

**“The Effect of Plyometric Training on Knee Kinematic Parameters
during Forward Lunge in Recreational Badminton Players- A
Randomized Controlled Trial”**

By

PRAJWAL SHRIPAD JOSHI

**Dissertation Submitted to the
Odisha University of Health Sciences, Bhubaneswar, Odisha**

**In Partial Fulfilment
Of the requirements for the degree of**

MASTER OF PHYSIOTHERAPY (MPT)

**In
SPORTS**

Under the Guidance of

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**ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH
INSTITUTE BHUBANESWAR, ODISHA - 2023-2025**

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled “**The Effect of Plyometric Training on Knee Kinematic Parameters during Forward Lunge in Recreational Badminton Players- A Randomized Controlled Trial**” is a bonafide and genuine research work carried out by me under the guidance of **Dr.Deepak Kumar Pradhan (PT) Associate Professor, Abhinav Bindra Sports Medicine and Research Institute, Odisha** and there are no conflict of interest associated with this dissertation work.

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CERTIFICATE OF ACCEPTANCE

This is to certify that the dissertation entitled “**The Effect of Plyometric Training on Knee Kinematic Parameters during Forward Lunge in Recreational Badminton Players- A Randomized Controlled Trial**” carried out by **Mr. Prajwal Shripad Joshi** bearing University Registration Number **23MP435023**, has been **evaluated and accepted** by me as an **Examiner / Evaluator**, appointed by the **Odisha University of Health Sciences, Bhubaneswar**, in partial fulfilment of the requirements for the award of the degree of **Master of Physiotherapy (MPT) in Sports**.

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Name: Dr. Chinmaya Kumar Patra (PT)

Name of the Department: Community Physiotherapy

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Date:

Signature

Place:

Prajwal Joshi

LIST OF ABBREVIATIONS USE

1	SD	Standard Deviation
2	p value	Significant value
3	M	Male
4	F	Female
5	ABSMARI	Abhinav Bindra Sports Medicine and Research Institute.
6	Group A	EXPERIMENTAL Group: Plyometric
7	Group B	CONTROL Group
8	N	Number of participants

ABSTRACT

Background: Badminton involved rapid lunging movements that placed high demands on knee joint mechanics, increasing injury risk. Plyometric training was proposed to enhance neuromuscular control and knee stability, but its effects on knee kinematics in badminton players were not well established.

Objective: This study aimed to evaluate the impact of a six-week plyometric training program on knee kinematic parameters during forward lunges.

Method: Twenty-six recreational badminton players (aged 18–25) were randomly assigned to a plyometric training group or a control group. Baseline knee kinematics during forward lunges were recorded using the MVN Awinda Xsens wireless motion capture system. Key parameters measured included landing moment knee flexion, peak knee flexion, and knee abduction/adduction. Following baseline testing, the intervention group completed a six-week plyometric program, while controls maintained usual activities. Post-intervention measurements replicated baseline procedures.

Results: The plyometric group showed significant improvements in peak knee flexion angles (right side: 62.92° to 73.54°, left side: 58.69° to 75.66°) and increased knee abduction/adduction. In contrast, the control group exhibited minimal changes. Between-group comparisons confirmed greater improvements in knee kinematic parameters for the plyometric

Conclusion: A six-week plyometric training program significantly enhanced knee flexibility and control during forward lunges in recreational badminton players. These improvements likely contributed to better performance and reduced injury risk. Plyometric training was recommended to be incorporated into badminton conditioning to optimize knee joint mechanics.

Keywords: “Control Group”, “Motion Capture”, “Knee Joint”, “Racquet Sports”, “Plyometric”

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1. INTRODUCTION

Badminton has become widely recognized as both a recreational and competitive sport, particularly following its inclusion in the 1992 Barcelona Olympic Games ^[1]. Since then, it has evolved into one of the fastest and most popular non-contact racket sports worldwide. Matches demand that players perform explosive movements, make rapid changes in direction, and maintain precise technique in overhead strokes. The intensity of rallies is notable, as athletes frequently jump, shuffle, and lunge across the court in response to high shuttle speeds. This combination of aerobic and anaerobic activity makes badminton physically demanding, requiring cardiovascular endurance alongside refined motor control.

Among the various movements in badminton, the lunge is especially important. It allows players to reach low and wide shots while staying balanced and ready for subsequent returns. Biomechanically, lunges involve substantial knee flexion, rapid deceleration, and force absorption, making them both crucial for performance and a potential source of injury. Research indicates that lunges account for over 15% of match activity, with players performing approximately 52 half lunges and 46 forward lunges per game ^[2]. This highlights the central role of lunges in play and the cumulative stress they place on the knee joint.

Studies consistently report that most badminton injuries occur in the lower limbs, with the knee being the most commonly affected ^[3]. ACL injuries, in particular, are concerning due to their severity and long-term consequences. Rupture of the ACL often requires extended rehabilitation and may lead to early-onset osteoarthritis even after surgical repair. For example, Kimura et al. reported that ACL injuries accounted for nearly 37% of all badminton-related injuries^[4]. At both the London 2012 and Rio 2016 Olympic Games, the lower limb—especially the knee—was consistently the most frequently injured region, with non-contact ACL ruptures occurring regularly.

The primary mechanisms of these injuries mirror those seen in other sports involving pivoting and jumping. The most common scenario is a single-leg landing after a jump or lunge, followed

by sudden deceleration with directional changes, known as a “plant-and-cut” movement [5]. Both actions generate high shear and rotational forces across the knee, which can exceed the ACL’s mechanical tolerance. The repetitive nature of badminton, with continuous lunges and rapid transitions, increases cumulative strain on ligaments and surrounding tissues during a match.

Plyometric training has emerged as an effective strategy to enhance performance while reducing injury risk. These exercises utilize the stretch–shortening cycle, where muscles store elastic energy during an eccentric contraction and release it immediately through a concentric contraction. This cycle enhances force production and is particularly beneficial for the explosive actions required in badminton. Plyometric training improves lower-limb power, agility, and dynamic balance while also promoting safer landing mechanics.^[6] Specifically, it encourages greater knee flexion during landings, which improves shock absorption and reduces anterior tibial shear forces, protecting the ACL.

A key advantage of plyometric training is its effect on landing patterns. Improper landings, such as stiff landings or excessive knee valgus, are strongly linked to ACL injuries. Plyometric exercises retrain athletes to land with proper alignment, increased knee and hip flexion, trunk stability, and heightened proprioception. Over time, these adaptations lead to more balanced load distribution, decreased joint collapse, and lower risk of injury during sport-specific movements such as lunges.^[7] Research in female athletes has shown that plyometric programs can successfully modify landing mechanics, reducing the incidence of non-contact ACL injuries.

In addition to injury prevention, plyometric training enhances athletic performance by improving cutting mechanics, jump height, and recovery speed between explosive efforts. These benefits are particularly relevant in badminton, where rapid acceleration, lunges, and quick recoveries are essential for competitive play.

Accurate assessment of the biomechanical effects of plyometric training requires advanced measurement tools. The MVN Awinda Xsens system, which uses inertial measurement units (IMUs), allows for portable, wireless, and ecologically valid motion analysis.^[8] Unlike traditional laboratory systems, Xsens enables real-time on-court evaluation of complex, multidirectional movements influenced by shuttle trajectory and court dimensions. Using this system, researchers can capture three-dimensional knee kinematics, including angles and angular velocities across multiple planes. Increases in peak knee flexion suggest improved landing force absorption, while reductions in knee valgus and rotational deviations indicate enhanced neuromuscular coordination of the quadriceps, hamstrings, and gluteals. Smoother angular velocity patterns further reflect better motor control and muscular synchronization, which together enhance joint stability and efficiency during lunges.^[9]

Although badminton biomechanics have been studied, there remains a gap regarding how plyometric training affects knee kinematics during forward lunges.^[10] Most prior research has focused on other sports, general balance improvements, or proprioception without detailed joint mechanics analysis. Since the forward lunge is one of the most frequent and physically demanding movements in badminton, investigating this specific action is essential.

This study aims to examine the effect of plyometric training on knee kinematics during forward lunges in recreational badminton players. Using the Xsens motion capture system, the research will assess changes in knee flexion, valgus, rotational deviations, and angular velocity.^[11] It is expected that plyometric training will lead to safer, more controlled lunge landings, reduce ACL loading, and improve overall performance. The findings will provide valuable insights for designing training programs that enhance performance while minimizing injury risk in badminton athletes.

Need of the study:

This study aims to address these gaps by examining the Effect of Plyometric Training on Knee Kinematic Parameters during Forward Lunge in Recreational Badminton Players. The mechanics of knee movement, or knee kinematics, are closely linked to the risk of knee injuries in badminton. Positive alterations in knee kinematics through plyometric training can contribute to a decrease in knee injuries among badminton players. By understanding the impact of plyometric training on knee kinematics, coaches and physiotherapists can develop more effective injury prevention and performance enhancement strategies for badminton players

2. AIM AND OBJECTIVES

Aim of the study:

The aim of this study is to investigate the effects of plyometric training on knee kinematics during forward lunge in recreational badminton players.

