does a vertical leap, touching the wall with both arms and legs at the peak of the leap. The distinction between the jump height and the standing reach point is the measured metric. [12].

For most of these jumps, the primary motion is vertical (dominant in the sagittal plane). In a vertical jump, the center of mass must move laterally, causing a sagittal cut that effectively divides the body in half. As a result, the center of mass can shift vertically. The specificity principle underpins the use of sagittal plane-aligned plyometric exercises to enhance vertical leaps. This theory states that strength training should incorporate biomechanically similar movements to those seen in a particular sport in order to yield positive training outcomes.[13]. The Agility T test measures the capacity to quickly change directions while retaining balance and speed. It is a four-directional evaluation of agility and body control.

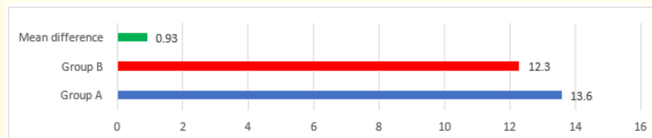
The administration of this test is simple and requires little setup or equipment. When assessing leg power, leg speed, and agility for performance evaluation, it shows to be valid and dependable. Three cone- shaped object (B, C, and D) are placed at corners to ensure precision when conducting the test. With feets both planted behind initial point A, participants begin. After running 9.14 meters (10 yards) to B, they touch the bottom of a cone using their right extremity, move to the left for 4.57 meters (5 yards) to touch point (C), and shuffle right for 9.14 meters to touch cone marked (D) Using the right hand, shuffle left and return 4.57 meters to point B, making contact with the left hand. At last, they run backward and cross the finish line at point A, with a timer used to record the time. In badminton matches, agility-which is characterized as swift whole-body motion with path and/or velocity changes as a reaction to a stimulus-is a critical component of physical performance. As such, it is a crucial element that is usually included in strength and conditioning regimens for players participating in team sports [14]. In a badminton match, agility showed a strong association (r = 0.83) with physical performance. Because of the shuttlecock's unusual and erratic flight path, hitting with expertise is essential. Agility and vertical jump are two fundamental motor abilities needed to hit the birdie well from varying spots on the shuttle court [15].

Methodology

Review Board of RVS College of Physiotherapy, Coimbatore has approved this comparative study and a written consent was obtained from the participants after giving clear instructions regarding the procedure and its implications. This study was conducted in physiotherapy outpatient department of RVS College of Physiotherapy Sulur, Coimbatore. 40 subjects aged between 18 and 25 were chosen and split into two sections. Prior to the data collection, the subjects were told about the study's goal and methodology, and informed consent was acquired. The investigator provided a thorough explanation of the several test protocols, including the vertical jump test to gauge the individuals' explosive power and the agility test to gauge their agility. Exercises in the Sagittal plane was carried out by group A, and exercises in the Frontal plane were carried out by group B. The values were analyzed by application SPSS.



Graph 1: Graphical representation of the group A and group B mean and mean difference values of jumping performance.



Graph 2: Graphical representation of the group A and group B mean and mean difference values of agility.

The Graph 1 shows an illustration of the mean and mean difference values of jumping performance for groups A and B. When the mean values of groups A and B were compared, Group A patients who were treated with sagittal plane plyometrics had a greater difference than Group B.

The Graph 2 shows an illustration of the mean and mean difference values of agility for groups A and B. When the mean values of groups A and B were compared, Group B patients who were treated with frontal plane plyometrics had a greater difference than Group A.

Discussion

The study's objective was to assess the effects of frontal plane and sagittal plane plyometrics on young collegiate badminton players' agility and jumping performance. Forty subjects were chosen and split into two groups according to the criterion for inclusion and exclusion. There were twenty subjects in each group. Group B engaged in frontal plane plyometric activities, whilst Group A engaged in Sagittal plane plyometric exercises.

The current study's findings demonstrate that Sagittal plane plyometric activities were superior to Frontal plane plyometric exercises in terms of enhancing young college badminton players' leaping performance agility.

Cipriani., *et al*. (2010) conducted research that corroborated the current findings, supporting this outcome. The key objective of their study was to compare how high school basketball players' vertical jump height was affected by preseason frontal and sagittal plane plyometric training programs. 32 junior and high school basketball players participated in the study's 6-week plyometric training program. Throughout the program, participants were allocated to either the Frontal plane or the Sagittal plane plyometrics. The specificity of training hypothesis may be used to explain the observed improvement in the Sagittal Plane Plyometric group as opposed to the Frontal Plane Plyometrics group. This idea states that athletes who have more practice with a certain movement likely to perform better than athletes who have less expertise with the same action. Because the participants were used to vertical leaping in this setting-a crucial aspect of basketball-there is a chance that, following the 6-week intervention, the Frontal Plane Plyometrics group's neuromuscular efficiency was lower than that of the Sagittal Plane Plyometric section. [16].

Ozmen., *et al*. (2017) study is another that supports similar conclusions. Their study compared how plyometric training affected the agility and leaping ability of teenage badminton players. The study found that adolescents who played badminton benefited from plyometric training in terms of their agility and vertical leap ability. Considering that the training session lasted less than eight weeks, it is possible that the increased jump height that was seen was the result of brain changes. Increasing the frequency and recruitment of α-motoneuron firing is one of these adaptations. It has been proposed that plyometric exercise increases voluntary muscle activation by eliciting adaptations at the spinal and/or supraspinal levels, contingent upon the contraction mode. The current study's findings further demonstrate that frontal plane plyometric activities were superior to sagittal plane plyometric exercises for enhancing young college badminton players' agility. [17].

To examine the effects of frontal and sagittal-plane plyometrics training on power aspects and change-of- direction speed in adolescent female basketball players, McCormick., *et al.* (2016) conducted research that supports these findings. Twenty-three male collegiate students took part in the study. The lateral shuffle test was used to examine change-of-direction speed, the lateral hop test was used to evaluate power element in the frontal plane, and the counter movement vertical leap test was used to assess the players power in the sagittal plane. The amount of progress seen in the Frontal plane plyometrics group indicates that training specificity, not task complexity including change- of-direction speed, determines the quantity of improvement. According to the study, rather than improvements in strength or power, the 6-week plyometric exercise increased change-of-direction speed performance mainly through motor control, neural adaptations, and improved show recruitment. Because of the plane of motions and angles involved in the lower extremity, frontal plane plyometric exercises may have made it easier for participants to learn the precise movements and positions needed for direction changes [18]. This could lead to an increase in neuromuscular efficiency during change-of-direction tasks. Thus, it can be said that while Frontal plane plyometric exercises were more beneficial than Sagittal plane plyometric exercises in terms of enhancing jumping performance, Sagittal plane plyometric exercises were more beneficial in terms of enhancing agility among young collegiate badminton players.

Conclusion

The study was conducted to compare the effectiveness of Sagittal plane plyometrics and Frontal plane plyometrics on jumping performance and agility in young collegiate badminton players. Forty subjects were selected based on Inclusion criteria and Exclusion criteria were selected and divided into two groups. Group A and Group B. Each group consisted of 20 subjects. Group A performed Sagittal plane plyometrics exercises while group B performed Frontal plane plyometrics exercises. From the statistical result, it is concluded that there is significant improvement in jumping performance and improvement in agility in both groups. When comparing the mean values of group A and B, Group.

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