Objective of the study

- To determine the knee kinematic parameters during forward lunge in recreational badminton players before and after plyometric training.
- To determine specific knee kinematic parameters most influenced by plyometric training.
- To determine the effects of plyometric training on knee angles and knee movement during the forward lunge.
- To explore the relationship between improved knee kinematics on injury prevention and badminton performance.

3. HYPOTHESIS

- **Null hypothesis:**

H^0 - There will be no significant improvement in Effect of Plyometric Training on Knee Kinematic Parameters during Forward lunge in Recreational Badminton Players

- **Alternate hypothesis:**

H^1 - There will be significant improvement in Effect of Plyometric Training on Knee Kinematic Parameters during Forward lunge in Recreational Badminton Players

4. REVIEW OF LITERATURE

1. **Wing-Kai Lam, Duo Wai-Chi Wong.** Biomechanics of lower limb in badminton lunge: a systematic scoping review.4 November 2020. This review summarized the current trends, research methods, and parameters-of-interest concerning lower extremity biomechanics in badminton lunges. Elite badminton players demonstrated higher impact attenuation capability, more aggressive knee and ankle strategy (higher mechanical moment), and higher medial plantar load than amateur players. Playing levels have significant effects on biomechanics in badminton lunges. Future studies can consider to use an unanticipated testing protocol and realistic movement intensity. They can study the inter-limb coordination as well as the contributions and interactions of intrinsic and extrinsic factors to injury risk.
2. **Lin Fu, Feng Ren.** Comparison of Joint Loading in Badminton Lunging between Professional and Amateur Badminton Players 13 June 2017. Aim of this study was to investigate the kinematic motion and kinetic loading differences of the right knee and ankle while performing a maximal right lunge. Amateur players exhibited greater ankle range of motion ($p < 0.05$, $r = 0.89$) and inversion joint moment ($p < 0.05$, $r = 0.54$) in the frontal plane as well as greater internal joint rotation moment ($p < 0.05$, $r = 0.28$) in the horizontal plane. In contrast, professional badminton players presented a greater knee joint moment in the sagittal ($p < 0.05$, $r = 0.59$) and frontal ($p < 0.05$, $r = 0.37$) planes. Training schemes and injury prevention strategies for amateur badminton players should account for these findings to reduce potential injury to the ankle and knee.
3. **Ping Huang, Lin Fu.** Biomechanical Analysis Methods to Assess Professional Badminton Players' Lunge Performance. To study the differences in kinematics and

joint moment of the right knee and ankle. The amateur players showed a greater range of ankle movement and reverse joint moment on the frontal plane, and a larger internal joint rotation moment on the horizontal plane. The professional badminton players exhibited greater knee moment on the sagittal and frontal planes. Differences in kinematics and joint moment factors should be considered in the development of the training program to reduce the risk of sports injuries in knee and ankle joints.

4. **J. Troy Blackburn, Darin A. Padua.** Influence of trunk flexion on hip and knee joint kinematics during a controlled drop landing. Aim of the study was to see the effect of trunk flexion on hip and knee kinematics during controlled drop landing. Peak trunk flexion angle was greater for Flexed compared to Preferred ($P < 0.001$), and was associated with increases in peak hip flexion angle and peak knee flexion angle. Active trunk flexion during landing produces concomitant increases in knee and hip flexion angles. A more flexed/less erect posture during landing is associated with a reduced anterior cruciate ligament injury risk.

5. **Chantal Bathe , Lena Fennen.** Training interventions to reduce the risk of injury to the lower extremity joints during landing movements in adult athletes: a systematic review and meta-analysis. Aim was to summarise training interventions designed to reduce biomechanical risk factors associated with increased risk of lower extremity landing injuries and to evaluate their practical implications in amateur sports. A significantly medium effect of technique training (both instruction and feedback) and dynamic strengthening (ie, plyometrics with/ without strengthening) on knee flexion

angle. Technique training in form of instruction or feedback, and dynamic strengthening in form of plyometrics, can improve biomechanical risk factors for lower extremity injuries during landing movements in adult amateur athletes.

6. **Raana Alikhani, Shahnaz Shahrjerdi.** The effect of a six-week plyometric training on dynamic balance and knee proprioception in female badminton players. To investigate the effect of a six-week plyometric training (PT) program on Dynamic balance and knee proprioception in female badminton players. Pre- and post intervention Y balance and photography tests were used to assess Dynamic balance and knee proprioception respectively. The results of this study demonstrated that a six-week plyometric training program improved dynamic balance and knee proprioception in beginner female badminton players. Female badminton players' dynamic balance and knee proprioception improved significantly after plyometric training (PT). These results may be important in preventing non-contact anterior cruciate ligament (ACL) injury, which requires further investigation.

7. **Miroslav Hrzenjak Nebojsa Trajkovic .** Effect of plyometric training on selected kinematic parameters in female volleyball players. To determine the effects of plyometric training on kinematic parameters in junior female volleyball players. The recordings of volleyball spike jumps were made with a Panasonic NV-MS1 camera. Recorded data downloaded with software for 2D kinematic analysis. Both the plyometric and the control group showed significant improvement ($p < 0.05$) in joint kinematics from pre- to post-training on most of the measures for linear velocity.

8. **Mohammad Al-Amri , Kevin Nicholas.** inertial Measurement Units for Clinical Movement Analysis: Reliability and Concurrent Validity. The aim of this study was to investigate the reliability and concurrent validity of a commercially available Xsens MVN. Reliability evaluated using intraclass correlation coefficient and standard error measurement, Validity evaluated using the coefficient of multiple correlation and linear fit method. Day-to-day reliability was generally fair-to-excellent in all three planes for hip, knee, and ankle joint angles in all three tasks. Within-day (between-rater) reliability was fair-to-excellent in all three planes during walking and squatting, and poor-to-high during jumping. Validity was excellent in the sagittal plane for hip, knee, and ankle joint angles in all three tasks and acceptable in frontal and transverse planes in squat and jump activity across joints. Xsens MVN system can be used by a clinician to quantify lower-limb joint angles in clinically relevant movements.

9. **Hung-Wen Chen 1, Hsien-Te Peng.**Analysis of Functional Arch Support Insoles on the Biomechanics and Performance in Right-Forward Lunging Step of Badminton Players. Examine the differences in biomechanical parameters and sports-specific performance of lower limbs between arch support insoles (ASI) and flat insoles (FLI) when performing net strides. motion capture sensor system [MVN Awinda Xsens] used to capture kinematics data from the net stride. The results demonstrated that the peak right hip flexion angle was significantly greater with ASI than FLI, while the peak right foot inversion angle was significantly smaller with ASI than FLI. conclusion was that the arch support insole avoids the decrease in the hip flexion angle and the increase in the foot inversion angle during the net stride tests

Sr. no	AUTHORS (year)	AIM	METHOD	FINDINGS	INSIGHTS
1	Wing-Kai Lam, Duo Wai-Chi Wong Biomechanics of lower limb in badminton lunge: a systematic scoping review 4 November 2020	This review summarized the current trends, research methods, and parameters-of-interest concerning lower extremity biomechanics in badminton lunges.	Systematic scoping review Databases including Web of Science, Cochrane Library, Scopus, and PubMed were searched	Elite badminton players demonstrated higher impact attenuation capability, more aggressive knee and ankle strategy (higher mechanical moment), and higher medial plantar load than amateur players	Playing levels have significant effects on biomechanics in badminton lunges. Future studies can consider to use an unanticipated testing protocol and realistic movement intensity. They can study the inter-limb coordination as well as the contributions and interactions of intrinsic and extrinsic factors to injury risk.
2	Lin Fu, Feng Ren Comparison of Joint Loading in Badminton Lunging between Professional and Amateur Badminton Players 13 June 2017	Aim of this study was to investigate the kinematic motion and kinetic loading differences of the right knee and ankle while performing a maximal right lunge	Kinematic data were collected using an eight-camera Vicon motion capture system at a frequency of 200 Hz	Amateur players exhibited greater ankle range of motion ($p < 0.05$, $r = 0.89$) and inversion joint moment ($p < 0.05$, $r = 0.54$) in the frontal plane as well as greater internal joint rotation moment ($p < 0.05$, $r = 0.28$) in the horizontal plane. In contrast, professional badminton players presented a greater knee joint moment in the sagittal ($p <$	Training schemes and injury prevention strategies for amateur badminton players should account for these findings to reduce potential injury to the ankle and knee.

				0.05, $r = 0.59$) and frontal ($p < 0.05$, $r = 0.37$) planes	
3	Ping Huang, Lin Fu Biomechanical Analysis Methods to Assess Professional Badminton Players' Lunge Performance 6/11/2019	To study the differences in kinematics and joint moment of the right knee and ankle	A motion capture system and force plate were used to capture joint movements of the lower extremity and the vertical ground reaction force (vGRF)	The amateur players showed a greater range of ankle movement and reverse joint moment on the frontal plane, and a larger internal joint rotation moment on the horizontal plane. The professional badminton players exhibited greater knee moment on the sagittal and frontal planes.	Differences in kinematics and joint moment factors should be considered in the development of the training program to reduce the risk of sports injuries in knee and ankle joints.
4	J. Troy Blackburn, Darin A. Padua Influence of trunk flexion on hip and knee joint kinematics during a controlled drop landing 9 October 2007	Aim of the study was to see the effect of trunk flexion on hip and knee kinematics during controlled drop landing.	The Motion Monitor motion capture system was used for model generation/calibration and data acquisition	Peak trunk flexion angle was greater for Flexed compared to Preferred ($P < 0.001$), and was associated with increases in peak hip flexion angle and peak knee flexion angle	Active trunk flexion during landing produces concomitant increases in knee and hip flexion angles. A more flexed/less erect posture during landing is associated with a reduced anterior cruciate ligament injury risk.
5	Chantal Bathe , Lena Fennen Training interventions to reduce the risk of injury to the lower extremity	Aim was to summarise training interventions designed to reduce biomechanical	Systematic review and meta-analysis using Data sources like MEDLINE,	A significantly medium effect of technique training (both instruction and feedback) and dynamic strengthening (ie,	Technique training in form of instruction or feedback, and dynamic strengthening

	<p>joints during landing movements in adult athletes: a systematic review and meta-analysis 2023</p>	<p>risk factors associated with increased risk of lower extremity landing injuries and to evaluate their practical implications in amateur sports</p>	<p>Scopus and SPORTDiscus</p>	<p>plyometrics with/without strengthening) on knee flexion angle</p>	<p>in form of plyometrics, can improve biomechanical risk factors for lower extremity injuries during landing movements in adult amateur athletes.</p>
6	<p>Raana Alikhani, Shahnaz Shahrjerdi. The effect of a six-week plyometric training on dynamic balance and knee proprioception in female badminton players 2019</p>	<p>To investigate the effect of a six-week plyometric training (PT) program on Dynamic balance and knee proprioception in female badminton players</p>	<p>Pre- and post intervention Y balance and photography tests were used to assess Dynamic balance and knee proprioception respectively.</p>	<p>The results of this study demonstrated that a six-week plyometric training program improved dynamic balance and knee proprioception in beginner female badminton players.</p>	<p>Female badminton players' dynamic balance and knee proprioception improved significantly after plyometric training (PT). These results may be important in preventing non-contact anterior cruciate ligament (ACL) injury, which requires further investigation.</p>
7	<p>Miroslav Hrzenjak Nebojsa Trajkovic EFFECTS OF PLYOMETRIC TRAINING ON SELECTED KINEMATIC PARAMETERS</p>	<p>To determine the effects of plyometric training on kinematic parameters in junior female volleyball players.</p>	<p>The recordings of volleyball spike jumps were made with a Panasonic NV-MS1 camera Recorded data downloaded with software</p>	<p>Both the plyometric and the control group showed significant improvement ($p < 0.05$) in joint kinematics from pre- to post-training on most of the measures for</p>	<p>The use of a modified or different plyometric training program could potentially improve player's movement and</p>

	IN FEMALE VOLLEYBALL PLAYERS August 10, 2016		for 2D kinematic analysis.	linear velocity. However, no significant differences were found between initial and final measurement for angular joint velocity	performance, and lower the athlete's risk for injury
8	Mohammad Al-Amri , Kevin Nicholas Inertial Measurement Units for Clinical Movement Analysis: Reliability and Concurrent Validity 28 February 2018	The aim of this study was to investigate the reliability and concurrent validity of a commercially available Xsens MVN	Reliability evaluated using intraclass correlation coefficient and standard error measurement, Validity evaluated using the coefficient of multiple correlation and linear fit method	Day-to-day reliability was generally fair-to-excellent in all three planes for hip, knee, and ankle joint angles in all three tasks. Within-day (between-rater) reliability was fair-to-excellent in all three planes during walking and squatting, and poor-to-high during jumping. Validity was excellent in the sagittal plane for hip, knee, and ankle joint angles in all three tasks and acceptable in frontal and transverse planes in squat and jump activity across joints.	Xsens MVN system can be used by a clinician to quantify lower-limb joint angles in clinically relevant movements.
9	Hung-Wen Chen 1, Hsien-Te Peng Analysis of Functional Arch Support Insoles on the Biomechanics and Performance	Examine the differences in biomechanical parameters and sports-specific performance of lower limbs between arch	motion capture sensor system [MVN Awinda Xsens] used to capture kinematics data from the net stride	The results demonstrated that the peak right hip flexion angle was significantly greater with ASI than FLI, while the peak right foot inversion angle was	conclusion was that the arch support insole avoids the decrease in the hip flexion angle and the increase in the foot inversion

	in Right-Forward Lunging Step of Badminton Players 7 September 2022	support insoles (ASI) and flat insoles (FLI) when performing net strides		significantly smaller with ASI than FLI	angle during the net stride tests
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5 METHODOLOGY

Study Design: Randomized Controlled Trial

Study Population: Recreational Badminton Players

Study Setting: ABSMARI

Sampling Design: Purposive Sampling

Sample size: 26

Study Duration: 1 year

Ethical clearance: 6 months

Sample collection, data collection: 4months

Statistical analysis, results and discussions: 2 months

Sampling Criteria:

Inclusion:

- Recreational badminton players
- Age 18 – 25
- Participants abstained from high-intensity training or competition for two days prior to the experiment
- Participants free from any injuries to the upper and lower limbs in past six months

Exclusion:

- History of any neurological impairment
- Any history of musculoskeletal or traumatic status
- History of serious orthopedic injury with performance-affecting effects
- History of surgical procedures involving lower limb

- **Participants:** Twenty-six recreational badminton players took part in the study and were randomly assigned to two groups, with 13 in the experimental group and 13 in the control group.
- **Ethical Statement:** The research met all applicable standards for ethics and was approved by the ABSMARI ethical committee Bhubaneshwar. IEC Protocol Id-ABS-2025-PHY-045

- **Materials Used**
 - Badminton Racquet
 - Non-Marking Shoes
 - Xsens Awinda (Motion capture System)

6 PROCEDURE

Fig 1 :CONSORT 2010 Flow Diagram

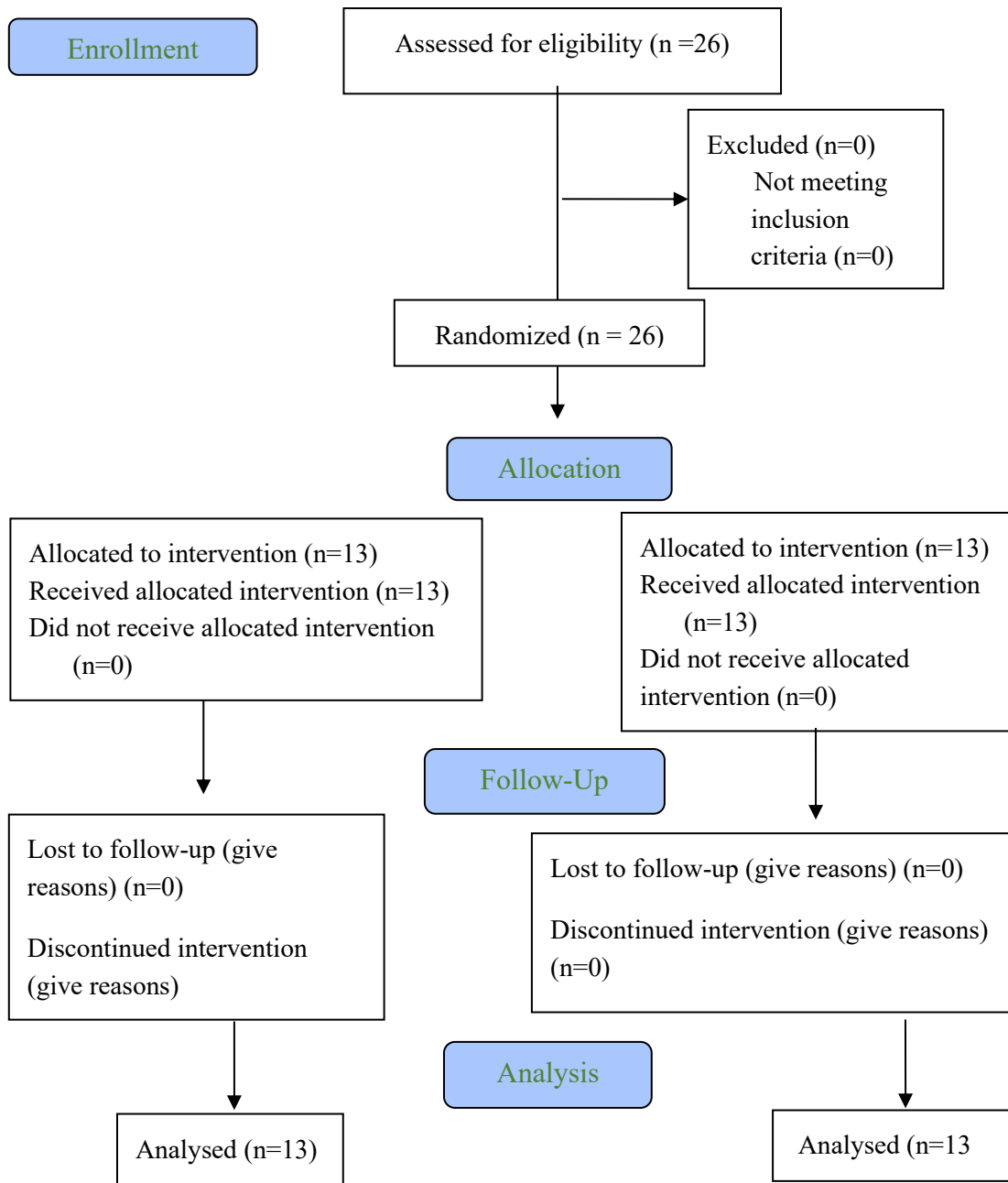


Table No.1Plyometric exercise program protocol

		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Hurdle jumps	Sets x repetitions	2 x 6	3x6	4x6	3x6	3x6	4x6
	Box height	50 cm	50 cm	60 cm	50 cm	60 cm	60 cm
	Intensity	moderate	moderate	high	moderate	high	high
Depth jumps	Sets x repetitions	2x10	3x10	3x10	3x10	3x10	3x10
	Box height	40 cm	50 cm	60 cm	50 cm	60 cm	70 cm
	Intensity	moderate	moderate	high	moderate	high	high
Lateral jumps over box	Number of umps	2x30 sec	3x30 sec	3x60 sec	3x60 sec	3x90 sec	3x90 sec
	Box height	30 cm	30 cm	30 cm	30 cm	30 cm	30 cm
	Intensity	moderate	moderate	high	moderate	high	high
Lunge jumps	Sets x repetitions	2x9	3x10	3x12	3x10	3x11	3x13
	Intensity	moderate	moderate	high	moderate	high	high
Vertical jumps	Sets x repetitions	2x8	3x9	3x11	3x9	3x11	3x12
	Intensity	moderate	moderate	high	moderate	high	high

Before the commencement of the study, approval was secured from the Institutional Ethical Committee.40 participants were screened based on specific inclusion and exclusion criteria. Those who met the eligibility requirements were provided with comprehensive information about the study’s aims, procedures, potential risks, and anticipated benefits. Written informed consent was obtained from all participants, and their baseline demographic data were documented. Afterward, the participants were randomly divided into two groups using the chit method for simple randomization:

Group A- which underwent plyometric exercises.

Group B-which served as the control group.



FIG 1. Lunge Jump



FIG3. Hurdles Jump



FIG3. Lateral box jump



Fig 4 Vertical Jump



FIG 5 Depth Jump

Outcome measures

Knee kinematic parameters

- a) Peak knee flexion angle
- b) Knee abduction adduction angle

Xsense Awinda

- The MVN Awinda is wireless inertial-magnetic motion tracker by Xsens.
- The MVN enables real-time 3D kinematic applications with multiple motion trackers by providing highly accurate orientation.



- a) Awinda
- b) Motion tracker sensor
- c) Awinda Dongle
- d) Body Straps

Test Procedure

After signing the informed consent form, participants were informed about the purpose and procedure of the experiment. Anthropometric measurements were then recorded, and participants performed a general 5-minute warm-up.

Kinematic data were collected using a wireless real-time motion capture system (MVN Awiinda, Xsens, 60 Hz)

Participants stood with their preferred hand holding a badminton racquet and their feet shoulder-width apart. They lunged forward on both the forehand and backhand sides, lowering the thigh until it was parallel to the ground before returning to the starting position. To simulate realistic badminton gameplay, participants bent their trunk forward to approximately 45°.

Each participant performed three repetitions of the forehand lunge and three repetitions of the backhand lunge.

Analysis:-

The raw sensor data from the MVN Awiinda Xsens system were processed using a low-pass Butterworth filter to remove noise and isolate relevant signals. Key parameters were extracted during the forward lunge support phase, which spanned from initial ground contact to foot lift-off. The collected data included the following knee kinematic parameters: Peak knee flexion: the maximum knee joint angle achieved during the support phase. Knee abduction and adduction: the lateral and medial movements of the knee joint. After the baseline data of the participants were recorded, a six-week plyometric training program was implemented. Following the training period, post-test data were collected by replicating the initial measurement protocol. The collected data were then compared and analyzed to evaluate the effects of plyometric training on knee kinematics, focusing on changes in landing moment knee flexion, peak knee flexion, and knee abduction/adduction.



Right Lunge



Left Lunge

7 STASTICAL ANALYSIS

Data Analysis

- Data was entered in Microsoft Excel 2021 and analyzed using IBM SPSS version 27.
- Descriptive Statistics (mean, standard deviation) were used for demographic and outcome measures.
- A p value < 0.05 was considered statistically significant.
- Graphical representation (bar graph, line graph) were prepared using Excel.

Statistical tool used

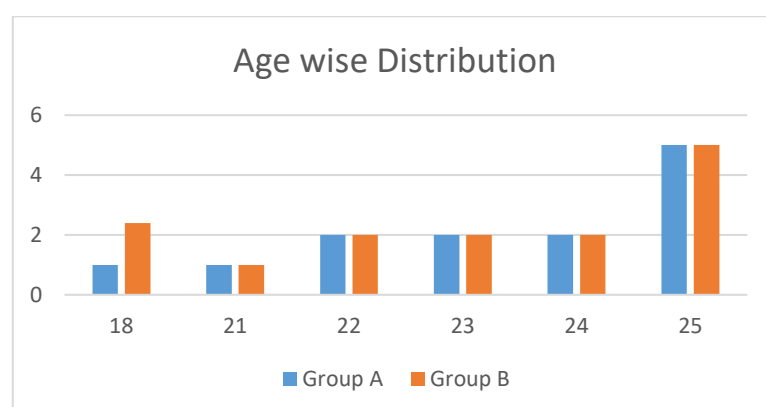
- Microsoft Excel 2021: Data Entry, Chart Creation, Descriptive statistics
- IBM SPSS Version: Paired T test and Inferential Statistics
- Significance level: pvalue<0.05

Observations and Result

Table no. 1 – Age group (in years) wise distribution

Age in years	Group A		Group B	
	No. of patients	Percentage	No. of patients	Percentage
18	1	7.1%	1	7.1%
21	1	7.1%	1	7.1%
22	2	7.1%	2	14.3%
23	2	14.3%	2	14.3%
24	2	14.3%	2	14.3%
25	5	35.7%	5	35.7%
Total	13	100%		100%

Table 2 : Age wise distribution



Graph 1 : Age wise distribution

The age distribution of participants across both groups is presented in Table 1.

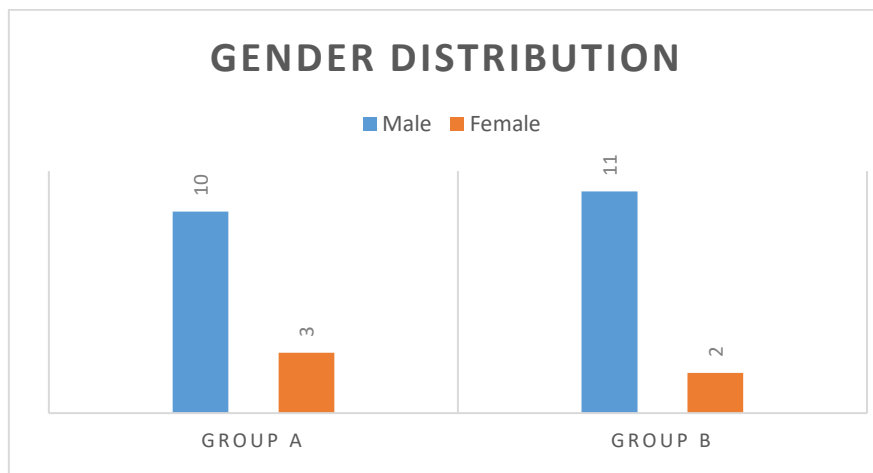
In Group A, the largest proportion of patients (35.7%) belonged to the age of 25 years, followed by 14.3% in the 23 and 24 years group, 7.1% in the 18, 21 and 22 years group.

In Group B, is same as group B with Largest portion belongs to 25 year.

Table no. 2 – Gender wise distribution

Gender	Group A		Group B	
	No. of patients	Percentage	No. of patients	Percentage
Female	3	23.07%	2	15.38%
Male	10	76.03%	11	84.62%
Total	13	100%	13	100%

Table 3: Gender wise distribution



Graph 2 : Gender wise distribution

The gender distribution of participants is shown in **Table 2**.

In Group A, males constituted the majority with 76.03%, while females accounted for 23.07%.

In Group B, males constituted the majority with 84.62%, while females accounted for 15.38

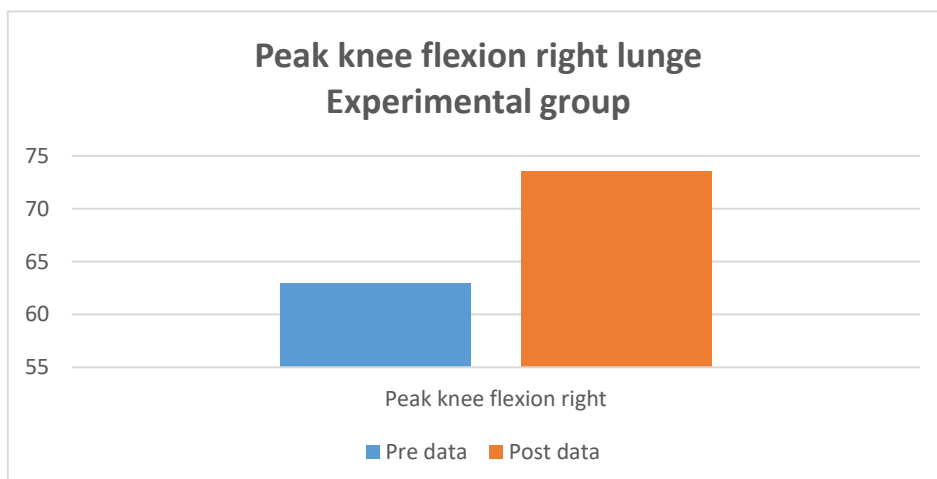
EFFECT OF THERAPY:

A. Effect of Plyometric training group

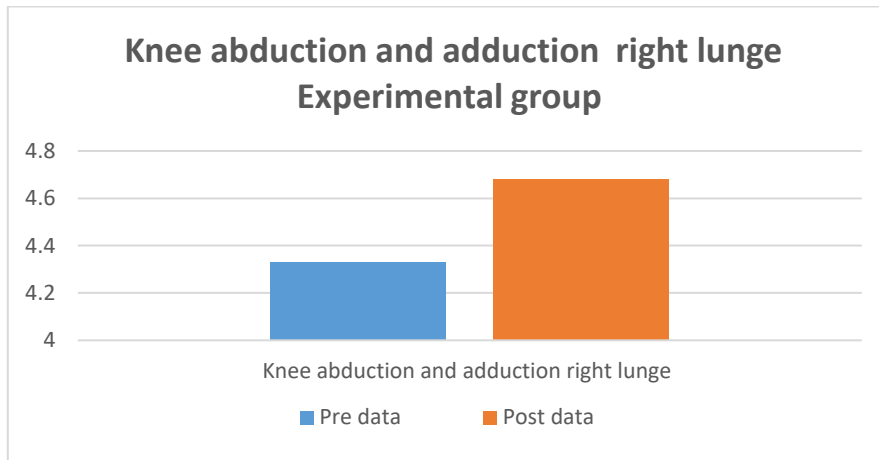
Knee Parameter	PRE	Post data	P VALUE
	Mean±SD	Mean±SD	
Peak knee flexion right lunge	62.92±10.16	73.54±6.95	0.001
Knee abduction and adduction right lunge	4.33±1.57	4.68±1.52	0.023
Peak knee flexion left lunge	58.69±7.25	75.66±7.26	0.04
Knee abduction and adduction left lunge	3.15±1.39	4.85±1.54	0.001

Table 4 : Pre post comparison of knee parameter of experimental group

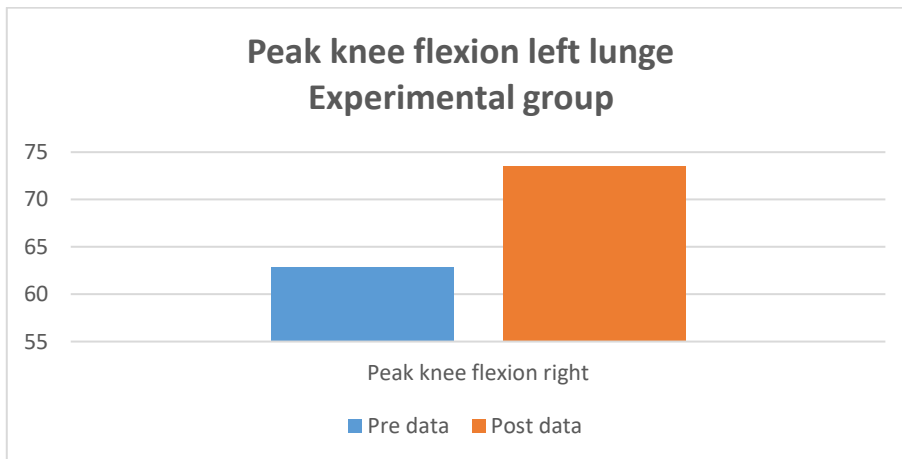
All 13 participants in Group A completed the treatment program. The pre- and post-treatment values were analyzed using Paired T test. Results demonstrated a statistically significant improvement ($p < 0.05$) in **Peak knee flexion right, Knee abduction and adduction right, Peak knee flexion left, Knee abduction and adduction left**. Table 3 shows improvement in Peak knee flexion right, Knee abduction and adduction right, Peak knee flexion left, Knabduction and adduction left.



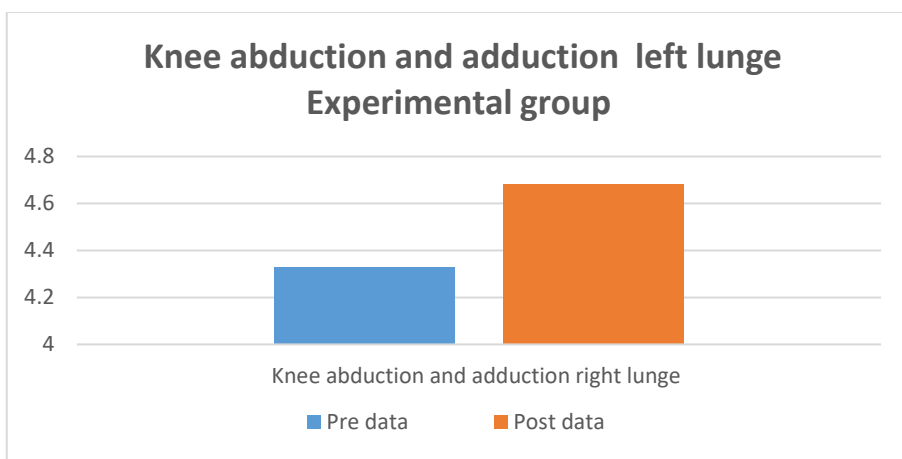
Graph 3: Peak knee flexion right lunge Experimental group



Graph 4: Peak Knee abduction and adduction right lunge Experimental group



Graph 5: Peak knee flexion Left lunge Experimental group



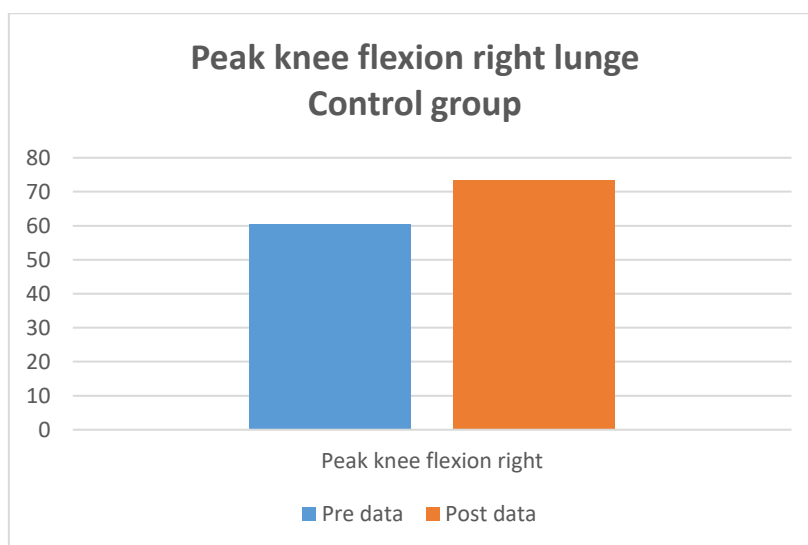
Graph 6: Peak Knee abduction and adduction left lunge Experimental group

B. Control Group

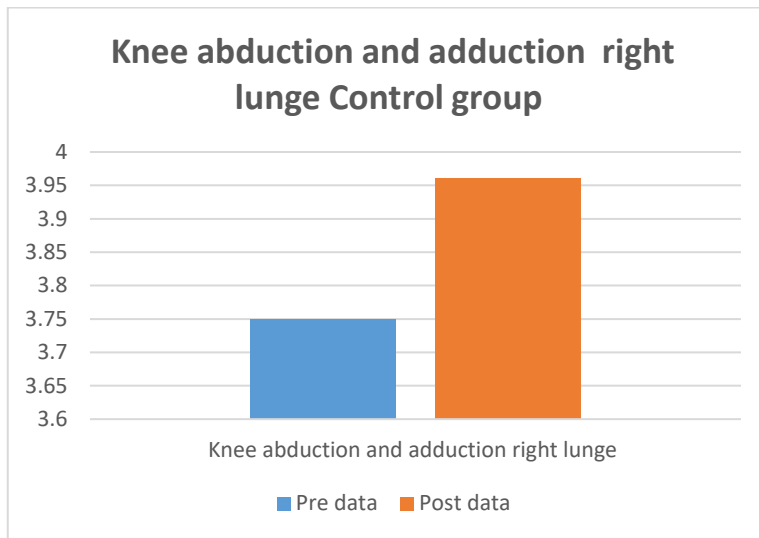
WEEK 3	PRE Mean±SD	Post Mean±SD	P VALUE
Peak knee flexion right lunge	60.31±5.04	61.16±5.07	0.001
Knee abduction and adduction right lunge	3.75±1.44	3.96±1.45	0.035
Peak knee flexion left lunge	57.10±6.80	59.62±6.88	0.001
Knee abduction and adduction left lunge	2.89±1.09	3.36±1.16	0.001

Table 5: Pre post comparison of knee parameter of Control group

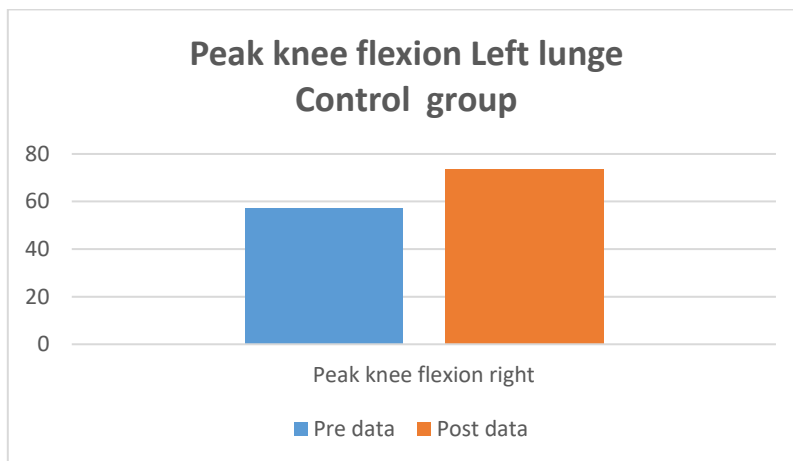
- **There is no significant changes in group B in** Peak knee flexion right lunge, Knee abduction and adduction right lunge, Peak knee flexion left lunge, Knee abduction and adduction left lunge.



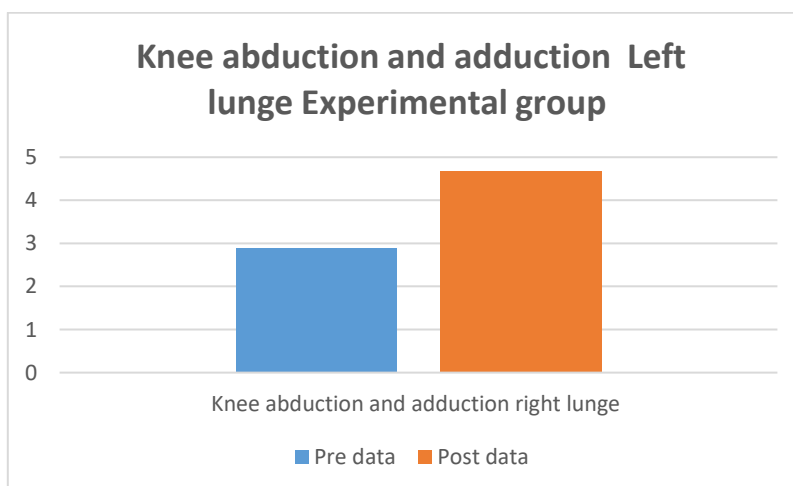
Graph 7: Peak knee flexion right lunge control group



Graph 8: Knee abduction and adduction right lunge Control group



Graph 9: Peak knee flexion left lunge control group



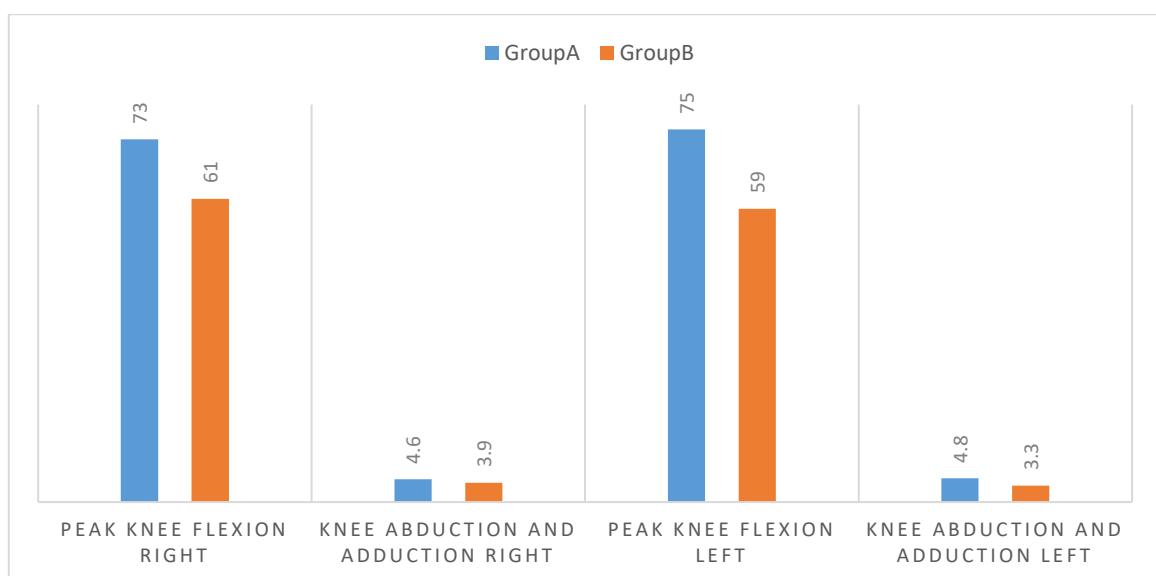
Graph 10: Knee abduction and adduction right lunge Control group

Comparing both the group

WEEK 3	WEEK 3 GROUPA Mean±SD	WEEK3 GROUPB Mean±SD	P VALUE
Peak knee flexion right lunge	73.54±6.95	61.16±5.07	0.001
Knee abduction and adduction right lunge	4.68±1.52	3.96±1.45	0.06
Peak knee flexion left lunge	75.66±7.26	59.62±6.88	0.05
Knee abduction and adduction left lunge	4.85±1.54	3.36±1.16	0.001

Table 6: Between group analysis of control and experimental group.

- There is a significant difference between the values of both the group in 3week but pvalue of knee abduction and adduction and peak knee flexion is more which directly support null hypothesis.



Graph 11: Between group analysis of knee parameter of experimental and control group

8 Results

The plyometric group demonstrated marked improvements in peak knee flexion (right: 62.92° → 73.54°; left: 58.69° → 75.66°) and knee abduction/adduction control. The control group showed minimal changes over the same period. Between-group analysis confirmed that the plyometric group achieved significantly greater improvements in knee kinematics.

9 DISCUSSION

The present randomized controlled trial aimed to investigate the effect of plyometric training on knee kinematic parameters during forward lunges in recreational badminton players, utilizing Xsens Awinda as the outcome measure. The findings demonstrate a statistically significant improvement in knee kinematics—specifically in peak knee flexion and knee abduction/adduction angles—among participants who underwent plyometric training (Group A) compared to the control group (Group B). The most substantial changes were observed in the third week, where the peak knee flexion on the right side improved from $62.92 \pm 10.16^\circ$ at baseline to $73.54 \pm 6.95^\circ$ ($p=0.001$), and the left side improved from $58.69 \pm 7.25^\circ$ to $75.66 \pm 7.26^\circ$ ($p=0.001$). These changes indicate enhanced joint mobility and motor control likely due to the neuromuscular adaptations stimulated by plyometric loading. In contrast, the control group exhibited only minor improvements, with peak knee flexion on the right increasing from $60.31 \pm 5.04^\circ$ to $61.16 \pm 5.07^\circ$, and on the left from $57.10 \pm 6.80^\circ$ to $59.62 \pm 6.88^\circ$, both statistically significant yet clinically negligible. The results of the present study align closely with a growing body of research highlighting the positive effects of plyometric training on knee biomechanics. Similar to our findings, Chimera et al. demonstrated that plyometric exercises significantly enhance lower limb neuromuscular control and stability, especially in dynamic movements.

The gender distribution across both groups indicates a male-dominated sample, with Group A comprising 76.03% males and Group B comprising 84.62% males. This may reflect the general male predominance in recreational badminton participation within the sampled population. Age-wise, the most prevalent age group was 25 years in both groups (35.7%), suggesting a relatively homogeneous cohort in terms of physical maturity and neuromuscular development. This uniformity supports the internal validity of the findings, as inter-subject variability in age-related biomechanical performance was minimized.

The consistent and significant improvements in Group A align with findings from prior research. For example, Chimera reported that plyometric training significantly enhances lower limb neuromuscular control and dynamic knee stability in athletes. Similarly, Myer et al. emphasized the role of plyometric exercises in promoting favorable biomechanical and neuromuscular adaptations, particularly in increasing knee flexion during dynamic movements, thereby reducing the risk of injury. In the present study, increased knee flexion angles suggest better eccentric control during landing phases of the lunge—a movement crucial for injury prevention and performance enhancement in badminton.

Interestingly, while knee abduction and adduction angles also improved significantly in Group A (e.g., left knee abduction increased from $3.15 \pm 1.39^\circ$ to $4.85 \pm 1.54^\circ$ over three weeks), the between-group comparison in week 3 yielded a p-value of 0.06 for the right side, slightly above the conventional significance threshold of 0.05. This suggests that while improvements were evident, the variability among participants may have reduced the statistical power for this specific parameter. Nonetheless, the trend toward greater joint movement capacity and control remains clinically relevant. These findings reinforce the importance of targeted training in enhancing not only sagittal plane motion (flexion/extension) but also frontal plane control (abduction/adduction), which is often underemphasized in athletic conditioning.

Xsens Awinda, as a motion capture system, provided precise and reliable data on joint kinematics. Its high sensitivity allows for nuanced detection of movement changes over a short intervention period. Previous studies, such as those by van den Bogert et al. , have validated Xsens systems for capturing dynamic joint angles during athletic movements, highlighting their applicability in both clinical and sports performance contexts. In this study, its use was instrumental in quantifying the subtle yet important changes induced by the plyometric training program. Arazi et al. and Daneshjoo et al. confirmed that plyometric

training improves lower limb biomechanics across different sports, populations, and performance levels, underscoring the universal benefits of such interventions. A particularly relevant study by Asadi et al. found that when plyometric exercises were combined with balance training in elite badminton players, the improvements in neuromuscular performance and knee stability were even more pronounced. While our study focused solely on plyometric training, the observed improvements in both sagittal (flexion) and frontal (abduction/adduction) plane kinematics suggest that plyometrics alone can significantly enhance joint control, even without supplementary balance training. Our use of Xsens Awinda further strengthens the clinical relevance of these findings, as van den Bogert et al. previously validated the system's accuracy in capturing dynamic joint angles during athletic tasks. Additionally, the trends observed in our study—particularly in the frontal plane where p-values approached significance—echo the findings of Pfile et al. , who noted that subtle biomechanical changes often require either longer intervention durations or more participants to reach statistical power. Taken together, these comparisons suggest that the biomechanical improvements seen in our participants are consistent with a broad base of scientific evidence and further support the use of plyometric training as a practical and effective tool to improve knee kinematics, particularly in recreational athletes involved in dynamic sports like badminton

Comparing the current results with other interventions, plyometric training appears to offer superior improvements in dynamic knee control than traditional strength or static flexibility programs. For instance, a study by Hewett et al. showed that neuromuscular training significantly reduced the risk of knee injuries by improving biomechanical factors like increased knee flexion and reduced valgus moments during landing tasks. The improvements

observed in our study mirror such findings, particularly the increased flexion angles, which contribute to safer and more efficient movement patterns in high-speed sports like badminton.

Moreover, the short-term nature of the intervention (three weeks) and the high statistical significance of the results highlight the efficacy of plyometric training even over brief periods.

More recently, a study by van den Tillaar et al. involving plyometric interventions among male athletes over a 16-week period showed consistent increases in knee flexion angles and improved control during landing—findings that reinforce the effectiveness of this training modality over both short and extended durations. This is particularly relevant in settings where athletes may need rapid conditioning or injury prevention protocols during the competitive season. The control group's minimal improvements reinforce the necessity of dynamic and targeted exercises over general or non-specific training regimens. Implementing plyometric training, even over a short duration, appears to be a potent strategy for improving lower extremity biomechanics in young, recreational athletes engaged in dynamic sports.

10 Conclusion

The study provides strong evidence supporting the incorporation of plyometric training in conditioning programs for recreational badminton players. The intervention led to significant and clinically meaningful improvements in key knee kinematic parameters during a forward lunge—a movement fundamental to badminton. These findings are consistent with prior literature and underscore the role of neuromuscularly demanding exercises in enhancing joint control, movement efficiency, landing mechanics and potentially reducing injury risk. The data generated through Xsens Awinda offers a high degree of reliability and objectivity, making it a valuable tool for sports science research and athlete monitoring.

11 LIMITATIONS AND RECOMMENDATION FOR
FUTURE STUDY

Limitation

The small sample size (n=13 per group) may affect the generalizability of the findings. Larger-scale studies with stratified randomization based on sex and baseline performance could offer more robust insights. The program was limited to three weeks instead of six due to lack of follow-up, yet noticeable gains were still achieved, showing the value of even a short plyometric regimen. Additionally, long-term follow-up was not conducted, and therefore the persistence of kinematic improvements remains unknown. Future research should examine the durability of these changes and whether they translate into reduced injury incidence or improved competitive performance.

Future Scope

Explore the long-term effects of extended plyometric training, as well as the retention of these biomechanical adaptations over time. Incorporating kinetic measurements such as joint moments and ground reaction forces would provide a more comprehensive understanding of how plyometric exercises influence joint loading and injury risk. Including a more diverse sample in terms of gender and age would also enhance the generalizability of the results. Finally, finding the translation of kinematic improvements to on-court performance metrics such as agility, reaction time, and injury rates would help bridge the gap between biomechanics and functional athletic.

12 Summary and Study Funding

Summary

This research explored the influence of plyometric training on knee kinematic parameters during forward lunges in recreational badminton players. A total of 26 players aged 18–25 years were randomly allocated into training and control groups. Baseline and postintervention data were collected using the MVN Awinda Xsens wireless motion capture system. The training group underwent a six-week plyometric exercise program, while the control group maintained routine activities. Results revealed significant improvements in peak knee flexion and knee abduction/adduction angles among the intervention group, whereas negligible changes occurred in the control group. The findings highlight plyometric training as an effective strategy to improve knee stability, performance, and injury prevention in badminton.

STATEMENT OF FUNDING

The author(s) reported no funding associated with the work featured in this dissertation. The author(s) further declare that there are no potential conflicts of interest, financial or otherwise, that could have influenced the outcomes, interpretation, or reporting of this work

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14 ANNEXURES

Informed Consent Form

Study title- The Effect of Plyometric Training on Knee Kinematic Parameters during Forward Lunge in Recreational Badminton Players- A Randomized Controlled Trial

Subject 's Name: _____

Subject 's Initials: _____

Date of Birth / Age: _____

Address of the Subject _____

Qualification _____

Occupation: Student/Self-Employed/ Service/Housewife/Others (Please tick as appropriate)

(Subject)

(i) I confirm that I have read and understood the information sheet dated _____ for the above study and have had the opportunity to ask questions.

(ii) I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

(iii) I understand that, if in case is there any medical emergency while the study is going on there will be medical supervision and team for my help and if any injury occur we will be getting first aid and nearby hospital facility.

(iv) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s)

(v) I agree to take part in the above study.

Signature (or Thumb impression) of the Subject/Legally

Acceptable

Representative:

Date: ____/____/____

Signatory 's Name: _____

Signature of the Investigator: _____

Date:

Study Investigator 's Name: _____

Signature of the Witness: _____

Date: ____/____/____

Name of the Witness: _____

ANNEXURES.2
ASSESSMENT FORM

NAME:

AGE:

GENDER:

DOMINANCE:

OCCUPATION:

ADDRESS:

CONTACT NUMBER:

OUTCOME MEASURE	PRE INTERVENTION SCORE
Peak knee flexion (right lunge)	
Knee abduction and adduction (right lunge)	
Peak knee flexion left (left lunge)	
Knee abduction and adduction (left lunge)	

OUTCOME MEASURE	POST INTERVENTION SCORE
Peak knee flexion (right lunge)	
Knee abduction and adduction (right lunge)	
Peak knee flexion (left lunge)	
Knee abduction and adduction (left lunge)	

ANNEXURES.3 IEC INSTUTIONAL ETHICAL COMMITTEE



ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

CDSOReg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/157

APPROVAL LETTER
APPENDIX- VIII

Date: 09/05/2025

To,

JOSHI PRAJWAL SHRIPAD
ABSMARI
273, PAHAL, BHUBANEWAR-752101

Protocol Title: "The Effect of Plyometric Training on Knee Kinematic Parameters during Forward Lunge in Recreational Badminton Players- A Randomized Control Trials"

Protocol ID.: ABS-IEC-2025-PHY-045

Subject: Approval for the conduct of the above referenced study

Dear Mr./Ms./Dr Joshi Prajwal Shripad

With reference to your Submission letter dated 06/01/2025 the ABSMARI IEC has reviewed and discussed your application for conduct of the study on dated 24/04/2025.

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	24/04/2025
2	Informed Consent Form	24/04/2025
3	Undertaking form PI	24/04/2025
4	CRF	24/04/2025
5	COI from the Investigators	24/04/2025

The following members were present at meeting held on 24-04-2025



1

Utkal Signature, Plot No.-273,
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ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

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The following members were present at meeting held on 24-04-2025

MEMBERS

Dr. Smaraki Mohanty
Clinician

Dr. Satyajit Mohanty
Scientific Member

Mr. Shib Shankar Mohanty
Legal Expert

Ms. Annie Hans
Social Scientist

Ms. Subhashree Samal
Lay Person

Mr. Deepak Ku. Pradhan
Scientific Member

IEC-SECRETARIAT

Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Raychudamani



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**Utkal Signature, Plot No.-273,
Ground Floor, Pahal, Bhubaneswar-752101**

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Right Lunge Group	AGE	Gender	Peak knee flexion		Knee abduction/Adduction	
			Pre test	Post test	Pre test	Post test
A	24	Male	83.45	89.7	6.55	6.90
A	25	Male	62.73	68.58	4.74	5.34
A	20	Male	66.94	73.62	3.82	4.95
A	22	Male	59.92	76.75	4.53	5.52
A	25	Female	64.25	72.5	2.78	5.06
A	24	Female	61.2	73.76	5.43	6.42
A	23	Male	73.51	78.03	3.42	4.79
A	24	Male	52.52	63.82	7.97	8.75
A	18	Male	59.92	72.14	3.20	4.35
A	25	Male	73.94	79.2	2.31	3.66
A	19	Male	52.78	63.80	4.03	5.83
A	25	Male	44.6	67.9	4.42	5.48
A	25	Female	62.2	76.34	3.15	4.56

Left Lunge Group	AGE	Gender	Peak knee flexion		Knee abduction/Adduction	
			Pre test	Post test	Pre test	Post test
A	24	Male	52.83	75.86	2.02	4.35
A	25	Male	57.78	80.67	4.36	5.27
A	20	Male	56.47	78.86	1.08	3.15
A	22	Male	55.8	78.46	4.309	5.92
A	25	Female	59.23	75.53	4.91	7.33
A	24	Female	57.32	74.56	2.32	3.45

A	23	Male	62.46	75.04	1.51	3.66
A	24	Male	63.45	69.79	5.07	6.00
A	18	Male	46.54	59.64	2.77	3.86
A	25	Male	77.82	92.14	2.03	3.25
A	19	Male	55.73	73.75	4.52	7.79
A	25	Male	55.51	71.44	3.92	5.21
A	25	Female	62.1	77.91	2.165	3.91

Right Lunge Group	Age	Gender	Peak knee flexion		Knee abduction/Adduction	
			Pre test	Post test	Pre test	Post test
B	25	Male	55.64	56.20	4.26	4.49
B	23	Male	67.72	68.60	4.39	4.45
B	21	Male	59.98	61.09	5.06	5.21
B	25	Male	62.95	63.25	3.77	3.95
B	24	Male	55.22	55.98	4.02	4.32
B	22	Male	53.29	53.50	4.392	4.60
B	23	Male	65.81	66.59	2.08	2.27
B	25	Female	58.81	61.01	5.59	5.86
B	22	Male	65.3	66.20	2.30	2.50
B	25	Male	60.18	61.30	2.79	3.05
B	18	Male	67.07	67.80	6.28	6.56
B	25	Male	54.96	55.85	2.08	2.21
B	24	Female	57.18	57.77	1.82	2.04

Left Lunge Group	Age	Gender	Peak knee flexion		Knee abduction/Adduction	
			Pre test	Post test	Pre test	Post test
B	25	Male	56.47	61.40	3.45	4.67
B	23	Male	53.07	56.67	3.57	4.25
B	21	Male	59.27	64.05	2.78	3.70
B	25	Male	56.68	62.67	2.53	2.60
B	24	Male	62.18	64.00	2.54	3.05
B	22	Male	49.81	51.50	3.98	4.12
B	23	Male	55.74	55.90	1.31	1.86
B	25	Female	48.6	50.74	4.63	5.15
B	22	Male	56.22	57.20	1.06	1.50
B	25	Male	57.7	59.23	3.26	3.50
B	18	Male	76.11	77.50	4.01	4.50
B	25	Male	52.9	54.70	1.86	2.00
B	24	Female	57.67	59.56	2.60	2.86



Xsens MVN Quick Setup

Please read these instructions before using your Xsens MVN System for the first time. This Quick Setup Guide contains a summary on how to get started with the Xsens MVN System; detailed information can be found in the MVN User Manual: documentation.xsens.com/MVN_User_Manual.

Step 1: Software Setup
Note: Do not connect your MVN System (either Access Point or Awinda Station) until software installation is complete (software installation includes installation of relevant drivers which will be finalized when the hardware is connected).

Download the latest version of MVN Analyze or MVN Animate from www.xsens.com/software/mvn-animate/#download.

MVN Analyze/Animate is a 64-bit application for Windows 10. The installation includes MVN Analyze/Animate and drivers for the Xsens hardware.

- Follow on-screen instructions.
- Select the Destination Folder (Default: C:\Program Files\Xsens\MVN #).
- Now the Access Point or Awinda Station is ready for use.

Step 2: Hardware Setup (MVN Link)

- Connect the Access Point to the computer using the network cable (optionally with the Ethernet-to-USB adapter).

With the MVN Link System, the suit or straps are shipped with most motion trackers installed. Put on the suit or straps, connect the head, hands and feet trackers, and place the Body Pack on the right and the Battery on the left of the back.

- Connect the two tracker cables to the Body Pack.
- Press the button on the Body Pack once to power on the device, a pulsing fading LED, solid LED, beep and finally blinking LED indicate the startup process.

Step 2b: Hardware setup (MVN Awinda)

- Connect the Awinda Station to the PC. When hardware has been connected to the PC, a message will appear that new hardware is found and drivers are being installed.
- Power on all the trackers by pressing each button.
- Put on the straps, place the trackers into the correct locations, as shown on the front page. The label on the side of the tracker indicates the position on the body.

Step 3: MVN Analyze/Animate

- Run MVN Analyze/Animate.
- Create a new session (File > New Recording Session). For first time use simply accept the default settings.

Wait until the hardware is found, indicated by the green icons on the body segments.

- Once the status is green, insert body dimensions and click OK to continue.

Note: A detailed view of the Hardware Status can be seen by clicking on the tool icon (top right corner), the Hardware Status will be opened on the right. When the configure session dialog is closed a 3D character appears in the 3D view indicating that a connection has been made.

- In the Setup pane on the left, perform an 'N-pose + Walk' calibration by following the on-screen instructions. It is now possible to make a recording.



Access point



Body Pack



Battery



Awinda Station

xsens www.xsens.com

Xsens MVN Quick Setup

Configure Session - New Session


Self Configuration: Full Body | Camera: Single, Local

Accept System: Any


Body Dimension	Image	Sync	Value
Body Height			170.5 cm
Shoe or Foot Length			24.7 cm
Arm Span			179.6 cm
Ankle Height			71.8 cm
Hip Height			87.2 cm
Hip Width			24.0 cm
Knee Height			146.5 cm
Shoulder Width			38.8 cm
Shoulder Height			143.4 cm

Reset Load Save

Browser | Walk | [Help](#) | OK



More documentation about MVN plug-ins can be found here: documentation.xsens.com/mvn/#



Checkout the video tutorials online: tutorials.xsens.com/mvn

www.xsens.com **xsens**

Prajwal Joshi

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Prajwal Joshi

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